

How Many Hats Do You Wear: Building Research Capacity for STEM Faculty Development Workshop

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Dr. Linder is a co-author of multiple preschool, prekindergarten, and K-5 mathematics curricula. She has also worked to implement professional development models for preschool, prekindergarten, and K-5 teachers across the United States.

In addition to her work in curriculum, Dr. Linder has multiple national publications relating to early childhood and elementary mathematics motivation and achievement, preservice and inservice teacher quality and professional development, cross-curricular and technology integration in mathematics, and teacher beliefs related to mathematics pedagogy.

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Cindy M. Lee serves as the department chair of Clemson University's Engineering and Science Education Department, a graduate-only department that offers a graduate certificate program in STEM education pedagogy and introduction to education research methods as well as a PhD program in STEM education research. Cindy's research and teaching has focused on graduate education, sustainability education, and environmental chemistry. She has served as the founding program manager for the NSF Environmental Sustainability program. Cindy is an associate editor for environmental chemistry for Environmental Toxicology and Chemistry and a member of the EPA Science Advisory Board. She is on the board of the Association of Environmental Engineering and Science Professors, a professional society focused on education and research.

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Dr. Karen High holds an academic appointment in the Engineering Science and Education department and joint appointments in the Chemical and Biomolecular Engineering department as well as the Environmental Engineering and Earth Sciences department at Clemson University. Prior to this Dr. Karen was at Oklahoma State University where she was a professor for 24 years and served as the Director of Student Services as well as the Women in Engineering Coordinator. She received her B.S. in chemical engineering from University of Michigan in 1985 and she received her M.S. in 1988 and her Ph.D. in 1991 in chemical engineering both from Pennsylvania State University. Dr. Karen's educational emphasis includes: STEM faculty development, critical thinking, enhancing mathematics, engineering entrepreneurship in education, communication skills, K-12 engineering education, and promoting women in engineering. Her technical work and research focuses on sustainable chemical process design, computer aided design, mixed integer nonlinear programming, and multicriteria decision making.

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Abstract

Expectations for faculty members in the 21st century are high: Early career STEM faculty are expected to establish a sustainable research trajectory, a teaching practice, and a leadership role all while pursuing tenure success. Many colleges and universities have established faculty development programs, but there remains a deficiency in holistic professional support that integrates these disparate professional activities and aligns them with desired individual and institutional goals, especially for faculty in STEM. This paper will summarize an NSF funded workshop (NSF grant #EEC-1638888) designed to bring together multiple stakeholders in academia, government, and industry to begin to establish a research agenda for holistic STEM faculty development. This workshop was held February 17-18, 2017.

Introduction

The preparation and continued education of STEM faculty are more important than ever as we face a significant deficit in STEM graduates needed for workforce development. It is therefore important that holistic faculty development reinforce the importance of all aspects of faculty responsibility, including research, leadership, service and teaching. Unfortunately, many faculty struggle with balancing the sometimes competing goals of these responsibilities, and are often influenced by a reward structure that pushes research. However, research on teaching suggests that external motivation such as university reward structures can transition to more internal motivation through professional development experiences (Bouwma-Gearhart, 2012). Furthermore, research suggests that faculty support beyond the initial introductory workshop is needed for continued implementation of new teaching strategies (Henderson, et al., 2012). The same may be true for implementation of new strategies to enhance research, mentoring of graduate students, publishing, and the other requirements for tenure, highlighting the importance of sustained holistic faculty development.

To meet the grand challenges facing society, it is imperative that all are given an opportunity to contribute, including women and underrepresented minorities. Several efforts have used mentoring as a strategy to broaden participation in STEM. For example, women who were mentored as assistant professors were more likely to win grant funding than women who were not mentored (NRC, 2010). Other initiatives recommend that faculty development include topics such as teaching, service, collegiality, and racism to increase the number of traditionally underrepresented minority faculty at predominantly White institutions (Stanley, 2006). These kinds of strategies build an inclusive environment that is likely to improve job satisfaction and productivity leading to enhanced retention of all faculty.

Many other aspects of faculty development remain to be discussed and studied, including managing research agendas, participating in college service programs, and navigating the complicated requirements of tenure. Thus, it is essential that proper professional support is provided to STEM faculty.

