Misalignments: Challenges in Cultivating Science Faculty with Education Specialties in Your Department

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Science faculty with education specialties (SFES) are increasingly being hired across the United States. However, little is known about the motivations for SFES hiring or the potential or actual impact of this trend. In the context of a recent national survey of US SFES, we investigated SFES perceptions about these issues. Strikingly, their perceptions about the reasons for hiring SFES were poorly aligned with their perceptions about the potential and actual contributions reported by SFES themselves, and the advice that they extended to beginning SFES was varied. Although the preparation of future teachers and departmental teaching needs were common reasons offered for SFES hiring, the potential and actual contributions of SFES highlighted, instead, their roles as pedagogical resources and as contributors to curricular reform. Misalignments between SFES perceptions about what motivates SFES hiring and their perceptions of their most valuable contributions present challenges for those interested in maximizing the impact of SFES.

Keywords: science education, higher education, science workforce, faculty development, career development

Science faculty with education specialties (SFES) have been defined as faculty-level scientists who take on specialized roles in science education in their discipline either as part of their official job expectations or because they choose to focus on science education beyond their own classroom more than do typical faculty members in science departments. The seeding of university science departments with SFES is widespread and growing, with more SFES hired in the last decade than in all previous years combined (Bush et al. 2008, 2011, 2013). However, little is known about what is driving this SFES phenomenon in higher education. To gather evidence, we conducted a research study of SFES across the United States. As part of that investigation, we probed SFES on their perceptions of the following four questions often posed about the SFES phenomenon: (1) Why are science departments hiring SFES? (2) What professional contributions could SFES make? (3) What professional contributions do SFES actually make to their science department? (4) What advice do SFES have for both current and aspiring SFES?

Below, we explore common hypotheses and assertions that have been offered in response to each of these questions. Where it is possible, we highlight previously published policy statements and research reports in which the authors have made attempts to understand the origins and impact of the emergent SFES phenomenon. Finally, we present systematic analyses of SFES perceptions on these four questions from data collected in our study of US SFES.

Why are science departments hiring SFES?

Multiple hypotheses might explain why science departments appear to be hiring SFES increasingly over the last decade (Bush et al. 2011, 2013). To date, there has been little systematic investigation of academic science department motivations for hiring SFES, although possible reasons for hiring SFES abound. For example, to what extent are motivations for hiring SFES rooted in departmental teaching needs? One common assertion is that departments hire SFES primarily to fill a particular teaching role (Bush et al. 2011), often in large introductory courses, to relieve other faculty to focus on research. SFES hiring may be motivated by not only teaching needs but also coordination and management needs unique to these large courses. Alternatively, SFES may be hired to fulfill departmental needs that are

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more service oriented. For example, science departments are increasingly being called on to conduct program assessments about their own instructional efforts (Holme et al. 2010). In addition, science departments are often expected to collaborate with education faculty on issues of science teacher preparation (Bretz 2002, 2009). Furthermore, the increased hiring of SFES may be partially explained by financial concerns. In a recent study, we examined cost as a reason for which a department might hire SFES. In fact, although some might think that hiring into SFES positions would cost less than hiring into other science faculty positions, our study of SFES in the California State University system showed that most SFES felt that their starting and current salaries were similar to those of their non-SFES colleagues (Bush et al. 2011). However, many SFES did report receiving less start-up funding and less laboratory space than non-SFES, which may partially explain the interest in hiring SFES at times of budget cuts. As the federal funding landscape for science education has expanded, some have asserted that opportunities for SFES hires may result when departments and institutions want a faculty member who can pursue grant funding in science education (Bush et al. 2011). Finally, beyond reasons that may reflect teaching, service, and financial concerns, the motivations for hiring SFES may be tightly linked to SFES science education expertise and specific scholarly contributions that they could make in the arenas of undergraduate science education, K–12 science education, or discipline-based education research.

What professional contributions could SFES make?

