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Investigating the Antecedents to Instructors' Self-Efficacy for Teaching: Implications for Pedagogical Reform

Matthew T. Hora and Joseph Ferrare

Self-efficacy refers to an individual's self-appraisal about his or her ability to perform a particular task in a specific context based on reflection of past performance or consideration of feedback. High self-efficacy beliefs have been linked not only to superior task performance across multiple domains, but also to important outcomes in education settings. For example, teachers' beliefs about their teaching capabilities predicted student achievement in language and mathematics (Ashton & Webb, 1986). Self-efficacy is also related to persistence in the face of adversity, which is an important characteristic in light of current policy initiatives that encourage instructors[1] to adopt new research-based teaching methods, which invariably involve a degree of risk and investment of energy to acquire new skills (Tschannen-Moran, Hoy, & Hoy, 1998). However, self-efficacy beliefs do not develop in a vacuum, but instead are developed through the subtle interactions among the environment, performance, and individual characteristics (Bandura, 1995).

If self-efficacy beliefs are cultivated in complex environments, then the question arises: What are the sources of self-efficacy beliefs? Decades of research suggest that self-efficacy beliefs are formed through personal mastery, verbal encouragement, vicarious experiences (e.g., comparisons with peers), and physiological states that convey information about capabilities (Bandura, 1997). Yet relatively little empirical work has been conducted at the postsecondary level on instructors' self-efficacy beliefs in general and on these beliefs for teaching in particular. Identifying the current status of instructors' self-efficacy beliefs and the factors that shape them would provide important insights into the psychological and contextual underpinnings of teaching practice. Thus, in this paper we examine the antecedents of self-efficacy for instruction as a first step in explicating the role of self-efficacy beliefs in teaching practice. In doing so, we employ a mixed-methods approach that uses both formal modeling of questionnaire data, as well as inductive analysis of data collected through interviews. Using this approach, we examine the following questions:

(a) What is the degree of self-efficacy among math and science instructors for teaching undergraduates?

(b) What are the primary antecedents to instructors' self-efficacy beliefs and to what degree do they influence these beliefs?

Answers to these questions will shed light on the relationship between individuals' self-efficacy beliefs and organizational contexts, and will fill in to gaps in the research literature,

[1] By *instructors* we mean all people who are primary instructors for undergraduate instructors (excluding teaching assistants) – whether full- or part-time, tenured or untenured – in postsecondary institutions.

while also providing actionable insights for those engaged in instructor development and pedagogical reform initiatives at the postsecondary level.

Background & Theoretical Framework

Research on classroom practice in K–12 schools has long focused on the psychological underpinnings of teaching, especially in the 1980s when the cognitive revolution led many scholars to view teaching as a complex act that should account for individuals' intentions and mental activities (see Shavelson & Stern, 1981). Increasingly, higher education researchers are taking a similarly cognitive approach to studying teaching practices by investigating the role of mental representations such as approaches to teaching that are either student- or teacher-centered, or conceptions of teaching and learning (see Hativa & Goodyear, 2001). However, while this research has contributed to our understanding of the psychological underpinnings of teaching, this line of inquiry has been critiqued for taking an overly global approach to the mental activities of instructors (Postareff & Lindblom-Ylanne, 2008). In particular, singular, over-arching constructs such as "conceptions of teaching" fail to account for the fact that complex tasks such as teaching typically activate distinct and multifaceted cognitive constructs depending on the situation (Bandura, 1995). This suggests the need to parse out with more nuance and precision the specific mental representations that influence teaching behaviors. In this vein, James Bess (1996) argued that motivational theories from organizational behavior should be applied to the study of work in institutions of higher education (IHEs) in general and on motivation to improve pedagogical practice in particular. This is because motivation determines commitment, performance, and perseverance in professional work. A core idea of motivational theory is that both intrinsic and extrinsic factors influence the amount of energy and skill that individuals will direct towards particular tasks.

Self-Efficacy Theory

One particularly influential intrinsic factor refers to beliefs about "one's capabilities to organize and execute the courses of action required to manage prospective situations," or what is known as self-efficacy (Bandura, 1995, p.2). Self-efficacy theory is based on a view of self-regulation where people make decisions and act based on their own self-imposed standards and expectations rather than others' desires or directives. In cognitive terms, the process of thought and behavior is regulated by the "self-system" that allows individuals to exercise some control over their actions. The emphasis on self-regulation is a reaction to the strict information-processing model of early cognitive science that conceptualized the mind as a computational device that manipulated abstract symbols (Newell & Simon, 1972). In contrast, a focus on self-regulation emphasizes how individuals perceive and encode features of their physical and social environments and how this information is then "heavily mediated through self-processes" (Bandura, 1993, p.118). Thus, the self-system is described by Pajares (1996, p.1) as being comprised of "one's cognitive and affective structures and includes the ability to symbolize, learn from others, plan alternative strategies, regulate one's own behavior, and engage in self-reflection."

The self-system develops over time through experience and reflection, and research suggests that self-efficacy beliefs in particular are developed through four primary sources (Bandura, 1997). Enactive mastery experiences refer to successful completion of a task and are the most influential source of self-efficacy beliefs because they provide firsthand, authentic evidence about one's capabilities. Vicarious experiences refer to observations about others' task performance, which can enhance personal self-efficacy if a successful action is observed. Verbal persuasion refers to active encouragement or discouragement from others about one's capabilities. Finally, physiological factors such as stress reactions to a situation (e.g., sweating, shaking) can influence an individual's self-efficacy and/or be minimized to a greater or lesser degree depending on one's self-efficacy beliefs (e.g., someone with high self-efficacy may ignore the sweating and shaking response). While these sources of self-efficacy are critically important to the formation and development of the self-system, on their own they are not meaningful. As Bandura (1997, p.79) says, information that can inform the assessment of self-efficacy is "constructive only through cognitive processing of efficacy information and through reflective thought."

Self-efficacy beliefs then play a considerable role in shaping how people think, motivate themselves, and ultimately act. People with high self-efficacy beliefs will visualize successful scenarios when planning courses of action, increase the difficulty and specificity of task-related goals, and decrease the amount of stress experienced in challenging situations (Bandura, 1993). In a meta-analysis of the effect of self-efficacy on successful task performance, Stajkovic and Luthans (1998) found a 0.38 weighted average correlation across 114 studies involving 21,616 subjects and a 72% probability that people with high self-efficacy would have better performance than those with low self-efficacy. Self-efficacy beliefs also can shape individuals' choices of activities and environments, causing them to avoid situations that are perceived to exceed their capabilities and engaging in tasks that they consider feasible. Thus, prior to selecting a course of action and determining the level of effort to commit to a task, an individual may reflect on his or her own capabilities for successfully completing a task. An important distinction here is between general self-efficacy (GSE), which refers to capability beliefs regarding a wide variety of tasks, and task-specific self-efficacy (SSE), which refers to efficacy beliefs for a specific task or domain (Stajkovic & Luthans, 2003). Finally, another critical feature of self-efficacy theory is that it is not solely an "in the head" construct that only exists in an individual's mind, but operates in a reciprocal fashion with other personal factors (e.g., demographics), features of the environment, and performance itself. Bandura's theory of triadic reciprocal causation is based on the notion that individuals are both "products and producers of their motivation, their respective environments, and their behaviors" (Stajkovic & Luthans, 2003, p.126).