Overview of Workshop Structure

Much of the method for workshop organization was inspired by the recent 2016 NSF-sponsored

conference, *Who's Not At The Table?: Broadening Participation in Engineering* (NSF grant #EEC 1551605); a conference designed to develop a national research agenda related to engaging persons self-identifying as lesbian, gay, bisexual, transgender or queer (LGBTQ+), veterans, low income/first generation, or having disabilities in engineering. The authors of this paper used their participation in the *Who's Not At The Table?* conference to shape the organization of the workshop outlined here; one team member and author of this paper, Stefl, organized the *Who's Not At The Table* conference and two other team members and authors, D. Lee and High, participated in the event. Additionally, High worked with Stefl and Martin, to develop the strategy for the second day of the conference where research ideas (on sticky notes) were used to create concept maps that informed the research agenda.

As organizers of the *How Many Hats Do You Wear* workshop, we were able to leverage our experiences with the previous conference to successfully host an NSF-sponsored event to develop a national research agenda on holistic faculty development. The methods in which we structured discussions around workshop threads, the ways we engaged participants, and some of the ways we collected and incorporated participant feedback in this workshop were inspired by the work of Martin, Stefl, and Slaton (2017). Specifically, we adopted key features of their event (Martin and Stefl, in preparation) including:

- (a) Discussion Threads: Similar to the above-described conference, we organized our workshop around core questions and research considerations (referred to as “threads”) essential to establishing a research agenda on holistic faculty development. Specifically, our workshop centered around three key dimensions of holistic faculty development: (1) Inputs for Holistic Faculty Development, (2) Mechanisms/Processes for Holistic Faculty Development, and (3) Outcomes of Holistic Faculty Development (described in detail in the following section). Each thread explored research questions, methods, practices, and potential limitations of existing faculty development programs and research.
- (b) Collecting Participant Information: Some of the key components inspired by the previous conference include pre-event surveys to collect and analyze applications for attendance (participant selection described in detail in following sections). In addition to the surveys developed by Martin, Stefl, and Slaton, we also collected pre-workshop assessment surveys where participants answered questions such as “How do you define STEM faculty development?” and “What do you see as the main issues or concerns surrounding STEM faculty development?” We used the participants’ responses to inform discussions throughout the workshop, and attendees participated in directed discussions about the three separate workshop threads in separate breakout session rooms. Before the workshop, we gave attendees the option to select which thread discussions they would prefer to participate in so that our attendees could choose which thread was most interesting, pertinent, or novel to them.
- (c) Engaging Participants Before the Event: We also followed the above-mentioned conference’s steps for engaging the participants ahead of the event. First, participants were asked to read articles selected by the organizers related to faculty development. Second, we required participants to share their knowledge of the existing literature surrounding faculty development by contributing journal article references to our growing bibliography related to holistic STEM faculty development. The participants’ contributions, along with references built up by this paper’s authors, are being assembled into an annotated bibliography. Third, we had attendees participate in an online discussion forum where they were given a chance

to weigh in on questions related to each one of the workshop threads. Each week participants were asked to respond to questions such as:

- “What aspects of faculty productivity should be measured to fully capture faculty development? Do current metrics suffice, and if not, what adaptations are needed?” and
- “In his article “The mythologies of faculty productivity,” Fairweather asserts that “simultaneously achieving high levels of productivity in teaching and research... is relatively rare” and suggests that viewing faculty productivity as an aggregate across faculty members is the key to increasing teaching and research productivity. Does your institution have policies in place to differentiate individual faculty responsibilities and allocate rewards in this way? Do you think such policies would be a good idea?”

Finally, participants created posters about themselves that were presented during the workshop. Each participant’s poster included information about their professional and research experience and interests related to holistic faculty development; we shared their feedback with other attendees during our opening session to paint the picture of the range of interests and experiences represented by our attendees.

- (d) Engaging Participants During the Workshop: We utilized much of Martin, Stefl, and Slaton’s (2017) model for developing a national research agenda through engaging the research community in a workshop or conference. Their model outlines the steps and materials through which event organizers can collect and leverage the knowledge of the research community to develop a national research agenda. We used this model to design our workshop’s sessions and materials. As mentioned previously, High worked with Martin and Stefl to develop some of the strategies used on day 2 of the workshop. Having both events in mind, pre-event discussions between High, Martin, and Stefl took place with the idea that the workshop and conference could employ the strategies described to organize sticky note research ideas into concept maps.

