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# Science Faculty Improving Teaching Practice: Identifying Needs and Finding Meaningful Professional Development

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While research into the effectiveness of teaching professional development for postsecondary educators has increased over the last 40 years, little is known about science faculty members' teaching professional development needs and their perceptions regarding what constitutes meaningful teaching professional development. Informed by an extensive review of the literature and numerous research projects involving hundreds of faculty members in the sciences from multiple universities, this paper seeks to help science faculty members assess their own teaching professional development needs as well as to seek out meaningful and effective teaching professional development activities to help meet their needs.

There is a national movement to improve undergraduate science instruction, specifically, and to increase the number of students graduating with a science degree. While much of the movement seems fueled by concerns that the US may be losing its competitive and creative edge in science, there is also a growing concern that undergraduate students not majoring in the sciences leave college with little understanding regarding science and are, thus, ill prepared to function as scientifically literate citizens. A wide array of stakeholders have pushed for the better preparation of postsecondary science faculty and staff to serve as educators knowledgeable and able enough to help diverse undergraduate student bodies succeed in the science disciplines (see American Association for the Advancement of Science, 1989; Committee on Science, Engineering, and Public Policy, 2006; Project Kaleidoscope, 2006; U.S. Department of Education, 2006; U.S. Office of Science and Technology Policy, 2006)

One means to improve science faculty members' teaching practice is through professional development for faculty with a focus on teaching and learning. While research into the effectiveness of teaching professional development (hereafter TPD) for postsecondary educators has increased over the last 40 years, little is known about science faculty members' TPD needs and their perceptions regarding what constitutes meaningful TPD (Bouwma-Gearhart, 2008, 2012). Researchers have claimed that professional development should not be treated as a "one size fits all" endeavor, arguing for more personalized TPD relevant for faculty with diverse backgrounds and professional realities (Cowan, George, & Pinheiro-Torres, 2004; Cross, 1990; Evenbeck & Kahn, 2001; Ory, 2000; Travis, 1997; Wallin, 2003; Weimer, 1990; Zuber-Skerritt, 1992).

Still recent research has highlighted some of the commonalities regarding TPD needs and effects that exist between faculty, including the research that this work summarizes regarding what is known about best meeting the TPD needs of those teaching in the science disciplines. The arguments in this paper are informed by an extensive review of the peer-reviewed literature, from the 1980s and on, and numerous research projects of the author involving hundreds of faculty members in the sciences from multiple universities. Ultimately, this paper seeks to help science faculty members assess their own TPD needs as well as to seek out meaningful and effective TPD activities to help meet their needs.

## Review of Literature

### Past Research into Science Faculty as Educators: Identification of Strengths and Needs Regarding Research-Confirmed Best Teaching Practices

Most postsecondary educators have room in their professional lives for teaching improvement. Empirical research has demonstrated that postsecondary faculty most often teach as they were taught, for instance, choosing to predominantly lecture even though this practice, while potentially useful in dynamic, discipline-specific form, has often been shown to be inferior to active learning for student knowledge acquisition and retention (Cross, 1990; Eble, 1988; Travis, 1997; Zuber-Skerritt, 1992). Like all postsecondary faculty, most in the sciences earned their advanced degrees at research universities, institutions not known, historically, for their focus on training graduate students to be effective educators (Austin & Barnes, 2005; Cole, 1982; Eble, 1988; Menges, 1994). Once employed at postsecondary institutions, the majority of science faculty receive little, if any, professional development aimed at improving teaching practice. Not surprisingly, then, there is room for improvement regarding this very important facet of most science faculty members' professional lives (as most readers of this journal recognize).

Nicholls' (2005) empirical work demonstrated that even the best-intentioned faculty members still hold

preconceived notions of teaching and practices that are resistant to change even in the face of widely accepted better teaching practices. Resistance toward reform of teaching practice occurs for a variety of reasons including the most often cited, and difficult to remedy: the unbalanced rewarding of faculty research over teaching efforts at many postsecondary institutions (Bouwma-Gearhart, 2008, 2012; Brookfield, 2000; Cole, 1982; Healey, 2005; LaPointe, 2005; Travis, 1997), especially within the "harder" disciplines (Hativa & Marincovich, 1995; Lee, 2000). Yet science faculty have shown agency in remedying some of the typical barriers in the way of improving their teaching practices (Bouwma-Gearhart, 2011, 2012); lessening two of these barriers is the focus of this article. This article concerns science faculty members' (1) recognition of common, but previously unidentified, needs with respect to improving teaching practice and (2) identification of meaningful and effective TPD activities to best address these needs.