Self-Efficacy Research in Education Settings

Interest in the role of self-efficacy in education settings is largely based on its demonstrated link to student achievement and teacher behaviors (see Pajares, 1996; Tschannen-Moran et al., 1998). For example, Gibson and Dembo (1984) found that high teacher self-

efficacy is associated with strong, group-oriented instruction with supportive behaviors, whereas low self-efficacy is associated with more one-on-one instruction, being flustered when routines are disrupted, and critiquing students when incorrect. Ashton and Webb (1986) found that while controlling for students' prior abilities, teachers' self-efficacy predicted student achievement in math and language, and that teachers with high self-efficacy were more willing to build relationships with students and perceive low achievers as teachable and deserving of teachers' attention. Similarly, Woolfolk and Hoy (1990) found that teachers' self-efficacy affects their general orientation to teaching and their specific pedagogical approaches. Of particular relevance to pedagogical improvement efforts, self-efficacy is related to the use of new practices that may be challenging for teachers to learn and master. Teachers with high self-efficacy beliefs are more likely to take on new tasks and challenges and persist in the face of challenging situations including failed lessons (Gibson & Dembo, 1984; Tschannen-Moran et al., 1998). This is because:

> Self-efficacy beliefs help determine how much effort people will spend on an activity, how long they will persevere when confronted with obstacles, and how resilient they will prove in the face of adverse situations. The higher the sense of efficacy, the greater the effort, persistence and resiliency (Parajes, 1996, p.544).

This attribute of self-efficacy is particularly salient to considerations of pedagogical reform and institutional change, which invariable place stress on teachers and administrators and may involve taking risks in adopting and then utilizing new teaching techniques. Based on the growing evidence demonstrating self-efficacy's role in education practice, Tschannen-Moran and Hoy (2007, p.954) call self-efficacy a "little idea with a big impact."

In contrast to research in K–12 contexts, less research has been conducted on self-efficacy beliefs in postsecondary settings, though researchers recognize the potential value of the construct to better understand both instructor and student motivation (e.g., Morris, 2004). Some scholars have examined research self-efficacy for conducting research, finding that factors such as sex, age, and the presence of a rewarding workplace environment influence the strength of self-efficacy beliefs (Landino & Owen, 1988). Bailey (1999) found that individuals with higher academic rank and research qualifications exhibited stronger self-efficacy beliefs related to research, whereas those with low success in research had stronger self-efficacy beliefs for teaching. Research on a faculty self-concept, which is more focused on self-knowledge that people hold about themselves, demonstrates that instructors' self-concepts for teaching are strongly influenced by student feedback (Roche & Marsh, 2002). In research on graduate teaching assistants, Prieto and Altmaier (1994) found that previous teaching experience was significantly related to instructor self-efficacy. Of particular salience to current efforts regarding pedagogical reform in IHEs, research suggests that self-efficacy is linked to the use of research-based pedagogical techniques, which generally require instructors to expend effort to learn and master new teaching methods. Colbeck, Cabrera, and Marine (2002) found correlations between self-efficacy and the use of alternative teaching methods (e.g., group/design projects) in

engineering courses, and Tollerud (1990) found that doctoral students with high self-efficacy expressed confidence using research-based teaching methods.

In recognition of the recursive interactions among self-efficacy, performance, and environmental factors, education researchers have examined the effects of various contextual factors on self-efficacy beliefs including feedback on performance, leadership support, and pedagogical training. For example, Tschannen-Moran and Hoy (2007) suggest that the feedback K–12 teachers receive from parents or performance reviews are significantly related to their self-efficacy beliefs and play an important role in providing information to teachers regarding their performance, as well as whether or not they should seek to improve or change their practice. One of the most common sources of feedback in higher education is end-of-semester student ratings, and evidence suggests that instructors use this information to evaluate their performance relative to their peers. Then, on this basis, instructors form self-efficacy beliefs regarding their teaching abilities (Roche & Marsh, 2002). Similarly, DeChenne (2010) found that feedback for graduate teaching assistants is critical, especially from peers and immediate supervisors, and that teaching experience explained 23% of the variance in her participants' self-efficacy beliefs.

Another environmental factor related to teacher self-efficacy is organizational atmosphere and organizational leadership. Hoy and Woolfolk (1993) found that a strong organizational emphasis on student learning was related to high teacher self-efficacy beliefs, and Tschnnen-Moran and Hoy (2007) discovered that the support of peers and the community-at-large was related to strong self-efficacy beliefs. These findings point to the important role of school leaders and teaching staff in shaping a supportive and positive environment for teaching—a phenomenon being increasingly explored through research on collective self-efficacy, or the perceived ability of an entire organization to enhance performance (Goddard, Hoy, & Hoy, 2000). Finally, another potential influence on self-efficacy beliefs is pedagogical training and its subsequent influence on the degree to which instructors develop a reflective approach to their practice (Schon, 1983). Prieto and Altmaier (1994) found that self-efficacy correlated with high levels of prior training and previous experience, and Tollerud (1990) found that as pedagogical coursework increased, so too did self-efficacy. Tollerud's (1990) finding suggests that studying pedagogy increases self-reflection which leads to increased efficacy beliefs. Similarly, Postareff, Lindblom-Ylanne, and Nevgi (2007) found that participation in professional development increased instructors' self-efficacy beliefs, largely because the training required faculty to reflect on their practice and assess their capabilities. In this way, reflection may play an important role in mediating the relationship between the environment (e.g., training programs, performance feedback) and the development of self-efficacy beliefs.

The study reported in this paper extends these promising lines of inquiry in three ways. First, no empirical research has been conducted examining SSE beliefs for teaching, particularly among math and science instructors. Second, research on antecedents to instructors' self-efficacy has typically focused on singular, isolated factors instead of attempting to capture a multiplicity of factors and their potential interactions. Given that the literature suggests that instructors' self-efficacy beliefs are strongly shaped by performance feedback, self-reflection, academic rank, and

professional development, there is a need to examine precisely if and how these and other factors interact with one another and with self-efficacy beliefs.