Development of the Three Workshop Threads

The workshop consisted of three threads that are explained below (Inputs for Holistic Faculty Development, Mechanisms/Processes for Holistic Faculty Development, Outcomes of Holistic Faculty Development). Each thread focused on identifying and refining research questions, potential methods and pathways for exploration and potential limitations. Within each thread, supporting strands explored various aspects of the concepts.

- Thread 1. Inputs for Holistic Faculty Development
- a. Motivation
 - b. Engagement
 - c. Institutional Expectations

This thread of holistic faculty development inputs focused on topics related to the characteristics of faculty members and institutions that serve as barriers or supports to the adoption and implementation of holistic STEM faculty development programs. Such inputs could include issues at the institutional, administrative, and individual level. For example, conflicts between institutional expectations and faculty expectations for holistic development, potential mediators of faculty engagement, faculty

motivation, financial support, or the policies of administration regarding STEM faculty development. Through this thread, we explored the factors that may influence STEM faculty development adoption and implementation. Topics that were raised by this thread included questions like:

- *What types of faculty development do faculty pursue?*
- *What incentives exist for engaging in faculty development? What are the disincentives? Are there schools that factor faculty development into tenure/promotion/reappointment considerations? Are sabbaticals seen as a method for faculty development? Are sabbaticals encouraged or discouraged?*
- *What are the benefits of faculty development for students, faculty, and administrators?*

Thread 2. Mechanisms/Processes for Holistic faculty development

- a. Implementation Structures
- b. Assessment/Evaluation Procedures
- c. Fidelity of Implementation

The mechanisms/processes thread focused on topics related to the actual implementation of STEM faculty development. This thread was used to consider the potential models or structures of STEM faculty development that are currently in place or conceptualized in theory. In addition, we explored issues of fidelity within these structures and how it is tracked, potential models for assessment and/or evaluation and how assessment data feed back into improving or refining the faculty development processes, and logistical issues related to these structures. Some of the questions from Thread 2 are listed below.

- *Who is responsible for implementing faculty development?*
- *How do implementers determine that the adopted approach reflects theoretical frameworks?*

Thread 3. Outcomes of Holistic Faculty Development

- a. Faculty Identity and Wellbeing
- b. Productivity and Metrics
- c. STEM Cultural Norms

This thread focused on identifying and refining research questions, potential methods and pathways for exploration, potential or observed limitations of approaches and attempts to understand the influence of faculty development on the faculty experience. To understand, for example, the relationship between STEM faculty identity and faculty development, as well as how faculty development influences overall faculty wellbeing, career satisfaction, and work-life balance. This thread also considered levels of faculty productivity, the qualitative and quantitative metrics used to measure it, and the cultural norms in STEM that are validated by STEM faculty development efforts. In these discussions, we worked to identify additional topics that relate to outcomes of holistic STEM faculty development and discussed the broader impacts of STEM faculty development. Examples of some of the issues are shown below.

- *How is faculty productivity currently defined and evaluated? How could this definition and evaluation of productivity be expanded or reconceptualized to reflect a broader and more holistic*

approach to assessing faculty performance?

- *What are the current cultural norms surrounding faculty development? Should current cultural norms be reinforced or overturned or modified? Might the current cultural norms stand in the way of broadening participation?*

Workshop Participants

Advertisement of Workshop

The proposal for funding of the STEM faculty development workshop was funded in August of 2016. Between September and October of 2016, invitations were sent to representatives of academic, government, and industry sectors. To ensure that a wide variety of invitees were contacted, flyers and informational emails were distributed to listservs for national organizations such as MAA (Mathematics Association of America) and ASEE-ERM (American Society for Engineering Education – Education Research Methods) division, to individuals who attended STEM faculty development conferences, to national science centers like the Alan Alda Center for Communicating Science, to individuals within government agencies such as NSF, and industries such as Boeing. Faculty members who had published in the faculty development field or attended faculty development conferences were also contacted. In many cases, invitees facilitated distribution of the conference information by passing the information onto their colleagues. Our invitation efforts were rewarded in November of 2016 with 130 completed applications (over 180 total applications).

Participant Applications

Individuals interested in participating in our workshop completed an online application survey that asked applicants to relate their professional/research interests and experience to our workshop goals. We asked potential participants to list their name, college/university/organization/company affiliation, job title and contact information. We also asked them to respond to the following open-ended prompts:

1. What role do you play at your institution?
2. Please describe how your participation has the potential to enhance our collective understanding of current and needed research with regard to STEM faculty training and development that can lead to improved research and educational practice.
3. Please describe how your participation can contribute to creating a national research agenda supporting STEM faculty training and development.