**Identified Best Teaching Practices**

In order to attend to recognition of faculty members' teaching practice improvement needs, we must first problematize good teaching. A large body of empirical research has resulted in consensus among researchers regarding teaching practices that encourage positive student gains in terms of learning and retention in a wide range of contexts. The following review highlights some of the most commonly identified best faculty teaching practices and serves as the starting point for science faculty interested in improving their teacher practice by helping them to identify their teaching needs.

To begin, faculty should ask themselves, "How well do I…?"

**Engage students in active learning regarding science content and practices = inquiry.** Student engagement has been correlated strongly with student persistence and success regarding a subject, more so than many other student factors including student "preparation" for college (Astin, 1993; Kinzie, 2005; Pascarella & Terenzini, 2005; Trigwell, 2005; Umbach & Wawrzynski, 2004). Faculty should help students construct their own knowledge (Chickering & Gamson, 1987; Kuh, 2001; Umbach & Wawrzynski, 2004; Weimer, 2003). This is accomplished by engaging students in processes that resemble authentic scientific inquiry, including having students make observations and collect data, analyze data, construct their own explanations, engage in argumentation with peers about their explanations, and revise explanations as more data becomes available. While encouraging students' active learning is time consuming and may initially be met with some student pushback, the payoffs are worth it. Inquiry at the postsecondary level has been shown to encourage students' deeper understanding as well as their future commitment towards ensuring their own deeper understanding (Healey, 2005; Kinzie, 2005; Prosser, Ramsden, Trigwell, & Martin, 2003; Trigwell, 2005; Weimer, 2003). Inevitably, this has allowed for science educators' surprise in discovering a welcomed redistribution of power in the classroom, where students take more ownership of their learning and educators are free to respond to more advanced and pressing needs (Bouwma-Gearhart, 2010; 2011).

**Challenge students.** Faculty should provide students with enriching and challenging educational experiences (Kuh, 2001; Umbach & Wawrzynski, 2004) that require their gradual building of understanding of scientific phenomena and practices. While it is natural to assume that many students cannot, or will not, rise to the challenges presented by faculty, students of varying past school "success" have reported gains in social and personal development, as well as knowledge acquisition, when faculty challenge them (Umbach & Wawrzynski, 2004). Challenging curricula and instruction emphasize depth of student understanding over breadth (Weimer, 2003).

**Promote cooperative student learning.** In addition to mimicking the work of practicing scientists, collaboration between students has been shown to benefit students in multiple ways, including helping them to develop critical social work skills and, most important, heightening their learning (Chickering & Gamson, 1987; Kinzie, 2005; Kuh, 2001; Trigwell, 2005; Umbach & Wawrzynski, 2004).

**Respect and allow for diverse ways of learning and knowing.** Faculty should adjust curriculum, instruction, and assessment appropriately so that all students feel supported and challenged academically (Chickering & Gamson, 1987; Kinzie, 2005).

**Evaluate students for true understanding, in a way that increases students' understanding and that allows students to be metacognitive about their own learning.** As typical "tests" (e.g., journal submissions and conference presentations) of faculty knowledge and skills allow, students' assessments should also allow students to synthesize and extend their knowledge (Kinzie, 2005; Weimer, 2003). Faculty members need to help students to develop awareness of their own learning strengths and weaknesses (Weimer, 2003). Formative assessment of students has shown promise in allowing faculty to discover what students have and have not understood, timely related feedback to students has been shown to be most meaningful with respect to student impact (Chickering & Gamson, 1987; Kinzie, 2005).

**Effectively interact with students.** The most meaningful and effective faculty interactions with students have shown to be those that happen frequently,

are positive and encouraging in manner, and that clearly convey faculty expectations (Astin, 1993; Chickering & Gamson, 1987; Kinzie, 2005; Kuh, 2001; Pascarella & Terenzini, 2005; Reid & Johnston, 1999; Trigwell, 2005; Umbach & Wawrzynski, 2004; Weimer, 2003). It has been argued that how faculty interact with students is more important to student learning than either the structure or content of the curriculum (Astin, 1993). Students associate teaching that has fostered their deeper learning with faculty approachability and an ability to create an atmosphere that supports positive interactions (Reid & Johnston, 1999). Meaningful interaction can be both formal and informal (Astin, 1993; Pascarella & Terenzini, 2005), through electronic means or face-to-face (Kinzie, 2005).

