

Exploring the Construct of Pedagogical Discontentment: A Tool to Understand Science Teachers' Openness to Reform

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Abstract It is well established that many teachers are resistant to take up the messages of reform if these messages require them to substantially shift their teaching practices. What accounts for this resistance? One well established explanation is that teachers lack the self-efficacy required to attempt something new in their teaching—they simply do not feel capable of effectively enacting the messages. However, there are a host of studies describing teachers with high self-efficacy who remain resistant to messages of change. The purpose of this article is to address the gap in the application of self-efficacy to understand the change or lack of change of science teachers' practice through the introduction of a related construct, *pedagogical discontentment*. This construct reflects a state of cognitive conflict that exists when an individual recognizes a mismatch between her/his science teaching pedagogical goals and classroom practices. One potential result of this mismatch is that a teacher problematizes her teaching practices, prompting an increased receptivity to reform messages. Building on existing literature, we present vignettes of four hypothetical teachers who exemplify variations of pedagogical discontentment. When combined with self-efficacy, pedagogical discontentment provides a useful lens to understand teachers' consideration and adoption of messages of reform.

Keywords Pedagogical discontentment · Self-efficacy · Science teacher conceptual change · Teacher professional development

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Introduction

We'll begin with an examination of two hypothetical science teachers attending the same summer professional development workshop on discussion strategies in the classroom. Beth¹, a high school biology teacher, attends the workshop because it is required to maintain her certification. Beth is a noted 'master teacher' in the school district and teachers often come to her for advice on their teaching. She is pleasant and interacts positively with the other teachers and instructors in the workshop, offering suggestions and stories from her own teaching. During the workshop, which emphasizes student dialogue and construction of knowledge, Beth doesn't take notes during the experience, and she is quick to get "off task" during the activities. A visit to her classroom in the fall finds it to be an engaging place in which students are involved in experiments, but one in which students do little meaningful cross talk or student-lead sense-making. Little evidence in subsequent visits indicates that Beth has incorporated any of the activities or suggestions she was introduced to in the summer. In short, while her teaching seems effective in many regards, it is little changed as a result of her professional development.

The second teacher, Brian, a high school chemistry teacher, attends the workshop because one of his student teachers from the local university engaged his students in discussions that he himself has never been able to facilitate. His student teacher was able to ask open-ended questions that required the students to search for answers, and often that search had them speaking to one another, evaluating each others responses and the evidence they offered to support their assertions. Although Brian conceives of himself as a capable, effective teacher, he knows his own classroom discussions are often less than what he hopes for. Brian engages in the workshop, taking notes, asking questions, and requesting further materials to look over in the evening. A visit to his classroom in the fall finds students engaged in investigations, followed by discussion sessions in which students offer possible explanations for their results and querying one another about the evidence for their responses. Clearly, Brian has incorporated many of the activities or suggestions presented in the workshop in his teaching.

Beth and Brian are hypothetical teachers who represent many teachers we have worked with both in professional development experiences and graduate work. They are capable teachers who are successful in their teaching of science. But their uptake of reform-minded practices is starkly different. How can we understand this differential 'uptake' of the practices of reform? In recent discussions about the role of educational reform and teacher change, there have been some controversies regarding the role of beliefs in affecting lasting change. On the one hand, some would suggest that high confidence in one's teaching capabilities is a very important attribute. Individuals such as Bandura (1977) argue that the persistence and confidence that is associated with high teaching self-efficacy is a central concern. Indeed, there is a wealth of literature in science teacher preparation that follows from an extension of this argument—many science educators work to foster science teachers' self-efficacy to increase the likelihood that the teachers may attempt or adopt a new teaching practice (Brand and Wilkins 2007; Palmer 2006; Rice and Roychoudhury 2003; Scharmann and Orth Hampton 1995).

¹ Each of the four hypothetical teachers featured in this article are fictional amalgams (Gilmer 2004) drawn from teachers with whom we have worked, interviewed, and observed during a year-long science teacher professional development project funded by the Florida State's Department of Education (Sowell and Southerland 2006).

On the other hand, there is a growing collection of educators who suggests that doubt and uncertainty are necessary for real and lasting change (Settlage et al. 2009; Wheatley 2002). Indeed, conceptual change theory posits dissatisfaction as an essential starting point for changing a conception. Rather than a negative factor that must be subdued, we are exploring the value of teacher discontentment as a positive force for fostering the uptake of reform-based practices. In sum, the question we have as teacher educators is whether it is more important to align ourselves to the goal of creating highly self-efficacious teachers or if there is unrealized potential in fostering a certain amount of pedagogical discontentment as an entry point for professional development. In the balance of this paper, we weigh these contrasting perspectives and use vignettes of teachers to explain the possible benefits of using both self-efficacy *and* pedagogical discontentment when one attempts to understand teachers' resistance or openness to change.

Literature Review

It has been over 10 years since the publication of *The National Science Education Standards* (NSES) (National Research Council (NRC) 1996) and longer since the publication of *Science for All Americans* (SFAA) (American Association for the Advancement of Science, AAAS 1990). These documents were developed in order to define specific goals for science education reform in the United States and to make these goals explicit to all potential stakeholders. Despite these efforts, current research indicates changes inside the classroom are scant, at best (Southerland et al. 2007), resulting in something Woodbury and Gess-Newsome (2002) refer to as “change without difference”.