A total of 130 individuals submitted a complete application to attend. Once the application deadline had passed, we began the participation selection process. Participant selection was based on information provided by the individual on the application survey. Five research team members reviewed the applications. We printed each application and distributed to two reviewers. Reviewers rated each applicant using a rubric (see appendix A). The rubric assessed applicant engagement in faculty development, engagement in faculty development research, and understanding of faculty responsibilities. Additionally, using a 4-point Likert scale ranging from strongly disagree (1) to strongly agree (4) the reviewers rated applicants on a) whether the applicant should be invited to the workshop, and if invited, b) if the applicant should be a facilitator, or c) if the applicant should be a speaker.

Review of Applicants

We used the ratings for whether the applicant should be invited to the workshop to determine if the application merited further examination. Once we rated all applications, we compiled the data and rejected all applications that received a score of 2 or lower on invitation from both raters. Due to the overwhelming response from applicants, the number of quality applications that received a score of 3 or higher from both raters exceeded the number of participants that could be funded by the grant. As a result, we rejected almost all applications that received at least one unfavorable score with the exception that we accepted all applications from the home institution as these participants did not require accommodation or travel expenses and could be included with minimal funding. Additionally, we accepted one other application that received one favorable and unfavorable review since it was the only graduate student that applied, although graduate students from the home institution attended. The majority of applications received favorable scores (3 or above) from both reviewers and were reviewed further by three researchers. These three researchers evaluated the remaining applicants holistically, taking into account the balance of the workshop attendee population with respect to their professional affiliation with academia/government/industry, career phase, the role they play at their institution, and STEM field. From these metrics, the researchers decided to accept, reject, or place the applicant on a waiting list. Once application decisions were completed, we notified all applicants of their status. We asked accepted applicants to notify the organizers of their intent to attend the workshop, and to begin participating in pre-workshop activities. We invited waitlisted applicants to participate when accepted applicants informed the organizers that they were unable to attend. A total of 53 participants attended the workshop, with 11 of the attendees coming from the home institution.

Workshop Participant Description

Participants completed a pre-assessment survey before the workshop and an assessment after the workshop ended. In the pre-assessment survey, we collected data on the participants' backgrounds and interests related to STEM faculty development. As part of the pre-assessment survey, participants were asked for demographic information, permission to include their information in our research data, and to answer several open-ended questions. Participants were allowed to select all choices that applied when they answered demographic questions, so percentages may not add up to 100%. Of the participants that completed the pre-assessment surveys 95% worked at an academic institution while 5% worked for foundations and 4% worked in government-related positions. While no participants identified as working for industry, two representatives stated that they worked for industry foundations. Approximately 82% of participants classified themselves as faculty, with 27% classifying as director, 20% as administrator, and 5% as manager. 30% identified as early in their career phase, 50% as mid, 18% as late, and 2% as emeritus. These data indicate that the participants are skewed toward faculty in academia.

Participants' Previous Experience and Interests Related to STEM Faculty Development

We asked participants about the kinds of faculty development activities they had previously participated in or led. Their responses indicated that many of their previous experiences in faculty development were teaching-related; 68% participated in professional development in teaching while 53% participated in programs focused on research and 21% focused on service. Likewise, 83% of participants facilitated teaching professional development, 47% facilitated research, and 30% facilitated service professional development. This slant is also seen in the area in which the participants worked, with 57% of participants identifying STEM education as their area of work.

When asked to provide articles relevant to faculty development, participants reinforced the emphasis on teaching with respect to faculty development. Many of the articles provided by participants focused on professional development to improve teaching or ways to improve pedagogy. Other articles described strategies for introducing institutional change, acclimating new faculty to their institutions, and assessment of faculty development opportunities. Conspicuously absent are the two other aspects of professional development: service and research. It was therefore important for the workshop organizers to prompt participants to reflect on the relative importance of teaching, research and service aspects of professional development, and the significance of creating a balance among these three aspects.