Many individuals and professional organizations have identified and discussed the potential contributions that SFES could make to science education efforts from within science departments, as well as from within their disciplines more broadly. First, many have proposed that SFES could undertake educational innovations, faculty development, and curriculum development in the arena of undergraduate science education (Petersen 1959, Del Giorno 1969, Klopfer and Champagne 1990, Gess-Newsome et al. 2003, Russell 2004, Bralower et al. 2008, Rovner 2008, Anderson et al. 2011, Robson and Huckfeldt 2012), including the pedagogical training of graduate teaching assistants (French and Russell 2002, Kurdziel and Libarkin 2003, Meizlish and Kaplan 2008, Bodner and Towns 2010, Sandi-Urena et al. 2011, Rutledge 2013). In fact, policy documents from professional societies across the science disciplines have similarly asserted the importance of science faculty and science departments' implementing research-based pedagogies and developing curricular innovations that would better support undergraduate science learning (see, e.g., APS 1999, ACS 2013, SABER 2014).

Second, in the arena of K–12 science education, a variety of stakeholders have suggested that SFES could contribute to teacher education programs for preservice teachers (Bodner and Towns 2010), professional development for in-service teachers (Bretz 2002, Bodner and Towns 2010), support for K–12 schools (Bretz 2009), and other forms of outreach (Trautmann and Krasny 2006). Again, scientific professional societies have consistently endorsed this potential involvement of science departments and faculty in preservice and in-service K–12 teacher education, as well as broader partnerships with K–12 schools (GSA 2012, ACS 2013, APS 2013).

Finally, SFES could significantly contribute to advancing discipline-based education research in the sciences (Arons and Karplus 1976, Zubrick et al. 2001, Ebert-May et al. 2003, Bauer et al. 2008, Bodner and Towns 2010, Libarkin and Ording 2012, Singer et al. 2012). Physics education research was legitimized as a specialty within physics departments when the American Physical Society [APS] Council adopted its policy statement on research in physics education (APS 1999). Following the lead from the APS, the Geological Society of America policy on rewarding professional contributions (GSA 2012) and the ACS science education policy statement (ACS 2013) both recognized the value of discipline-based education research. Most recently, a professional society dedicated to discipline-based education research in the biological sciences—the Society for the Advancement of Biology Education Research—was founded in 2010 (SABER 2014).

What professional contributions do SFES actually make?

Although the SFES phenomenon is growing nationally and is an active area of interest, the documentation and investigation of the actual contributions of SFES has only started recently (Bush et al. 2011, 2013). These studies have shown that SFES occupy positions across a variety of institution types, both public and private, across the United States, and that SFES roles are not uniform in nature.

In an initial description of SFES activities in the 23-campus California State University system, the SFES reported being engaged in a variety of teaching, scholarly, and service activities rather than specializing in one of those areas (Bush et al. 2011). For teaching, most of the SFES reported teaching courses both for majors and for nonmajors, with over 50% teaching courses for preservice teachers (Bush et al. 2011). For scholarly activities, over half of the SFES reported seeking funding to support science education research, basic science research, curriculum development, or K–12 teacher development (Bush et al. 2011). Bush and colleagues (2011) found that SFES report doing more departmental service than do other faculty members, with almost all serving colleges of science and half providing service for colleges of education.

Similar variation in SFES professional activities was found recently in a national study of US SFES, the majority of whom characterized their positions as a combination of teaching, service, and research (Bush et al. 2013). However, some differences among SFES perceptions of their contributions were found when they were compared across institution types. For example, SFES employed at master's degree–granting institutions were more likely than SFES employed at either doctorate-granting or primarily undergraduate institutions to report the combination of roles in teaching, service, and research (Bush et al. 2013). Even with institutional differences, only a minority of the SFES across all institution types felt that SFES occupy positions primarily focused on teaching their disciplinary courses.

What advice do SFES have for both current and aspiring SFES?

With the wide variety in contributions that SFES could make and actually make, much advice has been offered to aspiring and current SFES. The advice ranges from collegial advice offered by a singular voice or small collaborative groups to advice grounded in research studies that systematically include the voices of hundreds of SFES. To aid in identifying departmental SFES expectations, a hiring guide was published for use by individuals and departments interested in hiring and retaining SFES (Bush et al. 2006). Perhaps the most common advice is to clarify the expectations of the SFES positions (Scantlebury 2002, Bauer et al. 2008, Stagg 2008, Coppola 2011, Singer et al. 2012, Rutledge 2013). Many current SFES endorse recommendations that beginning SFES obtain clear position expectations and advise SFES to find colleagues and mentors, seek extramural funding, reduce commitments, and publish their work (Bush et al. 2011).