Just as we have seen in our own work with teachers, the research indicates that some teachers are openly embracing reform-oriented practices (Crawford 2000), while others are either unable or unwilling to modify their curriculum or instruction to align more closely with current science initiatives (Davis 2002; Laplante 1997; Yerrick, Parke and Nugent 1997). What accounts for this difference? Anderson (2002) posits that “much of the difficulty [in enacting reform] is internal to the teacher, including teachers' beliefs and values related to students, teaching, and the purposes of education” (p. 7).

Teacher Thinking, Beliefs, and Practices

In their analysis of reform efforts in the teaching of mathematics, Woodbury and Gess-Newsome (2002) point to teacher personal factors and teacher thinking as the most promising constructs for understanding the change (or lack thereof) in teaching practices. Indeed, they argue that a teacher's abilities and/or inclinations to learn and relearn conceptions of content, learning, and teaching present the most profound influences shaping the change of teaching practice.

Research on teacher thinking provides evidence of a robust link between teachers' thinking, their knowledge and beliefs, and their inclination and/or ability to teach differently (Cohen and Ball 1990; Cooney and Shealy 1997; Gess-Newsome 1999; Gregoire 2003; Shulman 1987; Smylie 1988). *Teacher thinking* is defined as teachers' knowledge and beliefs concerning teaching, teachers, learning, learners, schools, schooling, and subject matter. Teachers' thinking and practice are shaped by professional and life experiences, the nature and extent of teacher preparation, and continued professional learning (Ball 2000; Berry et al. 2009; Fullan and Hargreaves 1996; Smith 2005).

Specific aspects of teacher thinking have been identified as important in teachers' adoption of reform-based practices. Teachers' subject matter knowledge and personal practical knowledge (Clandinin 1986) may affect if and *how* reforms are adopted (Laplante 1997; Wallace and Kang 2004). Teachers may be more willing to embrace reforms than others due to intrinsic psychological attributes (Hopkins 1990). The degree of the cognitive development, psychological state, or "personalities" (McKibbin and Joyce 1981, p. 254) of teachers, acting with the general context of the school and the movements in the wider society, allow some teachers to see possibilities for thinking about and implementing new ways of teaching. In contrast, other teachers fear and avoid the risks associated with change. Taken together, this research contends that more cognitively complex teacher thinking allows for greater use of new educational ideas.

Because current science education reforms efforts (AAAS 1990, 1993; NRC 1996, 2000) ask that teachers teach differently than they have in the past, adopting these reform messages requires a certain degree of "unlearning" of what teachers know about teaching (Woodbury and Gess-Newsome 2002). So, if the reforms necessitate learning and unlearning of one's teaching knowledge and practices, we suggest that a conceptual change model may offer a useful lens to examine teacher thinking regarding the adoption of reform.

Conceptual Change Models

Hewson (1992) has argued that teachers have their own individual conceptions of what it means to teach science, which may be very different from those described in reform efforts. So, just as students undergo conceptual change in their learning of science, teachers can be understood to undergo conceptual change in their learning about science teaching. Hewson describes that teacher learning, just as with their students, depends on teachers' prior knowledge—in this case, teacher learning about science teaching can be understood as a conceptual change involving their conceptions of the nature of knowledge, of science, and of learning. Dana et al. (1998) describe that what student teachers learn in a teacher preparation program is influenced by their prior knowledge and beliefs. They demonstrate that cognitive dissonance around an individual's prior knowledge is required in order to change deeply held knowledge and beliefs. They explain that the professional growth of teachers requires "creating dissonance" in which current knowledge and beliefs are challenged so that alternatives can be closely considered.

Many of models of conceptual change (CCM) (Dole and Sinatra 1998; Feldman 2000; Gregoire 2003; Strike and Posner 1992) recognize the importance of the learner's dissatisfaction with her existing understanding as a precursor to change. As described by Posner and his colleagues, "an individual must have collected a store of unsolved puzzles or anomalies and lost faith in the capacity of his current concepts to solve these problems" before learning can occur (1982 p. 214). Sunal et al. (2001) explores the processes and barriers of professional development in a higher education science faculty. They remark "[C]hange in faculty members will not occur unless they experience dissatisfaction with their existing conceptions of science teaching." Woodbury and Gess-Newsome (2002) and Feldman (2000) suggest that if teachers are not dissatisfied with some aspect of teaching, they have little motivation to engage in ideas of reform. Both Dole and Sinatra's (1998) and Gregoire's (2003) work leads us to understand that without pedagogical dissatisfaction, teachers may not deeply engage with the messages of reform;

without this deep engagement or systematic processing, long lasting change of conceptions is not possible.

Feldman (2000) argues that authentic transformation in understanding takes place when teachers “are *discontent* with their old practical theories and they find the new ones *sensible, beneficial, and enlightening*” (p. 613). Our work is focused on this first aspect: dissatisfaction or discontentment with one’s current science teaching pedagogical goals and strategies. Within the CCM, “existing conceptions with high status are well formed, have conceptual coherence, and achieve something of value for the individual holding them” (Hennessey 1993, p. 19). When an understanding or concept no longer is plausible or fruitful, its “status” is lowered (Hewson and Hewson 1992). This opens it up for replacement by a newer, higher status concept. Hennessey explains:

The new conception will not be accepted until the status of the existing conception is lowered. This happens, according to the model, if the individual holding the conception becomes dissatisfied with his or her existing conception. Therefore, the more dissatisfied an individual becomes with his or her current conception the more likely it is that a radical change will occur (p. 109).

Our current research focuses on the first condition for change within the conceptual change model, dissatisfaction, and its pivotal role in lowering the status of an existing idea so that change becomes theoretically possible.