Prior to the workshop, we asked participants to give their preferences for participating in the threads mentioned above. The results are shown in Figure 1. Choice of thread was generally mixed. Thread 1, inputs for holistic faculty development, was the least popular choice as the highest level of interest, but was the most popular choice for moderate level of interest. Thread 2, mechanisms/processes for holistic faculty development, was chosen the most as both the highest and lowest level of interest. Finally, Thread 3, outcomes of holistic faculty development, had equal numbers for highest and lowest levels of interest. While there was no general inclination for any of the threads, individuals did have preferences. These preferences were used to place participants into appropriate workshop sessions.

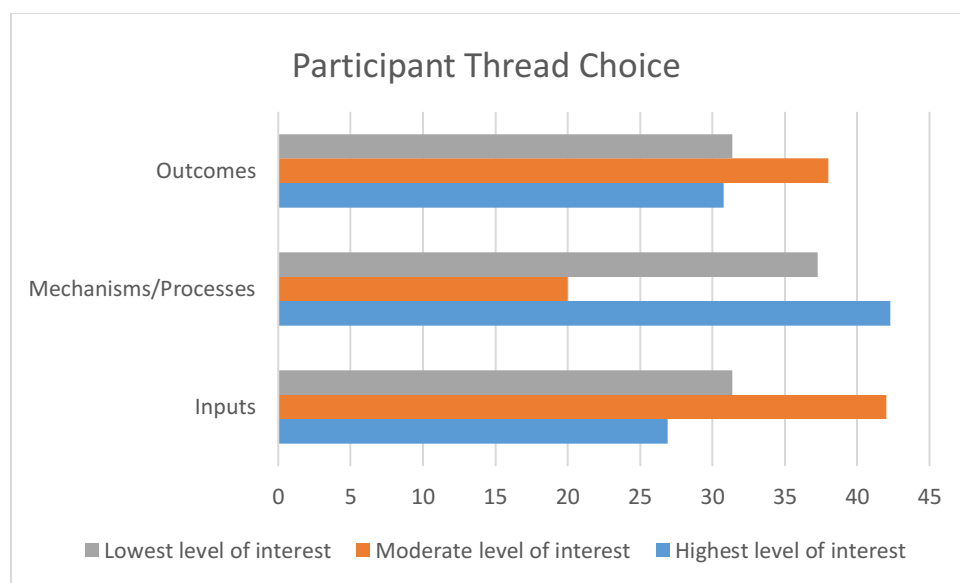


Figure 1 – Participant Thread Choice

The pre-assessment survey also asked questions about STEM faculty development issues, faculty expectations from the workshop, and information they would like to share with the workshop attendees. Following the workshop, the project team and external evaluator administered a post-assessment to all workshop participants. The post-assessment asked participants to rate workshop logistics such as ease of travel, transitions throughout each day, and accommodations. In addition, the post-assessment asked participants to describe how the workshop changed their views on holistic STEM faculty development and how they might go about defining this concept after having such in depth discussions with colleagues across the country. The post-assessment was administered two weeks following the workshop to allow for time to reflect on the entire process. These open-ended questions

to the assessment surveys will be coded, analyzed and will be reported in future publications.

Workshop Location and Schedule

The first day of workshop sessions (full day) took place in The Watt Family Innovation Center on Clemson University's main campus. The workshop sessions for the second day (half day) took place in The Clyde V. Madren Conference Center, also located on Clemson University's main campus. We have included a brief description of the workshop's sessions. We followed much of Martin, Stefl, and Slaton's structure of sessions (2017) as it was designed to build to a preliminary research agenda.

Day 1		
Session 1	Welcome, Expectations, Setting the stage, and Prior Research	Participants were formally welcomed to the workshop and organizers outlined the goals of the event, the model used to create the preliminary research agenda, and the three workshop threads. They also shared visual depictions of attendee's range of interests and experiences using word clouds generated from their responses to pre-workshop surveys.
Session 2	Poster Session	Participants shared their research interests with fellow attendees to help establish connections and network with each other before the breakout sessions.
Session 3	Speaker Session	Invited speakers took the stage to discuss their perspectives and experiences with each of the three Threads. They also addressed holes in the research in the three Threads.
Session 4	Breakout Session I	Attendees participated in one of three possible focused discussions about a single workshop thread led by a workshop organizer (C. Lee, Jamil, or Linder). These discussions were designed to share feedback from online pre-event discussions, and to encourage deeper reflection and responses to the thread questions. This was a new aspect that was not part of the <i>Who's Not At The Table</i> conference.
Session 5	Breakout Session II	Attendees participated in a second of the three possible discussions surrounding the workshop.
Session 6	Wrap Up Session	Workshop organizers summarized key discussions occurring throughout the first day along with commonalities and unique perspectives observed during the breakout sessions. Participants provided feedback and reactions to the first day of activities.