Methods

For this paper we analyzed survey and interview data from the first wave of data collection (spring, 2010) from a larger mixed-methods longitudinal study designed to examine the cognitive, cultural, and contextual factors related to teaching, and how dynamics among these elements influence pedagogical reforms. This study is based on a comparative case-study design in which the primary object is to describe the nuances of instructional decision making and teaching practice at three research sites. For this particular analysis we use a concurrent mixed-methods design where different types of data are collected simultaneously, and the results are integrated at the interpretation and reporting stage (Tashakkori & Teddlie, 2002). Importantly, our mixed-methods approach is not simply found within the types of data collected, but is apparent in the analytic approaches taken to investigate self-efficacy and its antecedents. That is, we adopted both a deductive and inductive approach to the problem, which entailed analyzing survey data using formal statistical techniques to test a model of self-efficacy, as well as interpreting interview data using a structured approach to grounded theory to generate new insights into these complex phenomena.

The sample for the survey component was drawn from the entire population of instructors in mathematics, biology, geological sciences, chemistry, and physics departments at three large, research-oriented, public universities in the U.S. For the survey, the sampling frame included 977 individuals that represented all instructors in each department, including tenure-track and non-tenure track lecturers and instructors. At the end of the month-long period of fielding the survey, a final response rate of 45% resulted in the final study sample for Wave 1 of the study (n=436). The sampling frame for the interviews included all those individuals who were teaching undergraduate courses in the spring of 2010, and 334 individuals were contacted up to two times by e-mail. A total of 137 instructors responded, and those whose schedule allowed for participation in the study, and who ultimately agreed to participate in the study, were scheduled for an interview (n=56). Detailed information about the sample is included in Table 1, next page.

Table 1
Description of Sample

	Survey n	Interview n
Total	436	56
Sex		
Female	119	22
Male	309	34
Missing cases	8	N/A
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
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

Data Collection and Measures

Data were collected in two distinct 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. The survey instrument was developed especially for this study, using both new and previously developed items and scales. For this analysis, the salient items include those for a latent construct of self-efficacy and pedagogical reflection (see Table 2, below), along with observed variables indicating frequency of feedback from student evaluations, informal feedback from students, participation in course-based teaching reforms, and tenure rank. To measure self-

efficacy we drew on the previously validated Teacher Sense of Efficacy Scale (TSES) instrument developed by Tschannen-Moran and Hoy (2001). In order to focus on measures specific to interactive teaching, we selected a subscale for efficacy beliefs related to selecting appropriate instructional strategies (4 items[2]). The items ask teachers to rate their abilities in this area using a 5-point Likert-style scale. To measure pedagogical reflection we drew on a newly developed survey by Larrivee (2008). We selected three items from the pedagogical reflection scale measuring frequency of reflective practices in order to derive a latent measure of "pedagogical reflection." The observed feedback items elicit the frequency with which respondents received feedback in the form of student evaluations and informal student feedback using a 5-point Likert-style scale. Our measure of participation in a teaching-based reform consists of an ordered categorical variable indicating the frequency with which respondents had participated in course-based professional development activities. Finally, we utilize a dichotomous measure of tenure rank indicating whether or not respondents hold a tenure track position.

Table 2
Descriptive Statistics for Endogenous and Exogenous Latent Variables

Latent and indicator variables	Mean	SD
Self Efficacy for Instruction (Alpha=0.688)		
q12e. To vary your teaching methods according to the needs of your students	3.51	0.828
q12f. To vary your assessment methods according to the needs of your students	2.84	0.966
Pedagogical Reflection (Alpha=0.726)		
q19a. You analyze the relationship between teaching practices and student learning	3.27	0.952
q19b. You elicit constructive criticism about your teaching	3.44	0.867
q19c. You experiment with new teaching methods out of curiosity about the effectiveness of different approaches	3.06	0.955

Interviews. For the interviews, the analysts used a semi-structured protocol containing 17 questions, with the primary question of interest for this analysis being: "How effective do you think you are as an instructor?" Responses to this question were followed up with the following probe: "How do you know?" Respondents provided answers of varied detail and length, and analysts encouraged elaborations related to the original question—an interviewing technique based on the ethnographic interview method of Spradley (1979). Each interview ranged between 30 and 45 minutes and took place in the respondent's office or in a nearby room.

Data Analysis

Statistical Analysis of Survey Data. Using the survey items described above, we specify and estimate a partially latent structural equation model. Structural equation modeling (SEM) is

[2] For the SEM analysis two of the items were removed because upon validating the scale we found that these two items did not load onto the factor. In addition, in order to construct a parsimonious model we elected to not use another scale from the TSES that was collected in our study – that of self-efficacy related to engaging students.

an extension of the general linear model (GLM) that enables researchers to account for, among other things, measurement error, direct and indirect effects, and latent independent and (multiple) dependent variables. This model is particularly suited to the present analysis, as it enables us to identify interactions between antecedent factors as well as between these factors and self-efficacy beliefs, which is consistent with the reciprocal relations among self-efficacy, environmental, and individual factors (Bandura, 1997). The specification of the model is informed by previous findings in the literature on antecedents related to self-efficacy. In particular, we test the effect of formal and informal instructional feedback on self-efficacy, both directly and indirectly as mediated through the latent construct *pedagogical reflection*. We also test for indirect and direct effects of participation in a reform and tenure track status.

To estimate the model we use maximum likelihood (ML), which is the default estimation procedure in AMOS 19[3]. However, since the latent endogenous and latent exogenous variables use 5-point ordinal-level scales, maximum likelihood may not be appropriate (Kaplan, 2009; Klein, 2011). Given the potential that ML may not recover the parameters of the model with ordinal data, we also estimated the results using the Bayesian estimation procedure available in AMOS. This procedure uses the Markov chain Monte Carlo (MCMC) algorithm to draw random samples based on the joint posterior distribution. In addition, we compared results from metric and ordinal multidimensional scaling of the latent indicator variables, and we found the results to be nearly identical. Given these results, we felt it was appropriate to proceed with the ML estimation for this particular analysis.

One of the observed exogenous variables—our measure of feedback via student evaluations—was severely negatively skewed. In an attempt to address this issue, we used the *square-root* data transformation technique (Osborne, 2002). This process begins by reflecting the distribution (due to the negative skew) and then adding a constant to bring it to 1.0. Next, we take the square root of each value and reflect the distribution yet again to attain the original order. To handle missing data, we used the direct approach based on ML estimation made available in AMOS 19. Based on the more common listwise deletion procedure, our sample size would have been reduced from n=436 to n=414, which constitutes a modest five percent reduction. However, with the direct approach based on ML we retain all cases for our analysis. Given the likelihood that the missing values are not missing completely at random, the ML approach will produce the least amount of bias. The primary difference in using ML estimation with incomplete data is in allowing for the estimation of means and intercepts, in which the latent factor means and error terms are constrained to zero. The addition of the intercepts thus results in a greater number of parameters to be estimated.[4]

Finally, in evaluating model fit for the measurement model and full structural equation model, we report a variety of model fit and approximate fit indexes: the model chi-square test

[3] SPSS AMOS structural equation modeling software, version 19.

