Holistic STEM Faculty Development

Subject/Problem

Challenges facing faculty in the science, technology, engineering, and mathematics (STEM) disciplines include facilitating learning of science as the validity of science is questioned daily in the popular press, securing funding as agencies tighten budgets, mentoring graduate students faced with an uncertain job market, and providing a skeptical public with practical information to demonstrate the importance of science in their lives. The support available to STEM faculty in the 21st century should encompass all of these challenges and more. Currently faculty development is focused either exclusively on teaching and learning or is fragmented with different campus units providing guidance and advice on grantsmanship, teaching and learning, and leadership. For the synergy needed to achieve job satisfaction and the necessary productivity, today's STEM faculty should have access to a holistic approach of faculty development that considers all aspects of their job as well as the balancing life and work.

The research underpinning holistic faculty development and the effects of such development is limited. The effects of faculty development focused on teaching and learning have been explored extensively (e.g., Bouwma-Gearhart, 2012; Henderson, Beach, & Finkelstein, 2011; Luft & Hewson, 2014; Sunal et al., 2001). However, the other aspects of roles important to promotion, tenure, and job satisfaction are less explored (e.g., Gonzales & Terosky, 2016; Pfund et al., 2015). The need for research on the effectiveness, productivity, and job satisfaction due to holistic faculty development for those in the STEM disciplines is evident. A recent workshop to develop a national research agenda examined research questions to fill the gaps.

Design or Procedure

The National Science Foundation funded the workshop "How Many Hats Do You Wear? Building Research Capacity for STEM Faculty Research Development" in February 2017. The hypothesis underlying the workshop was that STEM faculty development focused on the four major aspects of faculty work (teaching, research, service and leadership) will result in greater learning and success by students in STEM, productivity, job satisfaction, and retention. To deliver holistic STEM faculty development, evidence must be accumulated about its effectiveness, best practices, and effects for students, faculty, institutions, and the national STEM workforce.

The workshop engaged multiple perspectives by including a spectrum of communities engaged in research and practice. The workshop examined the inputs to, the process of, and the outputs from faculty development. Researchers and practitioners from science, engineering, and mathematics attended and contributed to wide-ranging discussions of the research questions regarding each of the aspects of holistic STEM faculty development.

The organization of the workshop was based on a previous workshop that developed a national research agenda for broadening participation in engineering by groups not routinely considered in such efforts. Research to engage individuals self-

Figure 1: Day 1 workshop process

Figure 2: Day 2 workshop process

identifying as veterans, LGBTQ+, low income/first generation, and those with disabilities in engineering was the focus of the previous research (Martin, Stefl, & Slaton, 2017). On day one of the two day workshop, the participants generated ideas about research questions, theoretical frameworks, and potential methods to investigate the questions around the three threads of inputs, processes, and outputs. The inputs thread examined the characteristics of faculty members and institutions that serve as barriers or supports to the uptake and implementation of holistic STEM faculty development. The processes thread the participants considered the implementation of faculty development, potential models, assessment, and logistical issues. The outcomes thread discussed the effects of faculty development on faculty identity, wellbeing, career satisfaction, and how these might be measured and evaluated. For each thread, the authors along with selected facilitators helped guide discussions to produce ideas related to an individual thread. Ideas were documented by participants on sticky notes. The participants wrote each question, theory, or method on a sticky note and then categorized each sticky note by attaching it to one of several sheets of butcher paper related to each thread (Figure 1). Participants circulated among focused discussions of each thread. On day two, small groups of participants worked together to produce concept maps to categorize and relate all the sticky notes accumulated on day one pertaining to a single thread (Figure 2). Each thread had two small groups analyzing the sticky notes, and therefore, two concept maps were developed per thread. The workshop is referred to as phase 1 of the agenda development process. A few weeks after the workshop, some participants returned and worked alongside the authors to produce a single concept map for each thread by blending the two thread concept maps generated during the workshop – this is referred to as phase 2 of the agenda development process. The authors analyzed the various concept maps with accompanying sticky notes to assemble a draft of the national agenda, which will be distributed to participants for member checking (phase 3). The draft agenda is also being shared via conferences such as this one with wider audiences to invite reactions, revisions, and feedback. Handouts and connections to a website will be available during the presentation.

Analyses and Findings

Some examples of the research questions that were developed for the three threads (inputs, processes, and outputs) by the workshop participants are shared in this section. The workshop participants who considered the inputs thread identified three broad themes of importance dealing with motivation, identity, and culture/context. The concept map developed in phase 2 (Figure 3) showed the themes as axes with endpoints for motivation of extrinsic and intrinsic, for identity of personal and professional, and for culture of institutional and individual. Motivation to seek or avoid faculty development could be related to the extrinsic motivation of the tenure and promotion process, according to the workshop participants. Rich research questions about tenure and promotion pressures and motivations for faculty development were apparent to the participants. Participants also suggested other sources of extrinsic motivation such as funding agencies and accreditation bodies. Administrators may be motivated by state legislators

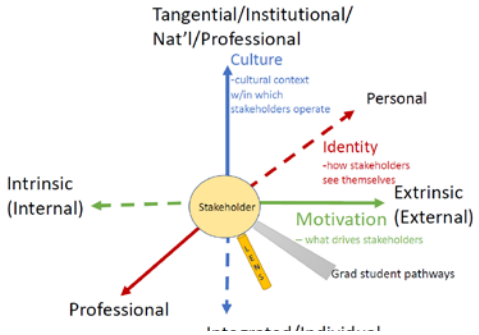

Figure 3: Phase 2 concept map for thread 1 Inputs.