The purpose of this article is to propose a new theoretical construct, pedagogical discontentment, to consider as one attempts to understand changes, or lack of changes, in teachers’ knowledge and beliefs and teaching practices. The development of this construct is based on an integration of science education and educational psychology literatures. To do this, we contrast pedagogical contentment and job satisfaction, and distinguish pedagogical discontentment from contextual dissatisfaction. We also explore the relationship between teaching self-efficacy and pedagogical discontentment. Our theoretical analyses are supported by four vignettes of hypothetical teachers based on teachers we have worked with in professional development experiences, providing the reader with images of how we understand this construct to interact with teaching self-efficacy to function within the professional lives of practicing science teachers. We suggest that the consideration of pedagogical discontentment will allow researchers and teacher educators a more robust understanding of how and why teachers change, or fail to change, their teaching.

Distinguishing between Pedagogical (Dis)contentment, Contextual and Job (Dis)satisfaction

Woodbury and Gess-Newsome (2002), Sarason (1982), and Feldman (2000) describe that if teachers are not dissatisfied with some aspect of their teaching, they have little motivation to engage in ideas of reform and have little investment in making reform “work.” Gess-Newsome et al. (2003) focus on two aspects of a teachers’ dissatisfaction that cause them to pursue change. They highlight pedagogical discontentment and contextual discontentment. According to Gess-Newsome et al. (2003), *contextual (dis)satisfaction* includes teachers’ assessment of contextual aspects of their work (e.g., is my room big enough, do I have enough materials, do my microscopes work), and often teachers pursue grants or reform efforts to secure sources of support to address aspects of their contextual (dis)satisfaction. *Pedagogical discontentment* revolves around more

internal, personal assessment of the degree to which a teachers' practices meets the teacher's teaching goals, and it is this assessment and a teacher's reaction to it that influences their decision to participate in the reform of some aspect of her teaching.

It is clear that a related construct, job satisfaction, is closely aligned with the contextual (dis)satisfaction Gess-Newsome et al. (2003) describe. Cranny et al. (1992) describe job satisfaction as an emotional reaction to a job that often is influenced by a host of contextual factors (i.e., the nature of interactions with supervisors and colleagues, the quality of the physical environment, pay) (Evans 1997). Given the degree to which job satisfaction is influenced by contextual factors, it is closely aligned with a teacher's contextual satisfaction.

Pedagogical discontentment is something very different from both job and contextual satisfaction. Job satisfaction refers to a person's emotional sense of fulfillment with their work, their degree of pleasure they derive from their job. Job satisfaction is often highly influenced by contextual factors surrounding employment. Like job satisfaction, contextual discontentment is a teachers' emotional reaction to their assessment of their teaching context. *Pedagogical discontentment* on the other hand, refers to a teachers' reaction to their assessment of the effectiveness of an instance of teaching. Pedagogical discontentment is not an evaluation of how satisfying working conditions or other external factors are. Instead, pedagogical discontentment is a teacher's affective response to her evaluation of the effectiveness of her existing science teaching practices and goals. The answer to this question, "Does the results of my teaching meet my teaching goal for this lesson?" evokes a teacher's sense of pedagogical discontentment. Thus, pedagogical discontentment is a very different construct from a teacher's sense of satisfaction with her working conditions.

Based on our review of the literature, we have elected to use Feldman's term *discontentment* over the original *dissatisfaction* to describe the unease one experiences when the results of teaching actions fail to meet one's teaching goals, even though the latter term is more commonly found within the conceptual change literature. This choice is based on the need to distinguish explicitly the construct of *pedagogical (dis)contentment* from more general notions of *job or contextual (dis)satisfaction*.

Relationship between Pedagogical Discontentment and Teacher Self-Efficacy

The literature suggests there is a relationship between teacher discontentment and self-efficacy (Gess-Newsome et al. 2003; Gregoire 2003). To compare/contrast pedagogical discontentment with efficacy, we draw on the work by Bandura (1977, 1993, 1997) and his use of social cognitive theory. He explains,

Unless people believe they can produce desired effects by their actions, they have little incentive to act. Efficacy belief, therefore, is a major basis of action. People guide their lives by their beliefs of personal efficacy. Perceived self-efficacy refers to beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments (1997, p. 2–3).

Research using this concept of efficacy often involves two distinct factors: outcome expectancy and self-efficacy. Outcome expectancy is concerned with a person's belief that a particular behavior will generate a certain outcome. The second factor, self-efficacy, is concerned with a person's assessment of her ability, capacity, or competence to successfully engage in that particular behavior. For teachers, one's outcome expectancy might be that "hands-on" activities increase learning. A teacher's self-efficacy is her

belief that she is capable of successfully leading such hands-on activities in her classroom.

Efficacy is a future-oriented construct. Self-efficacy is the *forecast* about one's *potential capacity* to be successful in a future situation. For example, a self-efficacy may include a teacher's belief that she can effectively use a new teaching strategy. As Bandura (1993) explains:

People's beliefs in their efficacy influence the types of anticipatory scenarios they construct and rehearse. Those who have a high sense of efficacy visualize success scenarios that provide positive guides and supports for performance. Those who doubt the efficacy visualize failure scenarios and dwell on the many things that can go wrong (p. 118).

A teacher who holds a high teaching efficacy believes that she is capable of successfully accomplishing a task or performing a behavior that is positively related to student learning. If a science teacher has a low self-efficacy, she is less likely to imagine successfully accomplishing a specific, *prospective* teaching behavior.