In summary, common perceptions, assertions, and hypotheses about the SFES phenomenon exist, but the published research has revealed a more complex and varied phenomenon. Previous studies have been primarily focused on quantitative descriptions of the SFES phenomenon. Here, we present findings from a national research study of US SFES by sharing open-ended responses related to the questions highlighted above. Findings from an extensive sample of SFES can serve as a foundation for conversations to establish goals, expectations, and guidelines to promote the success of SFES positions broadly.

Open-ended survey responses from SFES

The perceptions of SFES regarding the questions mentioned above were collected as part of a research study of SFES in the United States. A volunteerism approach was used to construct a broad convenience sample that could provide information on the nature and extent of SFES across the United States. To maximize the breadth of this convenience sample, a list of likely SFES who would be eligible study participants was developed. This was accomplished through a national search conducted via e-mail between September 2009 and March 2011. Invitations for individuals to self-identify as SFES were sent to over a dozen professional societies in the sciences that have members involved in science education, as well as to multiple science education societies. The recipients of these invitations were further asked to forward the invitation to other individuals who they thought were likely to be SFES. The result was a database of 973 individual names of likely SFES with contact e-mail addresses.

Of the registrants from the national SFES search, there were 841 individuals who self-identified as SFES, who identified as college- or university-based educators located in the United States, and who included an e-mail address. These individuals constituted our convenience sample and were invited by e-mail to participate in our study and to forward the study invitation to other likely SFES. Between March and June 2011, 427 individuals participated in our national study without compensation. Assuming that the majority of those participants had previously registered with us as likely SFES, approximately 44% participated in the study.

Our findings are based on data from 289 individuals out of the 427 survey responses received. The responses from those whose surveys were incomplete, who were not in a science department faculty position, or who did not self-identify as SFES were excluded from the analysis. To prevent inadvertent or indirect disclosure of research participants, the data are reported in aggregate.

In the context of a 95-question, face-validated, anonymous, online survey (Bush et al. 2013), the SFES respondents answered four open-ended questions about why they may have been hired, what they perceive their most valuable contributions to their science department to be, their perspective on their current actual contributions, and their advice to a beginning SFES. Their responses to these four questions were investigated using grounded theory as an inductive methodology that leads to the emergence of ideas from patterns in the data (Glaser and Strauss 1967). At least two researchers examined all of the responses for each open-ended question, determined emergent themes independently, and then agreed on a common set of thematic coding categories. Each researcher independently coded the responses into these categories and calculated a percentage of the respondents who offered evidence in each category. The categories presented in the results are those that included comments coded from more than 18% of the respondents. The categories that represented comments from fewer than 20% of the respondents may warrant further investigation. Interrater reliability was calculated by dividing the number of scoring agreements by the total number of scoring decisions. Only those responses with an interrater reliability of 90% or greater are reported here.

Perspectives on SFES hiring, professional contributions, and advice

As is illustrated by sample quotes from the study participants (table 1), SFES indicated the most common reasons that they perceived for which a science department would hire an SFES (n = 259, interrater reliability [IRR] = 95%). The top reason, offered by 40% of the respondents, was the preparation of future teachers; 33% suggested that SFES are hired to fulfill a particular teaching role in the department. Many of the SFES mentioned the interest of their department in having SFES teach general education

Table 1. Reasons offered in response to "What would you consider to be three most common reasons that a science department hires a science faculty with education specialty (SFES)?" (n = 259)

Reason category	Sample reasons	Percentage
Preparation of future science teachers	To have preservice teachers trained by discipline based, teaching experts; to handle the secondary education majors in their department (e.g., biology high school teachers); to teach methods courses for science education undergraduates	40
Fulfill a particular teaching role in the department	Want to free non-SFES from unpopular teaching duties and potentially improve quality of courses; support for general education courses; to teach primarily large undergraduate courses for majors and nonmajors	33
Course or curriculum development and reform	Need support for course and curriculum development; to realign undergraduate curriculum; to develop or modernize undergraduate programs	24
Improve student learning experiences, outcomes, recruitment, and retention	To improve learning outcomes for students; to improve retention of students in the department, particularly minority students; they want to improve their failure rates	23
Generally improving undergraduate science education	To improve the teaching of students taking courses in their department; expectations of improved pedagogy; the introductory courses are very challenging to teach, and SFES who are trained in pedagogy may be better able to teach them effectively	22
Conducting educational research and broadening departmental research	The ability to conduct research that will inform instruction and curricular decisions; research in how students learn science; more and more university scientists have come to understand that disciplinary science-education research is a highly viable subdiscipline with robust funding programs and quality journals	19