[4] For a more thorough explanation of how AMOS estimates models with missing data, see Byrne, 2010.

statistic, root mean square error of approximation (RMSEA), comparative fit index (CFI), and normed fit index (NFI). The RMSEA is a badness-of-fit index in which a value of zero suggests the best fit, and Brown and Cudeck (1993) suggest that a RMSEA at or below 0.05 may be a good fit. The NFI and the CFI range from zero to 1.00, with the value indicating the extent to which the hypothesized model is an improvement over the independence (i.e. null) model. Hu and Bentler (1999) suggest that a CFI value at or greater than 0.95 indicates a well-fitting model.

Thematic analysis of interview data. All interviews were transcribed and entered into NVivo® qualitative software and coded using a coding scheme developed by the research team. The coding scheme consisted of both topics determined a priori by the requirements of the study and related theoretical concerns (e.g., self-efficacy), as well as topics that emerged from a preliminary review of the data (Charmaz, 2006). All of the interviews were coded using this scheme, which allowed for an analysis of the frequency with which each salient code category was mentioned by each respondent (e.g., sources of self-efficacy). Whether or not a respondent discussed each code category was recorded in a spreadsheet, and detailed notes about the nature of their utterance was recorded in a separate document. An utterance coded as "unclear self-efficacy" contained negative declarative statements regarding efficacy such as "I don't know how effective I am," or non-answers in which the respondent did not directly answer the question. An utterance coded as "positive self-efficacy" contained positive declarative statements such as "I am a very effective teacher." An utterance coded as "negative self-efficacy" contained declarative statements such as "I am not an effective teacher." Finally, relationships between codes were analyzed to identify patterns between utterances related to self-efficacy and other factors (Ryan & Bernard, 2003). This analysis entailed coding instances where respondents directly associated their self-efficacy beliefs with another factor (e.g., organizational policy, student feedback, etc.). These data were recorded in a spreadsheet and then graphically depicted using causal network analysis, which is a technique designed to visualize relationships among different topics (Miles & Huberman, 1994).

Results

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

Degree of Instructor Self-Efficacy Beliefs: Interview Results

Thematic analysis of interview data indicate that 33 instructors reported unclear self-efficacy, 22 reported positive self-efficacy, and one reported negative self-efficacy (see Table 3). Examples of responses coded as positive self-efficacy include "Oh wow, I am pretty effective," and the single response coded as negative self-efficacy was "I don't think that I'm a very good teacher in this type of setting [large undergraduate class]." Examples of responses coded as unclear self-efficacy include "I honestly don't know" and "Oh, that's tough to say," with no clear explication or elaboration offered. Given previous research suggesting that level of experience may influence self-efficacy beliefs (Landino & Owen, 1988), we then examined these results by position type. Equal numbers of lecturers/instructors and associate professors reported positive

and unclear self-efficacy beliefs, while both assistant and full professors reported more unclear self-efficacy beliefs than positive beliefs.

Table 3
Degree of Instructor Self-Efficacy Based on Interview Data (n=56)

	Positive Self-Efficacy	Negative Self-Efficacy	Unclear Self-Efficacy
Total	22	1	33
Position Type			
Lecturer/Instructor	14	0	14
Assistant Professor	1	0	5
Associate Professor	2	0	2
Professor	5	1	12

Degree of Instructor Self-Efficacy Beliefs: Survey Results

Descriptive statistics from the survey data indicate that of the two specific teaching-related self-efficacy beliefs measured in this study, instructors' beliefs regarding their ability to vary teaching methods to meet student needs were slightly above the mid-point of the 5-point scale (M=3.51, SD=.828), and instructor beliefs regarding their ability to vary assessment methods to meet student needs were slightly below the mid-point (M=2.84, SD=.966). These results suggest that respondents feel at least somewhat able to vary their teaching methods according to the needs of their students, but less so in the case of varying their assessment methods.

Antecedents to Self-Efficacy: Interview Results

Thematic analysis of the interview data revealed that respondents reported four categories of factors that are antecedents to self-efficacy beliefs: official feedback, student factors, organizational factors, and personal factors (see Table 4). The data indicate that self-efficacy is related to two official feedback factors (i.e., student evaluations and peer observations), two student factors (i.e., performance and career trajectory), and two organizational factors (i.e., incentives and departmental climate). The personal factor category included self-reflection and referred to active reflection on one's own teaching effectiveness after the conclusion of a particular class. No respondents referenced either participation in or factors related to pedagogical reform initiatives in their interviews when discussing self-efficacy beliefs

Table 4
Self-Efficacy and Relationship to Other Factors

	Positive Self-Efficacy	Negative Self-Efficacy	Unclear Self-Efficacy
Official Feedback			
Student evaluations	17	1	19
Peer observations	7	0	11
Student Factors			
Student performance	11	1	8
Student trajectory	6	0	2
Organizational Factors			
Tenure and promotion policies	3	0	7
Departmental climate	1	0	5
Personal Factors			
Self-reflection	8	0	6

Official feedback and **self-efficacy.** Official feedback sources include formal mechanisms for providing instructors with evaluations of their teaching effectiveness. The most frequently cited factor in this category was student evaluations (37 references). Student evaluations include surveys or questionnaires completed at the end of courses that gather student opinion concerning course content and teacher performance. In response to the question regarding her self-efficacy, one instructor stated, "I've had successful evaluations in what I've been doing, so it [teaching] seems to be working out fine." In this case, evaluations provided direct evidence regarding the efficacy of her teaching practice. However, not all instructors who discussed student evaluations maintained a positive opinion about this type of performance feedback. For example, one respondent noted, "There's some skepticism in this department about student evaluations," and three instructors made negative statements about the validity of student evaluations, stating that they do not provide a valid indicator of teaching quality.

While student evaluations were the most highly referenced factor by instructors with positive self-efficacy beliefs, nearly the same number of references was made by those with unclear self-efficacy beliefs (17 references to positive beliefs, 19 to unclear beliefs). In these 19 cases, respondents answered the question "How effective are you as a teacher?" by discussing factors such as student evaluations or student performance, without offering a clearly defined statement of their own capabilities. Possible explanations for this finding are that these respondents either did not have fully formed efficacy beliefs to articulate or did not want to answer the question for some reason. The other official feedback source referenced by respondents was peer observation (18 total references). Of these references, only 13 instructors

actually participated in peer observation activities, while 5 made general references to this factor. Similar to the answers regarding student evaluations, many respondents cited this factor without providing a clear assessment of their own efficacy (11 references).