In contrast to this anticipatory aspect of self-efficacy, we conceive of a science teacher's pedagogical discontentment as being an *immediate* assessment of *current* science teaching. A teacher who is pedagogically discontent *currently* experiences dissonance with regard to her science teaching goals and practices. We argue that there is a fundamental difference between beliefs about a present state of contentment with one's teaching practice and beliefs about one's possible efficaciousness in a future scenario; the former is based on an assessment of what has happened in the classroom, the latter is based on what the individual thinks she/he is capable of accomplishing. We understand a sense of pedagogical discontentment as a positive characteristic, something needed to foster change in teaching practice (Settlage et al. 2009).

Interactions of Pedagogical Discontentment and Self-Efficacy

Conceptual change theory would suggest that initial consideration of messages of reform would require teachers to have some discontentment with their *current* teaching practices. If so, as Gregoire (2003) describes, they may more thoroughly engage with and process the reform message. Following this processing and consideration, if the teacher has an adequate teaching self-efficacy, she is more likely to attempt to adopt the reform practice, as she conceives of herself as potentially capable of successfully enacting the new practice. Thus, we see that a consideration of both pedagogical discontentment and self-efficacy as required to more thoroughly understand a teacher's responses to messages of reform.

Although pedagogical discontentment and teaching self-efficacy are related, there is a fundamental difference between beliefs about contentment of one's present practice and beliefs about efficaciousness within a future scenario—and we argue that a consideration of both constructs is needed if we are to have a finer grain understanding of how teachers react to messages of reform. As Gregoire (2003) suggests, a teacher must have a degree of discontentment with the effectiveness of his/her current practices before she will thoroughly engage with and consider a new teaching practice. However this teacher must consider herself as capable of a new approach or technique, a positive sense of teaching-self efficacy, before she will attempt to employ a new teaching approach. Without pedagogical discontentment there is little need to consider a new practice; without an adequate level of teaching self-efficacy, the teacher will be too threatened to undertake a new practice. In

either case we would expect little reaction to or change in actual teaching practices in response to messages of reform.

Research into Science Teachers' Pedagogical Discontentment

The challenge remains: how do we put this new construct, pedagogical dissatisfaction, into practice in ways that are meaningful for teachers and researchers? Based upon the theoretical work described in this manuscript, we conducted in-depth, open-ended interviews with eighteen practicing science teachers of various grade levels, content areas, routes of preparation and amount of experience, and areas of commonality in the teachers' pedagogical discontentment were identified (Sowell and Southerland 2006). In the interviews, we asked the teachers questions such as: Are there aspects of your teaching that you are not completely satisfied with? How would you know/recognize when something is successful/effective in your classroom? What signs would you look for? The common areas of pedagogical discontentment voiced by the teachers in this study include: the ability to teach all students science, science content knowledge, balance depth versus breadth of instruction, implementing inquiry instruction, and assessing science learning. That said, this is the discontentment experienced by teachers in a particular location in the country (Southeastern United States) at a particular point in time (just after the turn of the 21st century). It is likely that a teacher's discontentment is influenced by the context in which they are teaching and professional development messages they are receiving, thus it seems necessary to describe this construct for a variety of teachers from a variety of locales.

Based on the findings of these interviews, we have developed an instrument to allow us to measure the degree of pedagogical discontentment a teacher might have, the *Science Teachers Pedagogical Discontentment* (STPD scale) (Southerland et al. 2006). After development and field testing with 171 teachers from 12 different states in the US, the STPD scale includes 30 likert style items (such as How contented or discontented are you with your current ability to find connections between science content and students' everyday lives? Your ability to lead successful inquiry-based activities?) These items were clustered around 5 independent subscales identified in the interviews previously described. Field tests suggest that the instrument has good reliability (with Cronbach alpha's of between .79 to .90).

Using this theoretical framework, the interview protocol (Sowell and Southerland 2006) and the quantitative instrument with practicing teachers (Southerland et al. 2006), there is growing empirical support, both qualitatively (Saka et al. 2009) and quantitatively (Golden et al. 2009; Blanchard et al. 2010), that a strong degree of pedagogical discontentment in teachers is predictive of greater gains in reform based teaching practices.

Saka et al.'s (2009) work studying the induction of novice science teachers is a first foray into empirically examining the interplay of pedagogical discontentment, self-efficacy, and teachers' adoption of reform-minded practices. In their qualitative, 2 year study of two novice science teachers, they found that a high degree of pedagogical discontentment combined with a moderate self-efficacy was necessary for the refinement of reform-minded teaching practice in these novices. In a quantitative examination of the effects of an extended professional development on 24 experienced teachers' use of inquiry, Golden et al. (2009) have found that teachers with a strong sense of discontentment (as measured by the STPD scale) are more likely to enroll in professional development that focuses on supporting changes in teaching practice, similar colleagues with less pedagogical discontentment are more likely to enroll in professional development designed to increase teachers' understanding of "cutting edge" science. Likewise Golden et al describe that a

teachers’ pedagogical discontentment is predictive of greater gains in the use of inquiry-based teaching as a result of professional development. They describe that teachers that enter professional development with higher degrees of pedagogical discontentment are more likely to use the practices described in professional development in their own classrooms following the professional development experience than similar colleagues with limited discontentment. It is important to note that Golden et al. (2009) found no such relationship between teaching self-efficacy and change of practice.

In a similar study, Blanchard et al. (2010) worked with middle school mathematics and science teachers at two rural middle schools in high need districts in the southeastern U.S. Teachers in the study participated in sustained professional development focused on integrating instructional technologies into teachers’ pedagogical practices in reform-based ways. The authors found that of twenty-three teachers with moderate to high self efficacy (Riggs and Enochs 1990), the teachers who also had moderate to high pedagogical discontentment as measured by the STPD scale were nearly 8 times more likely than their peers to change their classroom practices to more reform-based, as measured by increased scores on the Reformed Teaching Observation Protocol (RTOP) (Piburn et al. 2000). Thus, empirically there are links between a teacher’s sense of pedagogical discontentment and change in teaching practices.