Of course, faculty members' professional development needs in light of research-identified best teaching practices are more easily assessed then rectified; most faculty require more than just reflection to improve their teaching practices. In hopes of fostering more faculty agency in identifying and choosing meaningful TPD, let us now turn to what is known about what makes TPD effective in meeting faculty needs with respect to these best practices, specifically informed by research regarding effective TPD for science faculty.

## Past Research into Teaching Professional Development for Faculty as Educators: Identification of Quality Teaching Development to Meet Teaching Needs

For the purposes of this paper, teaching professional development (TPD) is defined as "programs and activities that engage educators in reflection or learning about pedagogy with the goal to improve teaching knowledge or practice" (Bouwma-Gearhart, 2012, p. 559). Broadly defined, TPD can take many forms in the postsecondary environment; yet certain forms, according to scholarly reviews and empirical research, have dominated.

**Common teaching professional development forms in higher education.** Weimer and Lenze (1994), in a review of empirical research on the matter, classified postsecondary TPD into five categories (defined below). Most institutions offer a variety of forms, and Zuber-Skerritt (1992) has argued that they should. Yet these forms, according to my research with hundreds of science faculty and confirmed by others' research, may be of differing worth to science faculty. The most common TPD forms, in order of worth according to my research participants (Bouwma-Gearhart, 2008) have been: (1) workshops, seminars, or courses; (2) consultation of teaching resource material, paper or electronic; (3) colleague-to-colleague mentoring; (4) consultations with individuals at education centers or with education "experts"; and (5) Grants/sabbaticals for work on teaching curriculum/instruction.

***Workshops, seminars, or courses.*** These are among the most common forms of TPD since the 1960s (Amundsen & McAlpine, 2008; Sunal et al., 2001; Weimer & Lenze, 1994), admittedly one possible reason for the saliency of this form for faculty. My research participants have also cited these forms' ability to foster greater collaboration and trust between participants with similar needs and the active learning of participants (Bouwma-Gearhart, 2008, 2012). Workshops and seminars can be relatively short in duration, less than an hour at times; yet short workshops have been shown to yield limited benefits (Levinson-Rose & Menges, 1981) and increased length of TPD initiatives (this type of TPD can last days or weeks) can yield greater participant gains (Kreber, 2001; Sunal et al., 2001). This type of TPD is commonly offered at disciplinary meetings, occurring alongside the typical sharing of disciplinary research. My own research participants have indicated that they value learning about teaching and learning from others who teach in their discipline (Bouwma-Gearhart, 2008, 2011, 2012).

***Consultation of teaching resource material, paper or electronic.*** Although potentially the most common form of TPD for faculty, little is known of its effectiveness (Sunal et al., 2001). Many faculty engage privately with journal articles (like the ones in this journal) and other forms of teaching resources. Teaching resources are ever more commonly distributed and acquired through electronic means, often taking the form of on-line tutorials and podcasts, instructor-led or self-paced (Wallin, 2003). My own research participants have claimed that this more private form of TPD has been most meaningful with respect to addressing their most pressing needs as participation in TPD with those with drastically different needs limits the positive effects of participation (Bouwma-Gearhart, 2008, 2011). In addition, my research participants working at research universities appreciated how this form of TPD avoids having to deal with others' real or perceived disapproval regarding their TPD participation (Bouwma-Gearhart, 2008).

***Colleague-to-colleague mentoring.*** Faculty may form partnerships or small study groups, participate in "brown bag" discussions, or engage in larger learning communities committed to exploring issues of teaching and learning. Sometimes these groups are more concerned with teaching methods and assessment; other times they take their inquiries to the level of classroom research (Cross & Steadman, 1996; Steadman, 1998). Faculty members have claimed to appreciate consultation regarding issues of teaching on a more

personal basis (Sunal et al., 2001) and this type of faculty development type can afford this. Similar to claims made about workshops, my research participants have claimed as benefits of colleague-to-colleague mentoring the ability to have their discipline-specific teaching needs met (Bouwma-Gearhart, 2008, 2011, 2012).