Day 2		
Session 1	Summary and Expectations for Group Work	Workshop organizers utilized Martin, Stefl, and Slaton's model to illustrate how attendees would take an active role in the research agenda development. Specifically, they walked participants through the model's steps for using

		concept maps (developed with High) to analyze participant-generated feedback related to the workshop thread discussions.
Session 2	Group Work	Participants were assembled into small groups where they were tasked with analyzing attendee's responses to thread questions and discussions to generate pieces of the preliminary research agenda
Session 3	Report Out and Workshop Evaluation	Participants shared the highlights of their group's discussions and were then asked to complete online surveys about their experiences in the workshop. Workshop organizers closed the workshop with a discussion about the insights and ideas participants had shared during the event and plans for dissemination.

Description of Preliminary Research Agenda

Results from the first day of sessions yielded a wealth of data related to each of the three themes. This data was further analyzed during the second day of the workshop where participants worked in teams to extract constructs from the ideas generated from day one sessions. The teams worked to create concept maps for each theme using these constructs. These concept maps are the main product from the two-day workshop that will be further refined over time to move towards the development of a preliminary research agenda.

Future Work and Plans for Dissemination

Products from this funded workshop include a workshop proceedings that is currently underway. These proceedings will include an overall description of the two day workshop, results from pre and post surveys of participant perceptions of the experience, and products from workshop sessions. In addition, a draft research agenda will be developed based on the concept maps created through the workshop. Following the workshop, the invited speakers and facilitators for each Thread provided feedback for the structure of the two days and identified aspects that they felt needed to be addressed before the final development of a research agenda. In particular, the participants felt that there was not enough time to fully develop ideas within each Thread. Resulting from this discussion, the research team felt an additional step was necessary before moving forward with final analysis of the workshop products. Therefore, a subgroup of participants from each Thread (Inputs, Processes, and Outputs) were invited back to Clemson to examine the concept maps and additional workshop products (e.g. observation notes, transcripts of workshop sessions, pre/post survey data) to refine our working understanding of each Thread, how they are interrelated, and how these results can be used to develop a final draft of a research agenda for holistic STEM Faculty Development. These meetings took place in April and May of 2017. Following these meetings, the research team begun final analysis of workshop products, a process that is currently underway.

The products outlined above will be made available to all participants and will be available for public consumption through the Clemson University STEM Faculty Development Collaboratory website (under development). In addition, the project team will work to disseminate multiple papers related to different facets of the project. Such papers will include an overarching review of literature related to STEM faculty development (utilizing the article database that was developed by recommended citations from all participants in addition to traditional literature review methods), an analysis of participant

beliefs related to faculty development both prior to and following the workshop (utilizing data from pre and post surveys, online discussions, and responses to workshop application questions), and an analysis of results from each thread in the workshop (inputs, processes, and outputs) to move towards a finalized vision for research in holistic STEM faculty development.

Acknowledgements

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Appendix A: Applicant Rubric

Name of applicant _____

Affiliation _____

From Clemson (Yes/No) _____

Demographics

Circle one from each:

From Industry Academia Government Foundation Other _____

Represents STEM Science Math Engineering Other _____

Career Phase Early Mid Late Emeritus

Applicant Role Faculty Administration Director Manager Other _____

Engagement

Engagement in faculty development	Applicant has not participated in professional development activities	Applicant has participated in national-level professional development activities	Applicant has facilitated department level professional development activities	Applicant has facilitated college-wide or national professional development activities
Engagement in faculty development research	Applicant has not, and does not plan to research faculty development	Applicant has not done research in faculty development but plans to	Applicant has researched faculty development at their institution but has not published	Applicant has published research in faculty development
Understanding of faculty responsibilities	Applicant has no understanding of faculty responsibilities	Applicant has understanding of one of the three faculty responsibilities	Applicant has understanding of two of the three faculty responsibilities	Applicant has holistic understanding of all of these faculty responsibilities: research, teaching, service/leadership

Recommendations

	1	2	3	4
We should invite this applicant	strongly disagree	disagree	agree	strongly agree
This applicant should be a facilitator	strongly disagree	disagree	agree	strongly agree
This applicant should be a speaker	strongly disagree	disagree	agree	strongly agree

Comments