Interactions of Pedagogical Discontentment, Self Efficacy in Four Hypothetical Science Teachers

To explicate how different levels of pedagogical discontentment may interact with different levels of self-efficacy to shape a teacher’s reaction to messages of reform, we discuss them from the perspectives of four hypothetical teachers (as described in Fig. 1). We present the following vignettes in light of our own experiences offering teacher professional development, the empirical work of Saka et al. and Blanchard et al. described previously, and Gregoire’s (2003) and Gess-Newsome et al.’s (2003) assertion that a degree of pedagogical discontentment, combined with considerable self-efficacy, may result in greater receptivity/openness to professional development activities. Conversely, a low degree of pedagogical discontentment, combined with a low level of self-efficacy, would likely result in an individual being less than receptive during such activities, thus provoking little or no real change as a result of those experiences. Although these vignettes are hypothetical, they are amalgams of teachers with whom we worked closely in professional development settings; interactions that highlighted for us the potential power of pedagogical discontentment on teachers’ receptivity to messages of reform. Descriptions of more ‘idealized’ teachers allow for a focus on the theoretical constructs with less distractions due to individual styles of teachers and the plethora of unique characteristics unique to every teacher’s context. In practice, we found many of the experienced secondary teachers we worked with to have moderate to high self efficacy, with lower self efficacy being seen in

Fig. 1 Models of teacher self-efficacy, contentment, & anticipated changes in practices, post workshop

	<i>High Self Efficacy</i>	<i>Low Self Efficacy</i>
<i>Pedagogical Contentment</i>	Beth No changes	Frank No changes
<i>Pedagogical Discontentment</i>	Brian Changes	DeeDee Possible changes

the elementary teachers of science, but we flesh out each of these examples for the purpose of fully developing the theoretical model.

Vignettes

We will return to Beth, one of the teachers who opened this paper. Beth is the high school biology teacher with National Board certification, whose students have a history of performing well on standardized examinations as well as in their future biology coursework in college. The following is a discussion between Beth and a colleague, Susan, the second week of school.

Beth: High Self-Efficacy, High Pedagogical Contentment

Susan: How was that university workshop you did in June?

Beth: Oh, it was fine. I really enjoyed seeing some of my friends, and it was a good chance for some of the newer teachers to get some strategies for teaching.

Susan: Are there things you can use this year?

Beth: Oh, there were some good suggestions for ways to increase student conversations during lab, but my students are already doing really well. You know I am always pulling in new inquiry-based labs and applets in my classes.

Susan: Do you think I should go next summer?

Beth: Well, they paid us \$500, and maybe there will be something you'll want to use. I suppose they will come and observe this year, but I'm used to that. I have administrators and student teachers in my room all the time trying to see what I am doing with my students.

We should not be surprised by Beth's limited engagement with the professional development experience, or lack of plans to change her teaching, post workshop. Viewed through our theoretical lens, Beth's current affective state (a high degree of teaching self-efficacy, low pedagogical discontentment) would not be conducive to openness, receptivity, or strong engagement with professional development messages. Beth is content with her limited use of discussion in the classroom and she understands her teaching to be highly effective, thus it is not surprising Beth does not adopt any of the ideas presented in the workshop. Beth's vignette reflects her contentment, and resonates with research that implicates a high self-efficacy (confidence) in preventing reflection, which is a necessary precursor to change (Settlage et al. 2009; Wheatley 2002). Although a successful teacher, Beth may embody beliefs that reflect Wheatley's (2002) assertion that "types of positive teacher ... beliefs ... can actually obstruct educational reforms" (p. 7).

Contrast Beth's return with that of Brian, the high school chemistry teacher in his 25th year who is science department chair and whose students enjoy success similar to those of Beth. Today, Brian is discussing the workshop with his student teacher, Marcus, as they plan a lab.

Brian: High Self-Efficacy, Moderate Pedagogical Discontentment

Brian: (Setting up lab stations) One of my concerns is that lots of the students are doing the lab, but not necessarily understanding what the process is all about.

Marcus: Yeah, I remember feeling that way in some of the labs I have done in college.

Brian: Last year, my student teacher Leah used some strategies that really got students talking productively in the lab. I decided to participate in the same workshop she did, this summer. The workshop gave me some ideas for how to encourage more productive dialogue in the groups. Let's try having them use white boards to explain their procedures and see how it works.

Marcus: That seems like a good idea. What if we also have the groups discuss what they record on their white boards? If they are talking to one another as they write their notes on the boards and if they report out to one another, then we will be able to walk around and see if they are 'getting it'.

Brian: Hey, I like the idea of having them report out on their white boards to the class. Great addition, Marcus!