***Consultations with individuals at education centers or with education "experts."*** Campus teaching and learning centers are becoming ever more common since the 1970s; according to Zuber-Skerritt (1992), most institutions of higher education in the United States had developed one. Such centers are staffed by education or faculty development specialists (Amundsen & McAlpine, 2008; Millis, 2001); while the underlying philosophy of the position may be "answer provider," others are built on a model of faculty development specialists as "facilitators" (Zuber-Skerritt, 1992). While administration conducting personnel evaluation may be seen as a form of faculty development falling under this category, faculty have been noted that do not view administrators as teaching experts or appreciate administrator feedback (Wallin, 2003). As have my own research participants (Bouwma-Gearhart, 2008, 2011, 2012), faculty members claim to appreciate consultation on a more personal basis (Sunal et al., 2001) and that is tailored to their immediate concerns (Cole, 1982).

***Grants/sabbaticals for work on teaching curriculum/instruction.*** Whether financed though institutions or outside sources, grants that provide release time or additional salary to work on the (re)development of curriculum and instructional activities are limited and, as such, so is the research looking into the pros and cons of such TPD. A general lack of financial support, as well as competing demands regarding any secured grant that may support some TPD, may be partly to blame for this type of TPD being ranked lower by my own research participants in terms of meaningfulness and effectiveness (Bouwma-Gearhart, 2008). Grants that encourage research on one's own teaching, specifically, allocate the power of faculty development to the actual practitioners with the potential to impact their actual students (Cross, 1990). A specific tie between research and teaching within TPD activity has been shown to be especially helpful towards faculty identifying their teaching weaknesses and strengths (Bouwma-Gearhart, 2012; Elton, 1995; Nicholls, 2005). Sabbaticals may encourage faculty outside of the field of education to publish on their findings related to teaching and learning during this time in lieu of publishing in their own discipline without fear of punishment (Kreber, 2001). Grants seen as more prestigious and meaningful towards tenure and promotion bids have been especially motivating of research university faculty to engage in TPD (Bouwma-Gearhart, 2011).

**Meaningful Teaching of Professional Development**

While it is important to take into consideration the characteristics of the different types of TPD in terms of meeting one's teaching needs, the quantity and quality of TPD, according to my science faculty research participants and the empirical research and scholarship of others, are important when choosing a TPD activity. Faculty have been shown to reap more benefits when engaged in various types of faculty development in close temporal proximity if not concurrently (Bouwma-Gearhart, 2011, 2012; Sunal et al., 2001). As one of my research participants, a faculty member in a medical school at one major research university, sagely noted, "The number one predictor of TPD involvement is TPD involvement," indicating that faculty engagement with TPD also begets more engagement. Yet my research participants have even more strongly argued for the importance of quality TPD, claiming quality TPD can motivate future participation, and participation in non-quality TPD can impede it (Bouwma-Gearhart, 2008, 2012). While the definition of "quality" TPD differs for those who have experienced it, there are research-identified TPD characteristics, practices, and theoretical orientations that have been shown to be most effective in encouraging faculty to positively reform teaching practice in a great variety of contexts. In creating, demanding, and seeking quality TPD, my research participants have asserted that science faculty should be aware of these factors identified as characteristics of effective TPD and seek out TPD with these characteristics (Bouwma-Gearhart, 2008, 2012).

TPD should be intentional (Guskey, 2000; Sunal et al., 2001) in terms of catering to individual needs (Bouwma-Gearhart, 2011; Cole, 1982). Effective TPD has shown to be based on the premise that faculty vary in their needs and strengths, especially at different points in their career (Bouwma-Gearhart, 2011; Cowan et al., 2004; Ory, 2000). Some aspects of faculty development are more salient at times than others (Akerlind, 2005). TPD must recognize faculty as always progressing in terms of their practice (Cowan et al., 2004; Ory, 2000). To cater to individual needs and continued growth, several different types of TPD activities should be available and connections between types should be apparent (Sunal et al., 2001).

TPD should be continuous and ongoing, increasingly challenging (Menges, 1997) and allow for incremental revisions to teaching practice (Angelo & Cross, 1993; Bouwma-Gearhart, 2008; Travis, 1997). Most learners need to gradually reconstruct their perceptions and practice and faculty are no exception. Kreber and Cranton (2000) cautioned that faculty cannot be expected to develop themselves significantly in too many facets of faculty practice at once. TPD should address the "lowest" needs of faculty first

(Owens, 2001; Wallin, 2003). Once mastered by faculty, topics should be eliminated from subsequent activities (Bouwma-Gearhart, 2008; Zuber-Skerritt, 1992). While science faculty have stated their preference for shorter workshops as their main TPD outlet (Bouwma-Gearhart, 2008), Levinson-Rose and Menges (1981), in their review of over seventy papers published between 1960s and 1980, found shorter workshops to have the most limited long-term effects on postsecondary educators and their students.