Student factors and self-efficacy. A reported antecedent to self-efficacy beliefs that was not suggested by the literature focused on student-related factors. These included student performance in a given course (20 references) and a student's eventual career trajectory (eight references). For example, one respondent stated, "I look for progression in student performance as an indicator of effectiveness." Student career trajectories were cited in instances where a former student went on to attend a prestigious graduate school or secured a faculty position or other high-status position. The success of former students was seen as an indicator of one's own teaching acumen. In this way, the use of indirect measures to form self-efficacy beliefs was addressed by Bandura (1993), who noted that many activities do not provide direct and objective standards for performance assessment. In these cases, people must identify other indicators such as comparisons with peers or other proxy measures with which to judge their performance and abilities.

Organizational factors and self-efficacy. Organizational factors that served as an antecedent to self-efficacy beliefs included incentive policies and departmental climate. Incentive policies included references to tenure and promotion procedures, as well as policies governing salary increases and the recognition of high-quality teaching (10 references). These factors were linked to official feedback, primarily in the form of student evaluations, which were reported as the primary source of teaching-related data used in annual or tenure reviews. Two references to the use of student evaluations and incentive policies are illustrative: "If anything is really positive or really negative that's part of the evaluation that does go into the raises that you get," and also, "This merit exercise [providing feedback about teaching efficacy] … determines how much of a merit increase you get." A second organizational factor was department climate, which refers broadly to both explicit and implicit messages about teaching within a given department (six total references). These references focused on instructors' expectations about teaching and engagement in professional development activities. One respondent described how high expectations for teaching excellence were conveyed through the publication of all instructors' teaching evaluations: "We send them to everyone in the department so you know how everyone's doing; we have a certain level you can't drop below." Thus, efficacy (i.e., how you're doing) is judged in part against standards for teaching quality, as measured by a certain level of student ratings.

Personal factors and self-efficacy. The final category reported by instructors as an antecedent to self-efficacy beliefs refers to personal factors, specifically that of reflection on one's own teaching practice (i.e., reflective practice) (14 references). These references included discussions about how instructors reflected on their practice after classes or discussed teaching with colleagues or family members in order to address challenging situations, all of which led to determinations of self-efficacy beliefs. For example, one respondent described her post-class activities in this way: "It's just that constant coming back and saying, 'Okay how have I

succeeded, how have I not succeeded? What are some ways that I can try it differently?' And then you'll experiment a little bit on one time or another time and if you find, 'Oh that worked pretty well.'" This retrospective reflection about the efficacy of one's own practice is a hallmark of what Schon (1983) called a reflective practitioner. In some cases, this reflection led to a realization about how poorly students were learning in a given class, which then resulted in enrollment in professional development courses. Other changes to teaching practice included altering personal mannerisms and more frequent use of questioning during lectures. A consistent feature of these references to pedagogical reflection was an appreciation of the fact that teaching was difficult and entailed a learning process throughout one's career. As one respondent noted, "I know that there are always ways to improve."

Factor interactions and self-efficacy. Given the importance of reciprocal relations among self-efficacy, environmental factors, and performance, we also conducted an analysis to identify to what degree the antecedent factors addressed in this study interacted with one another. The graph used to represent these results is similar to that of the SEM analysis, as the model depicts interactions among self-efficacy beliefs for teaching and antecedent factors (Figure 1).

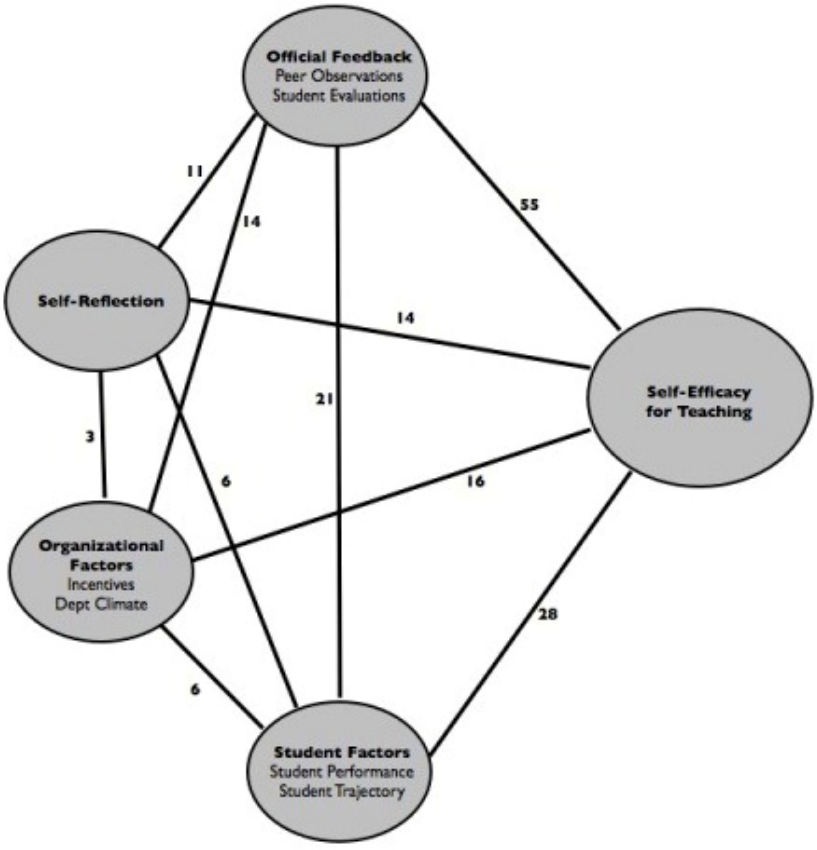

***Figure 1*. Model of interactions among antecedent factors and self-efficacy beliefs.**

However, this analysis differs from the SEM analysis in that it is based upon a separate dataset (i.e., interviews) and an inductive analysis of the data. The results demonstrate that each of the antecedent factors outlined above do not operate in isolation, but instead are associated with other antecedent factors operative within specific workplace settings. For example, 21 respondents linked official feedback and student factors when discussing self-efficacy beliefs, and 14 respondents linked official feedback with organizational factors. In one case, a respondent cited both an official feedback factor (i.e., student evaluations) and a student factor (i.e., student trajectory) as antecedents to the formation of self-efficacy beliefs. In response to the question about self-efficacy, she stated that, "What I've found is a lot of faculty are very jealous of my teaching evaluations, because I get the highest ratings from the students of any professor in our department," and "I've had quite a few of (my students) go to medical school, and I'm very proud of that fact." These data lend empirical support to the notion that individuals do not form self-efficacy beliefs in isolation from their environment, and that the environment itself is comprised of a multiplicity of factors that can be perceived and internalized while making self-efficacy judgments.