Viewed through our theoretical lens, Brian's affective state of a high degree of teaching self-efficacy is combined with a tendency to reflect on his teaching linked specifically to students' actions and students' learning in his classroom, rather than as thinking of it as overall a success. Thus, he examines the results of his teaching in terms of how he is directly involved, which is a feature of this general discontentment stance as opposed to one of contentment. This tendency to reflect may be due to a long-standing need to adapt his teaching to the dynamic nature of the student demographic he serves or it may be due to some personal characteristics. Whatever the case, the combination of these two (high self efficacy and tendency toward reflection) allows for the development of a moderate level of pedagogical discontentment. It is this combination of affective states that is optimally conducive to openness to change and strong engagement with professional development messages. Brian conceives of himself and his students as capable, and he tends to examine his teaching to determine if lessons "live up" to his expectations. When his lessons fail to allow students to achieve what he expects—that is, when he experiences some degree of discontentment with his teaching—Brian becomes open to looking for alternatives. As importantly, Brian also has the self-efficacy required to think of himself as capable of successfully employing these new ideas. Given that his student teacher exposed Brian to some discussion strategies Brian had not yet used himself with any degree of success, Brian had both the self-efficacy and pedagogical discontentment necessary to make him open to the ideas presented in the workshop.

Frank: Low Self-Efficacy, Moderate Pedagogical Contentment

Frank also was a teacher in this summer workshop, along with Brian and Beth. Frank is an experienced middle school teacher, whose first 10 years of service were in a suburban locale serving primarily middle class, English speaking students. Last year he relocated to a rural school district serving largely working class, English Language Learners in another state.

We listen to Frank as he plans with one of his colleagues, Jeannie, during the pre-planning days of the school year:

Jeannie: Is there anything new you want to do with our science classes this fall?

Frank: I'm not sure these kids will be able to read most of the materials that we have. I think we should keep things really simple, like we did last year.

Jeannie: Did you get anything out of that science workshop you went to?

Frank: Well, the ideas they discussed would work great with the kids I used to work with. They were emphasizing dialogue in labs to help student understanding. But the kids I had last year hardly spoke English, so I doubt most of them could carry on the dialogue they modeled for us. Really, most of the workshop seemed like it would work for mainstream kids.

Jeannie: So you think we should stick mostly to simple worksheets, again?

Frank: I guess that's our best shot at trying to get their test scores up a little this year.

In the workshop, it wasn't surprising to find Frank coming in at the last minute, leaving early and often socializing with colleagues more than grappling with the ideas presented. At his school, he struggles to meet the needs of his working class students and he recognizes that he doesn't have the skills necessary to teach science to English Language learners, thus his self-efficacy in this new teaching context is low. Frank's assessment of his new teaching context also reveals a strong contextual or job dissatisfaction. He views language ability as central to success in school and because his students are largely English language learners, he sees them as ill prepared for the rigors of school. Frank even views the students with stronger fluency in English as lacking prior knowledge and reasoning skills—considered necessary for success in science. Thus, Frank also has a strong contextual dissatisfaction.

Frank's self-efficacy for science teaching plummeted as his contextual dissatisfaction rose with the change in school and student demographics. It is interesting to note that this rise on contextual dissatisfaction was not accompanied by a strong increase in his pedagogical discontentment. The reason for this decoupling may be found in Frank's change in teaching self-efficacy. Given the massive change in context Frank is experiencing, he has come to think that it will be impossible for him to ever meet the needs of the students in his classes. He has begun to see his students as incapable of learning and himself of never being capable of teaching science in this context. Thus, Frank has developed a low teaching self-efficacy. Initially, he thought the summer workshop might help, as it stressed communication skills in class. However, it seemed clear to Frank that, lacking solid English language skills, his students would not be able to engage in the conversations promoted by the workshop.

Influenced by his strong contextual dissatisfaction and low self-efficacy, Frank again decides to simply teach each lesson as it is planned, not examining it afterwards to see its effectiveness as he does not anticipate success. This lack of reflection on his role in the success of the lesson and failure to examine a lesson to determine if it meets his teaching goals prevents Frank from developing a sense of pedagogical discontentment.

At this time Frank has neither the self-efficacy required to imagine himself capable of successfully teaching science in this new setting nor the pedagogical discontentment necessary to motivate him to deeply engage in the ideas of reform portrayed in the workshop. Frank's weak teaching self-efficacy and his contextual discontentment prevents him from viewing his teaching situation as anything other than hopeless. Overall, we would contend that professional development practices would be less than effective for Frank as he has not specifically problematized any aspect of his current teaching practice, and he understands the problems to lie with his students' skills, not his. His particular affective state (a low efficacy, low pedagogical discontentment, and extremely high contextual/job dissatisfaction) all work against his being reflective and receptive to learning novel teaching

strategies. We are not surprised to see few of these strategies employed in Frank's classroom—although he is quick to explain why these strategies wouldn't work for the children he is teaching.

DeeDee: Low Self-Efficacy, High Pedagogical Discontentment

DeeDee represents the last combination of pedagogical discontentment and self-efficacy that we'll consider. DeeDee is an elementary teacher, one with 5 years of experience. Her strength is in the teaching of the language arts and she has very high self-efficacy for teaching reading and literacy strategies. She loves helping her students learn to go beyond decoding, and DeeDee is particularly adept in selecting books to capture each student's particular interest to spark their continued engagement with texts. Although DeeDee has a high self-efficacy for the language arts, her self-efficacy for science is its polar opposite. Here she is discussing her plans for science with her colleague, Julia:

DeeDee: I thought we might do that integrated unit again on the rain forest.

Julia: That was fun last year. Do you want me to do the science part, again?

DeeDee: That would be great. I was completely out of my league when I tried to teach soil types and all of the information on the animals and classification 2 years ago. You did all those cool labs last year—I just wouldn't know where to start. It doesn't seem fair to the kids to saddle them with me for science. Let me help them with the writing. I'm good at that!

Julia: (Laughing). Yeah, you are pretty hopeless in science. Didn't that workshop help?

DeeDee: I really liked the ideas, but I don't feel confident doing open discussions when I don't know explain any of the basic science information. It's embarrassing.