TPD should actively connect faculty teaching practice with student learning (Bouwma-Gearhart, 2008; Cowan et al., 2004; Elton, 1995). Although often assumed to be most important, improved student learning has not always been the outcome, or even the focus, of many faculty development initiatives (Cross, 1990). While many TPD initiatives may have as their purpose the improvement of faculty teaching, their focus is most notably the remedy of general faculty teaching "errors" and less about helping faculty to aid in student learning in a specific context (Cross, 1990). In order to acquire new knowledge and skills, faculty must be allowed to try out their new knowledge and skills as soon as possible (Menges, 1997; Zuber-Skerritt, 1992). Active learning, experiencing the effects of novel teaching practices as students themselves, may be critical towards the future implementation of faculty members' reformed teaching practices (Cowan et al., 2004; Menges, 1997).

TPD should allow practitioners to adequately reflect on what they learn about teaching and student learning (Bouwma-Gearhart, 2008; Menges, 1997; Neumann, 2005; Nicholls, 2005; Ory, 2000; Prosser et al., 2003; Schön, 1987). There has been the tendency for faculty to evaluate new techniques during TPD activities too quickly; such process "is neither systematic nor reflective" (Weimer, 2003). Faculty must receive encouragement and the resources needed for prolonged reflection (Bouwma-Gearhart, 2011; Menges, 1997). Faculty members, if given the chance, have shown ability to discover discrepancies between their ideal and actual practice (McDaniel, 1987; Zuber-Skerritt, 1992) and need to discover for themselves the solutions to these conundrums.

TPD should allow practitioners to engage in a safe learning community regarding teaching and learning (Bouwma-Gearhart, 2008, 2011, 2012; Boyer, 1990; Evenbeck & Kahn, 2001; Kreber, 2001; McDaniel, 1987; Menges, 1997; Ory, 2000; Zuber-Skerritt, 1992). Hutchings and Huber (2005) have envisioned a "teaching commons" very similar to the "research commons" in which academics share a "conceptual space" with others interested in collaborative learning about pedagogy. Neophyte educators have been shown to benefit from collaboration with those with more experience, such as senior faculty and education specialists (Bouwma-Gearhart, 2011; Kreber, 2001; Zuber-Skerritt, 1992). Faculty members may better trust those from the same department or discipline (Evenbeck & Kahn, 2001), although a shared common interest with other TPD participants (regardless of discipline) towards improving teaching may be the most salient factor underlying science faculty members' conception of a safe TPD community (Bouwma-Gearhart, 2008, 2011, 2012).

TPD should be larger-context specific (Cowan et al., 2004; Cross, 1990; Evenbeck & Kahn, 2001; LaPointe, 2005; Menges, 1997; Millis, 2001; Ory, 2000; Sunal et al., 2001; Travis, 1997; Wallin, 2003; Weimer, 1990; Zuber-Skerritt, 1992). *Context* refers to many things, including the type of institution and discipline as well as other needs that may unite faculty from seemingly disparate institutions and disciplines. More systematic change can be achieved if TPD initiatives are built around a core group of courses, perhaps regarding a discipline's core curriculum (Bouwma-Gearhart, 2011; Weimer, 2003).

TPD should reflect administrative and institutional missions committed to providing and encouraging faculty participation in TPD (Cole, 1982; Wallin, 2003). Effective administrators have been seen as those making firm, long-lasting commitments of resources and other supports to guarantee institutional plans for teaching and learning reform (Bouwma-Gearhart, 2011; Millis, 2001; Travis, 1997; Weimer, 1990; Zuber-Skerritt, 1992). With the backing of their institution, faculty members have reported feeling more encouraged to venture out on a pedagogical limb (Bouwma-Gearhart, 2011; Cole, 1982). Additionally, a restructuring of the system to reward good teaching, as well as research, encourages faculty TPD (Bouwma-Gearhart, 2011; Healey, 2005; LaPoint, 2005). Administrators should attempt to lessen commonly cited barriers of faculty TPD participation, including limited time and resources (Bouwma-Gearhart, 2011, 2012; LaPointe, 2005; Sunal & Hodges, 1997), turf conflicts (Sunal & Hodges, 1997), and negative attitudes of colleagues towards TPD (Hannan & Silver, 2000; LaPointe, 2005).