who develop performance funding models for public institutions. Participants framed some research questions about how intrinsic motivation may change throughout a faculty member's career. Another question was whether there is a definable, useful, and common body of knowledge about STEM faculty life. Participants also considered the epistemic views of faculty and whether they assume that teaching, research, and leadership can be learned or that those talents are fixed. A key aspect of the discussion about the theme of identity was the intersectionality of multiple identities for faculty. An aspect of identity that arose was how the identity of the FD facilitator might affect delivery of guidance. The discipline, tenure status and rank or staff position might affect the faculty's perception of the facilitator's effectiveness. An issue raised by several participants was whether holistic STEM FD works for all faculty. Non-tenure track faculty, contingent faculty, adjunct faculty, non-traditional faculty, and two-year college faculty who have extensive experience in industry were some of the faculty who might not need FD across the four areas that were outlined in the workshop. Faculty development should be inclusive and support diverse faculty. Research questions that emerged for culture included how might the culture of a department, institution or discipline be a support or a barrier for holistic STEM faculty development. Another question that the participants suggested was the role of STEM faculty development in the recruitment and retention of diverse faculty. Participants also considered holistic to mean that not only should all aspects of faculty's work life be considered but their personal life should be part of development to achieve job satisfaction.

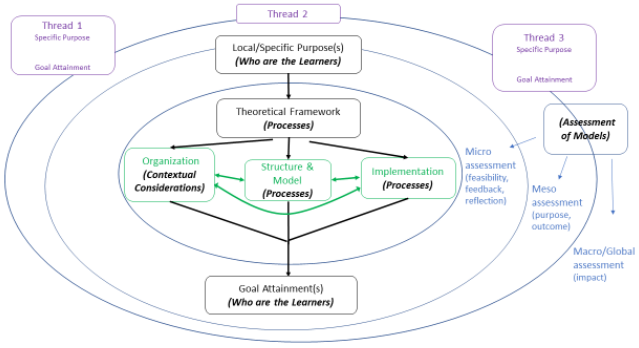

Figure 4. Phase 2 concept map for thread 2 Processes.

For thread 2, processes, we organized the emerging themes into four larger categories of contextual considerations, processes, assessment of models, and who are the learners. The conceptual map from phase 2 (Figure 4) shows how the four categories are related. The category of contextual considerations is related to the structural or organizational contexts that might influence the development and implementation of a model of holistic STEM faculty development. The workshop participants also stressed the notion that institutions are all different, whether two-year, four-year, teaching intensive, research intensive, and so on. In addition to these types of institutions, the contextual landscape within each institution is different. Added to these differences are the fast-moving trends in research, teaching, and commercialization that faculty must address. Research questions such as what support structures does one need to implement faculty development models, what is the optimal level of support for faculty development, and what are department-based cultures for supporting development were brought up in discussions. Workshop participants often cited concerns surrounding tenure and promotion as did the participants considering thread 1 (inputs), explaining either that faculty development should be part of the tenure and promotion structure or that the time commitment for faculty development stood in contrast to what was valued for tenure and promotion. Finally, participants identified the need to determine who is responsible

for FD when development comes from multiple units at a university (e.g. teaching and learning centers, conferences, special initiatives, development within each college/school).

The participants in the third thread concerned with outputs highlighted some of the same ideas that appeared in the previous two threads as well as several new insights. The concept map developed in the second phase (Figure 5) shows the concept map from phase 2. One of the new insights was research questions about the relationship between faculty development and a host of factors such as productivity, tenure or promotion success, learning by students, retention, sense of well-being, and feeling valued. The participants suggested metrics for assessment of holistic faculty development that included lifelong learning, developing self, and valuing holistic activities among other factors. The identity of individuals and communities in faculty development as scholars and faculty advocates is an important topic for research. Participants wondered if there are different models of STEM learning across the STEM disciplines. Participants also pointed to graduate students as being a particularly important population to consider with respect to faculty development. Some themes that occurred in all discussions of the three threads were alignment of the individual's and institution's goals, faculty's multiple identities, concepts of holistic faculty development, the roles of context (or culture). Inclusion of diverse faculty was valued by participants in all three threads. Participants also emphasized that reward and value for all competing goals (i.e., job satisfaction vs. productivity or teaching effectiveness vs. research leadership) need to be examined and aligned.

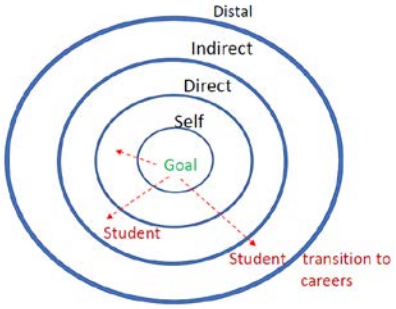

Figure 5. Phase 2 concept map for thread 3 Outputs.

Various processes have been used in the past to generate research agendas for emerging fields of interest to national priorities. None of these processes is without challenges (e.g., Rodriguez, 1997; Dede, Ketelhut, Whitehouse, Breit, and Whitehouse, 2009). We realize that a national research agenda is a process rather than a single document because with a topic as broad as holistic STEM faculty development there is a large constituency that should contribute to the shaping of the research agenda. As a result, we are providing information and collecting feedback at many venues and as such value the input of the National Association for Research in Science Teaching organization and its members.

Contribution and General Interest

Effective teaching and learning of science can be enhanced through holistic faculty development for those engaged in science instruction in higher education. However, the complexities of faculty life in the 21st century must be understood and supported in the faculty development efforts. The research questions raised by participants in the workshop showed considerable overlap among the three threads, suggesting that initial research efforts focus on these areas. Additionally, efforts to explore the factors that act as barriers or supports may be important initial studies. However, the themes presented here may not represent the complete picture of holistic STEM faculty development; through engaging the NARST community the authors hope to refine and expand the ongoing development of this research agenda so that it resonates with all disciplines of the STEM teaching and learning community.

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