Juliw: We make a good team.

DeeDee is interested in the techniques discussed in the workshop and she understands the rationale for their inclusion—she recognizes that deep understanding requires students to talk and think for themselves in an atmosphere that is both supportive and challenging. But she doesn't think she has the knowledge of science necessary to prepare for and support such discussions. DeeDee recognizes her own very limited knowledge of science and interest in science, and she recognizes that she currently lacks the conceptual or pedagogical tools necessary to effectively plan and teach science. But, her self-efficacy for literacy is high, and she knows what deep student engagement looks like. She recognizes student enthusiasm, interest and higher order thinking, and as she reflects on her teaching she recognizes that her current science teaching fails to illicit such enthusiasm, interest, and thought—thus her pedagogical discontentment for science is high. Although she realizes that her science lessons are typically lackluster, she doesn't think that she has the knowledge or skills to improve them: she has a low self-efficacy for science combined with a high pedagogical discontentment.

Discussion of Teachers' Receptivity to Reform

We've used the theoretical literature on conceptual change to suggest that pedagogical discontentment is an essential component of teacher change. We argue that problematizing

some aspect of one's current practice is essential in the early phases as it allows for teacher consideration of a new practice (Gregoire 2003; Gess-Newsome et al. 2003). Teaching self-efficacy is also a necessary component for a change in practice, as it influences whether or not a teacher will attempt to enact a practice that she has thoroughly considered. Thus, both a degree of pedagogical discontentment and a moderate to high self-efficacy are needed for teachers to adopt a teaching practice that runs counter to their current approach to teaching; but, as described by Gess-Newsome et al. (2003) and Gregoire (2003), pedagogical discontentment is required early in the process of considering a new practice and has been a missing component of the conversation to date.

Certainly, teachers' self-efficacy must be high enough (as is the case for Brian and Beth) for teachers to actively consider implementing a new teaching practice. However, in Beth's case, her self-efficacy is so high as to make any creation of pedagogical discontentment unlikely. Her long-term history of success at her school, her stable teaching context and her formula for adding some new items into her repertoire serves to limit Beth's deep reflection on her practices. Beth sees herself as very capable and she tends not to reflect closely on her teaching—preventing the development of pedagogical discontentment. Given this high self-efficacy we suspect that even if Beth's students were to fall in their performance, at least initially Beth would be likely to assume it is a change in the quality of the students rather than due to her instructional methods.

Brian's professional development encourages him always to try to improve his teaching. And, as with many schools, his school maintains a somewhat changing and challenging student demographic. This contextual instability causes Brian to constantly examine his teaching, as he finds that things that have worked in the past may not work as well with a current class. This tendency to reflect, allows for a moderate degree of pedagogical discontentment, resulting in Brian's fine-tuning of his practice to keep up with the changes he sees in his students.

Comparing these teachers allows us to see how their different degrees of teaching self-efficacy may be one factor that influences the development of pedagogical discontentment. Beth, who conceives of herself as very capable is largely unreflective and so has problematized little about her teaching practices, thus she has low pedagogical discontentment. Given this constellation of factors, Beth demonstrates little interest in engaging deeply in professional development activities in pursuit of changes to her current practices because she sees little need to improve. Instead, she considers herself a leader and a role model at the workshops she attends.

We assume that Frank will be encouraged to attend additional professional development programs in his district, given the low test scores of students at his school. If he maintains the goal of surviving and dealing with external contextual demands, if he continues to see the problem as a limitation of the students he is teaching instead of the manner in which he is teaching them, if he continues to see himself as incapable of teaching in this context, he is unlikely to closely examine his own teaching (a condition required to foster pedagogical discontentment) and so he will be unlikely to experience any real change as a result of professional development. Clearly a noteworthy event would be required to change this constellation of beliefs to allow Frank to become more open to reforms—perhaps the addition of a co-worker or student teacher who is very successful teaching a similar group of students would be enough to allow Frank to see what is possible in his teaching context.

DeeDee shows more promise for change from a theoretical perspective. If she could find a professional development experience that both addresses her limited self-efficacy in the teaching of science as well as allows her to see what is possible in the

teaching of science (and so understand what her current teaching is not achieving), there is a potential that she may find professional development effective in allowing for continued growth.

Brian, on the other hand, given his tendency to reflect allowing for his pedagogical discontentment and his high self-efficacy, is already equipped to find professional development potentially important in supporting him to address specific perceived problems in his practice.

We argue that the two constructs of *efficacy* and *contentment* are two important facets of a teacher's affective state that influence openness to reform messages and professional development. In terms of a conceptual change model of learning, only Brian and DeeDee currently reflect on their teaching, problematizing some aspects of their practices, thus creating dissonance and an impetus for change. We interpret Beth's extremely high efficacy and Franks' extremely low efficacy (along with a high contextual discontentment) combined with a lack of pedagogical discontentment as curtailing any meaningful movement toward change in their teaching.

These cases also allow us to see the influence of context on movements toward change. Both Frank and Brian work in challenging settings. Frank's recent change seems overwhelming, so his consideration of his teaching is overcome by his extreme contextual/job dissatisfaction. This pattern of extreme contextual dissatisfaction as overcoming any efforts toward reflection (thus negating the creation of pedagogical discontentment) has been documented in the novices examined by Saka et al. (2009). Brian's school context, while challenging, was not overwhelming, thus allowing for Brian to continue to engage in reflection on his practice.