TPD should help all stakeholders be both patient and aware of other pressures that may get in the way of significant change (Evenbeck & Kahn, 2001). Change in higher education, especially with respect to faculty practice, is slow (Neumann, 2005). Even when an entire faculty adopts a model of professional development the anticipated results have been shown to take seven-plus years to attain (Travis, 1997).

TPD should incorporate faculty input with respect to their development needs and the means through which they can develop professionally (Bouwma-Gearhart, 2011; Cowan et al., 2004; Ory, 2000; Sunal et al., 2001). Faculty, themselves, can be the primary

driving force of TPD activities (Bouwma-Gearhart, 2011; Elton, 1995; McDaniel, 1987; Menges, 1997; Travis, 1997; Wallin, 2003; Weimer, 1990; Zuber-Skerritt, 1992). Faculty attribute control over their academic interests as a main contributor to job satisfaction (Akerlind, 2005), and there are other practical reasons to grant them control.

TPD should be built on research documenting that faculty are motivated by intrinsic (Cross, 1990; Hutchings & Huber, 2005; McDaniel, 1987; Millis, 2001; Owens, 2001; Wallin, 2003; Zuber-Skerritt, 1992) as well as non-punitive extrinsic motivators and rewards (Bouwma-Gearhart, 2008, 2011, 2012; Cole, 1982; Hutchings & Huber, 2005). Postsecondary administrators have themselves acknowledged an inability to attain the faculty commitment they desire by forcing their staff to engage in TPD activities (Bouwma-Gearhart, 2011). There is evidence that higher education practitioner research has advanced over the last fifteen years because of the intrinsic interest of faculty and their realization of its usefulness (Cross, 1990; Hutchings & Huber, 2005). Yet this should not negate the possible gains that can be reached via document extrinsic rewards driving faculty members, such as internal and external financial support for TPD and the revision of promotion and tenure systems to reward good teaching (Bouwma-Gearhart, 2008, 2011, 2012; Cole, 1982; Hutchings & Huber, 2005).

TPD initiatives should be informed by educational research and theory (Kreber, 2001; Zuber-Skerritt, 1992). Faculty need to be exposed to educational research that addresses everyday classroom issues in order to be motivated to change their teaching practice (Weimer, 2003). Not only will this improve the effectiveness of efforts by conveying what is known about best teaching and learning practices, but this will also help secure the buy-in of a population who values academic scholarship (Kreber, 2001). Science faculty have reported needing help to better understand education research and theory by individuals more knowledgeable of this work and sensitive to their evolution (Bouwma-Gearhart, 2011).

## Conclusion

Historically, TPD for postsecondary faculty has been created and delivered with the view that faculty are solely "the objects of activities conducted by others" (Menges, 1997, p. 410; see also Brookfield, 2000; Kreber, 1999; Quinn, 2003) with too little attention to faculty members' desire and agency, individual or collective, in identifying their teaching needs and helping to conceptualize programs and activities to best meet these needs (Bouwma-Gearhart, 2011, 2012). Despite the concern and well-documented barriers concerning effective TPD for faculty, my own research and that of others indicates that many faculty are deeply concerned about their teaching and their students' learning and do work to make relevant improvements (Austin, 2002; Austin & Barnes, 2005; Bouwma-Gearhart, 2011, 2012; Nicholls, 2005). In addition, faculty can identify their own teaching and learning problems and direct themselves towards the information they need to form their own solutions (Bouwma-Gearhart, 2008, 2011, 2012; LaPointe, 2005; Lattuca, 2005; Nicholls, 2005). While institutions, administration, and policy makers have power and responsibility to provide the encouragement and resources for faculty to create their own realities (LaPointe, 2005), change must be recognized as starting with faculty at the individual level (Travis, 1997; Zuber-Skerritt, 1992). There is evidence that faculty change at the more individual level can even drive departmental-, unit-, and institution-based change with respect to teaching and learning (Bouwma-Gearhart, 2011; Hutchings & Huber, 2005). Informed by recent research with respect to professional norms of science faculty, research-informed best teaching practices, and research into effective TPD, this paper specifically advocates for science faculty members to act to both identify their teaching needs and work towards meeting these needs through TPD to, ultimately, help foster the widespread change needed in postsecondary science education.

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