Antecedents to Self-Efficacy: Survey Results

We next turn to the analysis of the survey data using SEM. Again, this model is based on prior research on self-efficacy that posits that feedback, pedagogical reflection, reform participation, and tenure status shape self-efficacy beliefs. The results of the measurement model suggest that there is not enough evidence to reject the hypothesis that the data are a good fit for the two latent variables (χ^2=6.339, *df*=4, p=0.175). In addition, the value of RMSEA is 0.037, and the close-fit hypothesis is not rejected (p = 0.595). The CFI (0.995) and the NFI (0.987) suggest that the relative fit of the model is a 99.5% or 98.7% (respectively) improvement from the independence model. Using each of these measures of fit, we concluded that the measurement model is a good fit for the data.

Table 5, next page, illustrates the factor loadings for the indicator variables relative to their latent constructs. The freely estimated parameters for the measurement model were all statistically significant (p<0.01). However, some of the standardized loadings are low enough so as to call convergent validity into question. In fact, three of the five indicator variables have R^2 values below 50%. Thus, the model explains less than half of the observed variance for more than half of the indicator variables. At the same time, that the largest estimated factor correlation (0.555) is only moderate in size suggests discriminant validity.

Table 5
Standardized Parameter Estimates for the Measurement Model

Parameter	Unstandardized	SE	Standardized
	Factor loadings		
Self Efficacy for Instruction			
q12e. To vary your teaching methods	1.000[a]	NA	0.584
q12f. To vary your assessment methods	1.332	0.199	0.908
Pedagogical Reflection			
q19a. You analyze teaching practices	1.000[a]	NA	0.671
q19b. You elicit constructive criticism	0.858	0.086	0.634
q19c. You experiment with new teaching methods	1.123	0.107	0.756
	Measurement error variances		
q12e. To vary your teaching methods	0.120	0.076	0.824
q12f. To vary your assessment methods	0.614	0.060	0.341
q19a. You analyze teaching practices	0.389	0.048	0.571
q19b. You elicit constructive criticism	0.449	0.040	0.403
q19c. You experiment with new teaching methods	0.502	0.048	0.450
	Factor variances and covariance		
Self Efficacy	0.317	0.064	1.000
Pedagogical Reflection	0.411	0.062	1.000
Self Efficacy <---> Pedagogical Reflection	0.200	0.038	0.555

[a]Not tested for statistical significance. All other unstandardized estimates are statistically significant at p<.001.

Although there is some indication that the measurement model fails to meet convergent validity, in assessing all the evidence about the model we felt justified in proceeding to the structural equation model (Table 6, next page, provides the correlation matrix and standard deviations). The model fit statistic and approximate fit indexes for the structural model present a mixed picture. First, the model fit (χ^2=31.040, *df*=16, p=0.013) suggests that there is enough evidence to reject the hypothesis that the model is a good fit for the covariance data. However, RMSEA is 0.046, and the close-fit hypothesis is not rejected (p=0.559). Finally, the CFI (0.972) and NFI (0.947) suggest that the hypothesized model is a good improvement over the independence model. We also examined the correlation residuals and found that all residuals were below an absolute value of 0.10 (the largest was 0.07). Taking these bits of evidence together, we cautiously proceed to interpret the path coefficients.

Table 6
Sample Correlation Matrix and Standard Deviations

Variable	1	2	3	4	5	6	7	8	9
Self-Efficacy for Instruction									
1. q12e.To vary your teaching	1.000								
2. q12f. To vary your assessments	0.520	1.000							
Pedagogical Reflection									
3. q19a. You analyze your teaching	0.374	0.228	1.000						
4. q19b. You elicit criticism	0.304	0.143	0.493	1.000					
5. q19c. You experiment	0.333	0.272	0.509	0.429	1.000				
Observed Variables									
6. Formal feedback (Square root)	-0.030	-0.007	0.051	0.118	0.048	1.000			
7. q9c. Informal feedback	0.102	0.143	0.075	0.165	0.155	0.223	1.000		
8. Courses	0.053	0.059	0.085	0.038	0.139	0.009	0.084	1.000	
9. Tenure	-0.127	-0.039	-0.174	-0.124	-0.039	0.009	0.096	0.067	1.000
SD	0.828	0.966	0.952	0.867	0.955	0.285	0.867	0.631	0.418

Table 7
Standardized and unstandardized path coefficients for structural regression model of self-efficacy

Parameter	Unstandardized	Standardized	S.E.	C.R.	P
Pedagogical reflection <--> Formal feedback (sqrt)	0.122	0.054	0.126	0.969	0.333
Pedagogical reflection <--> Informal Feedback	0.138	0.186	0.042	3.241	0.001
Pedagogical reflection <--> Course participation	0.131	*0.129*	0.057	2.314	0.021
Pedagogical reflection <--> Tenure track	-0.291	-0.189	0.086	-3.396	0.000
Self-efficacy <--> Formal feedback (sqrt)	-0.194	-0.098	0.100	-1.928	0.054
Self-efficacy <--> Informal feedback	0.042	0.065	0.033	1.253	0.210
Self-efficacy <--> Course participation	-0.008	-0.009	0.044	-0.183	0.855
Self-efficacy <--> Tenure track	-0.046	-0.034	0.067	-0.686	0.493
Self-efficacy <--> Pedagogical reflection	0.479	0.547	0.087	5.509	0.000

Table 7, previous page, shows the path coefficients for the structural regression model, and Figure 2 illustrates the standardized path coefficients. We begin with the path coefficients for the observed feedback variables and note that neither form of feedback—formal student evaluations or informal student feedback—yields a statistically significant direct effect on self-efficacy. Although the standardized coefficient for formal student evaluations suggests a negative effect on self-efficacy (-0.098, p=0.054), we cannot be confident enough that this coefficient is different from zero. In fact, the only significant path coefficient estimating a direct effect is "pedagogical reflection," and it turns out to be quite important. The standardized path coefficient (0.547, p=0.000) suggests that a level of pedagogical reflection one full standard deviation above the mean predicts a level of self-efficacy for instruction just over one-half a standard deviation above the mean (holding feedback, tenure status, and course-based reform participation constant).