Certainly, a teacher's predisposition to change practice is a complex interaction of many factors, some of which have been described in the literature (i.e., self-efficacy, identity, content knowledge, pedagogical knowledge, openness to new practice). This research introduces a new construct that allows for additional insight into an analysis of teacher change from the vantage point of self-efficacy, as it allows us to understand how even teachers with high self-efficacy can resist change in practice. And indeed, our analysis invokes the importance of teacher reflection as an important component of the change process, as it is only through this reflection that teachers can develop a sense of pedagogical discontentment. Reflection has been fostered in teacher professional development as a way for teachers to examine their beliefs and practices (e.g. Blanchard 2006; Borko 2004; Luft 2001). According to Richardson (1996), teachers' reflections on actions may change their beliefs as well as their actions, as beliefs and actions are interactive. Our work suggests one possible mechanism accounting for the change caused by reflection; a teacher's reflection on the results of teaching in terms of achieving teaching goals allows for the development of pedagogical discontentment, which allows one to more closely engage with messages of reform.

Implications for Pedagogical Discontentment Research

We entered this research trying to understand why "so many past attempts to reform schooling are invisible today" (Woodbury and Gess-Newsome 2002, p. 763). Recognizing that teachers must be at the heart of any attempt to change the practices employed in science teaching, we sought to understand what shapes the manner in which teachers respond to messages of reform (Smith and Southerland 2007). We recognized that conceptual change is shaped by affective concerns, such as motivations, emotions and beliefs (Park 2007; Pintrich et al. 1993; Sinatra 2005; Strike and Posner 1992). To date

much of this consideration of affective factors has focused on teachers' motivation, interest and teaching self efficacy (Brand and Wilkins 2007; Palmer 2006; Rice and Roychoudhury 2003; Scharmann and Orth Hampton 1995). The teacher education community has used an overly simplistic interpretation of the value of self-efficacy (Settlage et al. 2009; Wheatley 2002). A high teaching self-efficacy may prevent teachers from seeking change as they see themselves as already very capable. A moderate self-efficacy (measure of doubt of efficacy) may actually push teachers toward reflection, as they see that there is room for improvement in their teaching. We argue this time of reflection allows teachers to assess the effectiveness of their current practice (as opposed to their assessment of their future abilities) by asking "how was my teaching in that lesson?" Such reflection opens the door to pedagogical discontentment—and thus begins the process of refining one's teaching, modifying what they know and what they do in their science teaching practices. We argue that the inclusion of pedagogical discontentment in combination with self-efficacy allows for a much more useful model for understanding teachers' motivations to change than self-efficacy does, alone.

Wheatley (2002) discusses the role of self-efficacy in terms of teacher change and learning. He reminds us that teacher self-efficacy is context-specific and that it is unlikely teachers universally hold the same level of efficacy across all teaching practices or goals. He argues for educational researchers not to conceive of (and use) efficacy as a global construct, but rather as fluid affective state that may shift as teachers consider various aspects of their practice. Just as we view pedagogical discontentment as being an important antecedent factor in teacher change, Wheatley (2002) frames moderate self-efficacy in a similar light as he describes that limited but positive self-efficacy "may aid reform by fostering teacher learning in many ways: inducing disequilibrium and change, fostering teacher reflection, supporting motivation to learn and responsiveness to diversity, and promoting productive collaboration" (p. 16).

We are interested in how pedagogical discontentment emerges as a result of teachers' recognizing aspects of their current science teaching practices that are less effective than desired. As the contrasting cases of Beth and Brian suggest, certainly pedagogical discontentment is related to a teacher's tendency to reflect, as it is through this reflection that discontentment can be fostered. The reflection itself allows for an awareness of one's practices, a pre-cursor to considering change (Luft 2001; Park and Oliver 2008). Keeping within conceptual change models of learning, we argue that science educators should value these instances of uncertainty, dissonance, and discontentment. Just as Wheatley suggests that feelings of low self-efficacy about specific practices might be beneficial in change and learning, we argue the same for pedagogical discontentment. When embracing conceptual change models of learning to understand the professional development of teachers (i.e., Gregoire 2003), both may ring true.

Implications for Professional Development

One goal of understanding science teacher pedagogical discontentment is to better comprehend teachers' affective states prior to their taking part in professional development activities, thus assisting teacher educators to better craft such activities. A central aspect of this research trajectory is to describe (Sowell and Southerland 2006) and measure teachers' levels of pedagogical discontentment (Southerland et al. 2006). However, we feel it should be noted that this construct and associated scale development should not be used in a gatekeeper fashion, determining who should or should not participate in certain professional

development programs. Perhaps by allowing teachers to recognize how their own affective states can shape their learning, as is described in the work of Sinatra (2005) on intentional conceptual change, teachers can become aware of the need to reflect and problematize their practice in order to allow for learning (Park and Olive 2008). Many science educators set up situations to have preservice and inservice teachers problematize the results of their teaching (i.e., through a close examination of pre/post tests, interviewing students AFTER instruction). We've done that as a means of allowing teachers to see that current instructional practices may not be as effective as they had assumed. Perhaps the function of such practices is to engender pedagogical discontentment, and it is possible that such practices in combination with teachers' recognition of their own affective states, may allow for greater learning during professional development experiences.

Certainly, professional development should be crafted to include these central components, that of allowing teachers to understand the role pedagogical discontentment can play in shaping their own learning as teachers, followed by attempts to allow teachers to reflect on their own practice, fostering the development of some degree of pedagogical discontentment, thus increasing the effectiveness of such experiences. This work provides an additional theoretical tool to use in understanding teachers' affective states as we craft and evaluate professional development experiences designed to move teachers toward the use of reform-minded teaching practices.

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