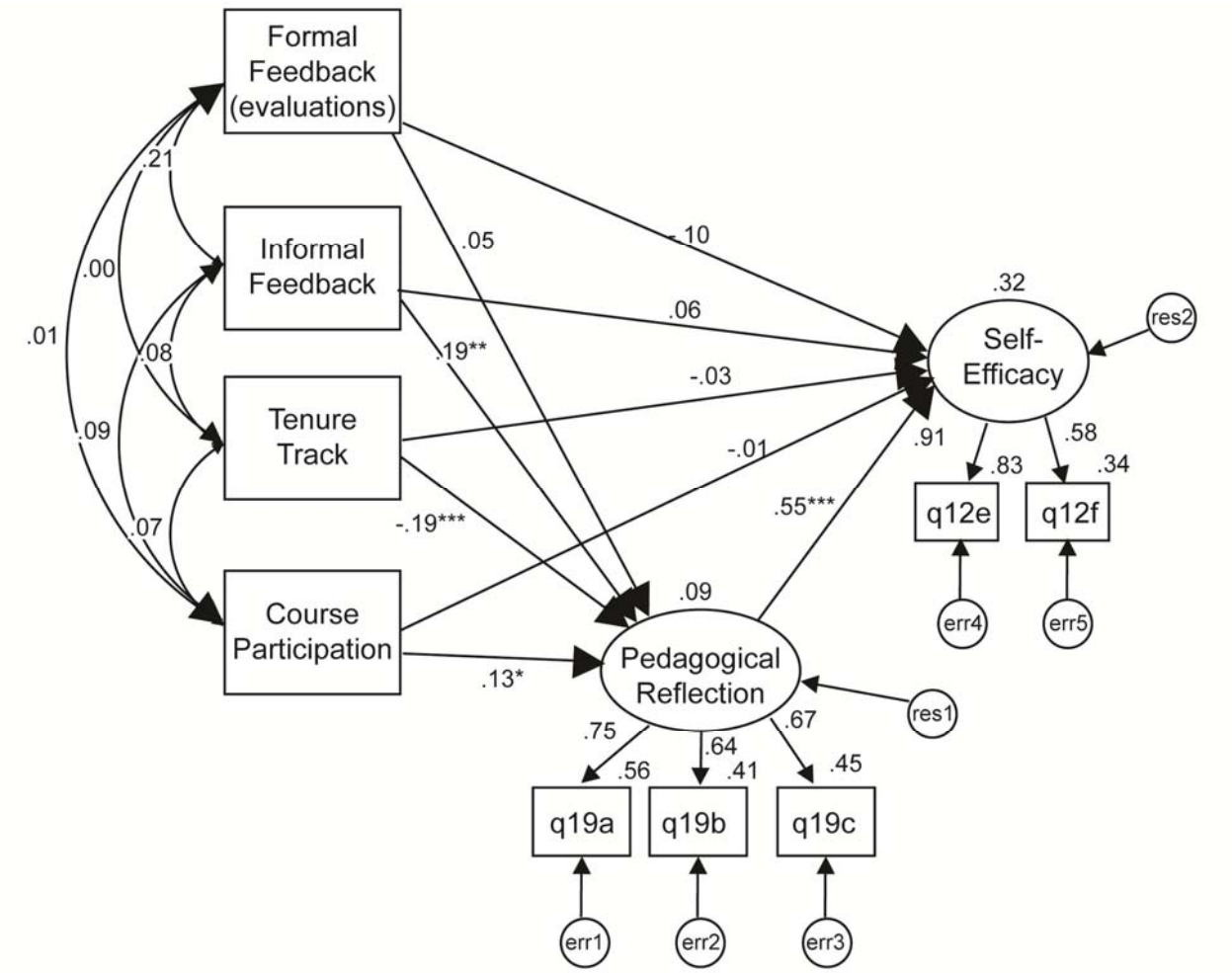

***Figure 2*. Path diagram showing standardized path coefficients.**

Although none of the observed variables have a direct effect on self-efficacy, there are a number of indirect effects as mediated through pedagogical reflection. For instance, the standardized indirect effect of informal student feedback on self-efficacy through the mediator pedagogical reflection is estimated as 0.102. This means that the level of self-efficacy is expected to increase by 0.102 standard deviations for every increase in informal student feedback of one full standard deviation via its prior effect on pedagogical reflection. Course-based pedagogical reform participation also has a positive standardized indirect effect of 0.071 standard deviations. Finally, being on the tenure track has a negative standardized indirect effect of -0.103. Formal feedback does not to have a significant effect on pedagogical reflection.

Discussion

This study makes several important contributions to our understanding of instructors' self-efficacy beliefs for teaching, and which antecedent factors are most influential in their formation. In this section we examine in greater detail the ambiguous status of self-efficacy beliefs among respondents in the study and the critical role of pedagogical reflection and performance feedback. Then we briefly consider implications of these findings for pedagogical reform efforts in math and science at the postsecondary level.

The Ambiguous Status of Instructor Self-Efficacy Beliefs

An unanticipated finding in this study was the ambiguous status of self-efficacy beliefs for 33 of the 56 (59%) instructors in the interview sample. Instead, these respondents provided answers such as "I honestly don't know," which suggests that these instructors simply did not have the vocabulary for self-efficacy and/or had not really considered the notion of their effectiveness as a teacher in a serious manner. For example, an instructor with unclear self-efficacy beliefs described how students "go away very happy" from a course, but offered no clear assessment of her own efficacy as an instructor. The survey results provide another perspective on the status of instructors' self-efficacy beliefs for teaching. The average respondent feels at least "somewhat able" to vary their teaching methods according to the needs of their students, but less so in the case of varying their assessment methods. In this case, however, that the interviews revealed a substantial number of respondents without any clear sense of self-efficacy for instruction suggests that the questionnaire format may be imposing a level of belief that does not exist in practice.

The literature is relatively silent on the implications for ill-formed self-efficacy beliefs, as most studies measure the strength, magnitude, or generality of self-efficacy, but not whether the beliefs exist at all (Stajkovic & Luthans, 2003). Since self-efficacy does play an important role in people's motivations for performing particular tasks, the types of goals they set, and the strategies selected to accomplish a task, it is likely that the lack of clearly formulated self-efficacy beliefs has some implications for teaching. For instance, in discussing the causal structure underlying the relationship between self-efficacy and performance, Bandura (1993) suggested that at first, those with less well formulated self-efficacy beliefs (e.g., novices) will rely on their past experiences and performance to judge their efficacy, which will then influence

the nature of the goals they set for future performance. Over time, as their schema for self-efficacy becomes more developed and articulated, performance is influenced directly by the strength of these beliefs and indirectly by improving the quality of analytic thinking and goal setting. That is, as individuals develop stronger and more complex self-efficacy beliefs, they will then set higher and more specific goals for future tasks, while also developing more sophisticated strategies for attaining these goals. Given that 59% percent of instructors in the interview portion of this study had unclear self-efficacy beliefs, further research should examine the nature of this ambiguity, the sources and dynamics of ambiguous instructional self-efficacy, and how such ambiguity may impede pedagogical reform efforts.

The Importance of Self-Reflection

One possible explanation for the prevalence of ambiguous self-efficacy beliefs is the lack of active reflection on teaching practices. This is important because information regarding one's efficacy alone are not by themselves useful, but they must be actively considered and reflected upon (Bandura, 1997). This suggests that without active reflection, an individual may not form highly developed efficacy beliefs. The importance of pedagogical reflection is underscored by our survey results, which indicate that only pedagogical reflection is significantly related to instructor self-efficacy. These results are consistent with the notion that self-efficacy is a type of knowledge generated by reflection on past performance. Schon's (1983) work on the role of reflection and continual re-assessment of one's skills and performance in shaping effective professionals lends support to the idea that reflection is a critical feature of education practice. Thus, for this group it is possible that they have simply not formed self-efficacy beliefs for teaching because they are not sufficiently motivated to actively reflect upon their own teaching practice.

The Role of Performance Feedback and its Relationship to Self-Reflection

However, another possibility is that not enough detailed information is available to instructors for them to reflect upon. As a result, it is worth considering the types of feedback that are available for instructors to reflect upon. The interview data indicate that student evaluations play a central role in providing information in relation to self-efficacy. This finding is corroborated by prior research that indicates instructors' self-concept beliefs are largely based on end-of-semester student ratings (Roche & Marsh, 2002). However, of the 37 references to student evaluations as being related to self-efficacy, 19 had unclear beliefs, which suggest that student evaluations may not be sufficient on their own to spur reflection that can inform self-efficacy beliefs. Given that several respondents questioned the validity and utility of the data provided by these evaluations, the question arises regarding whether or not other types of performance feedback (e.g., peer observations) may be better received by instructors and/or effective in spurring reflective practice. Furthermore, the fact that both the survey and interview analyses indicated that informal feedback (e.g., conversations with students about the course or their career accomplishments) influences both pedagogical reflection and self-efficacy beliefs reinforces the important role that feedback plays in shaping self-efficacy beliefs, regardless of

the type of feedback. However, given that informal feedback is provided to instructors on an intermittent and random basis, reliance on these evaluations of instructional efficacy as a way to further develop self-efficacy beliefs is not feasible.

While we do not claim that the most prominent type of performance feedback—student evaluations—contributes to under-specified self-efficacy beliefs, we do suggest that the sole reliance on them to provide performance feedback may be problematic. Consider differences in the type of feedback instructors at research universities receive on their efficacy as researchers and scholars. The peer-review process results in detailed feedback on the abilities of instructors in regards to research manuscripts submitted for publication, as well as grant proposals to funding agencies. In both cases, a panel of one's peers pays close attention to the technical and intellectual merits of a paper or proposal, and feedback is scrutinized upon receipt. If the feedback results in the rejection of a paper or proposal, that feedback is often incorporated into a revision. In sum, a system exists for the regular provision of detailed feedback about instructors' efficacy as scholars, and this feedback is carefully considered and reflected upon by individuals who frequently incorporate these insights into future behaviors. As a result, self-efficacy beliefs for research are stronger than those for teaching among instructors in research universities (Bailey, 1999). In contrast, K-12 teachers receive regular and extensive feedback that begins with their student teaching practice during teacher training. Once licensed, K-12 teachers continue to receive regular feedback from their peers (e.g., lead teachers) and their school administration, through professional development, and increasingly through a flurry of standardized test scores. Thus, if a goal of professional development in IHEs is to cultivate intentionality in teaching such that instructors will engage in a recurring cycle of reflection and revision of their teaching practices, it is necessary to provide instructors with consistent and robust feedback (Chism, Lees, & Evenbeck, 2002).

Implications for Policy and Practice

Given the demonstrated link between self-efficacy beliefs, teacher behavior, and student outcomes, researchers suggest that organizational leaders should work to support and sustain the development of strong efficacy beliefs (Pajares, 1996; Tschannen-Moran & Hoy, 2007). While the specific steps leaders can take to foster these beliefs in postsecondary settings are relatively unexamined, researchers are beginning to explore the role that professional development programs play in shaping self-efficacy beliefs. In examining the effects of programs at the University of Helsinki, Postareff and Lindblom-Ylanne (2008) found that participation in these programs had little effect on self-efficacy beliefs unless instructors continued their studies past the end of the program, that individuals experienced a decline in self-efficacy at the beginning of the program, and that novice instructors experienced higher gains in self-efficacy than more experienced instructors. These findings hint at specific features of professional development programs that could enhance and support self-efficacy beliefs, such as warning participants in advance to expect a sudden drop in their capability beliefs as they are forced to reflect on their practice. Based on the literature and findings reported in this paper, it appears that self-reflection (and the provision of high-quality performance feedback to facilitate this reflection) is a

promising area for pedagogical reformers to target, as one of the many positive outcomes of reflective practice is enhanced self-efficacy beliefs. Yet teaching people how to be reflective practitioners is not a matter of conveying a set of techniques or skills per se, but instead involves teaching instructors how to respond to problems and perceive their own work (Kay & Johnson, 2002). In any case, policy makers and administrators should be cognizant that an important component of the individual (and organizational) change process in regards to teaching and learning may rest in part on the ability and desire of instructors to engage in reflection practice, which in turn requires the provision of high-quality feedback on performance.

Conclusions

This study represents an initial attempt at articulating antecedents to instructors' self-efficacy beliefs for teaching. Limitations to the study include the small sample size in the interview portion of the study and the possibility that respondents did not have a reference point from which to answer questions regarding their efficacy as instructors. In addition, the SEM model did not contribute a substantive understanding of the factors that predict levels of self-efficacy, besides singling out the key role of pedagogical reflection. Meanwhile, it cannot be concluded that formal feedback has a direct effect on self-efficacy that is different from zero (-0.194, p=0.054). Thus, when a more robust measure of formal feedback is developed in the context of teaching, we suggest that this measure be included in the model. While this study provides no evidence regarding the relationship between self-efficacy and actual teaching practice, we do provide evidence for the ambiguity of some instructors' self-efficacy beliefs as well as for the critical role of pedagogical reflection in forming these beliefs. Future research in this area should continue to explore the precise nature of the relationship between self-efficacy and different types of performance feedback including student evaluations and peer observations. The next phase of this research program will examine the relationship between instructors' self-efficacy and selected teaching practices, and the role that efficacy beliefs play in decision-making processes leading to the development of lesson plans for specific classes. Taken together, the current analysis and a follow-up study examining self-efficacy and teaching practice will contribute to both the research literature and practitioners' understanding of pedagogical reform at the postsecondary level.

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