Table 2. Responses to "What are the three most valuable contributions that SFES [science faculty with education specialties] could make to a science department?" (n = 245)

Reason category	Sample reasons	Percentage
Being a pedagogical resource for the development and reform of faculty teaching	To help faculty members who want to make changes to pedagogy; to introduce new teaching methods to faculty; to help current and new faculty members understand what we know about how students learn	39
Course or curriculum development and reform	To improve the curriculum within the department; modifying curriculum to align with assessments and outcomes; to help establish a twenty-first century college science curriculum that benefits from science education research and that opens rigorous college-level science to a greater portion of the population	35
Cultivate departmental cultural change toward focusing on education in the sciences	To foster a culture of superb teaching and learning in science departments; contributing to a departmental culture that values evidence and research in science education; to elevate the importance of scientific teaching in the collective consciousness	29
Conducting educational research and broadening departmental research	Pioneering pedagogical research; conducting original research to increase discipline based educational research knowledge; providing another area of science research activity	27
Improve student learning outcomes, recruitment, retention, and overall student experience	To improve the overall educational experience of students in the department; to improve education within specific discipline's basic (nonmajor) courses; to recruit and retain more majors	26
Preparation of future science teachers	To collaborate with teacher education in preparing science teachers; to encourage the best and brightest students to consider K–12 teaching; to generate more discipline-specific preservice teachers	23
Generally improving undergraduate science education	To improve undergraduate education; to improve teaching or learning; to improve teaching	23
Assessment of student learning and program evaluation	To institute the scientific method with respect to teaching evaluations; to develop or improve assessment and evaluation of programs and instruction; to help departments with issues of assessment (student learning and program level)	20

classes with large enrollment numbers (table 1). Four of the next most common reasons that the SFES thought science departments might hire an SFES were mentioned in at least one-fifth of the responses and included course or curriculum development and reform (24%), the improvement of student learning experiences (23%), generally improving undergraduate science education (22%), and broadening a department's research focus by conducting educational research (19%).

When the SFES were asked to identify the three most valuable contributions that SFES could make to a science department (table 2; *n* = 245, IRR = 96%), over one-third of the responses highlighted the ability of an SFES to be a pedagogical resource to support pedagogical change among non-SFES faculty members (39%) or to support curriculum development and reform (35%). Over a quarter of the respondents mentioned the following three contributions: cultivating departmental cultural change toward focusing on education in the sciences (29%), conducting educational research (27%), and improving student learning (26%). The next three most common contributions an SFES could make included science teacher preparation (23%), generally

Table 3. Responses to "What are the three most valuable contributions that you as an SFES [science faculty with education specialty] actually make to a science department?" (n = 249)

Reason category	Sample reasons	Percentage
Course or curriculum development and reform	Redesigning or developing intro courses; to provide support in improving curriculum to match research-based best practices; a willingness to make major curricular changes	34
Being a pedagogical resource for the development and reform of faculty teaching	To be a resource person for science education developments; to share effective teaching methods with interested faculty; to provide guidance to interested faculty on improving their teaching	32
Improve student learning outcomes, recruitment, retention, and overall student experience	To promote retention by supporting students in rigorous learning; resolving student–faculty issues; the recruitment of science students	25
Cultivate departmental cultural change toward focusing on education in the sciences	To help the department think about curriculum, student learning outcomes, and how we can get evidence; to encourage reflective teaching and curriculum development; to improve the pedagogy of science education for the department	22
Modeling innovative and effective science teaching	To act as a positive role model for people who want to see teaching done using newer methods; to demonstrate to colleagues there are more ways to teach than just lecturing; to model evidenced based approaches to teaching for colleagues	21
Preparation of future science teachers	Teaching courses designed for future teachers; to advise secondary education majors; serving as a knowledgeable point of contact (academic advisor) for prebiology teachers and as a liaison between departments	20
Assessment of student learning and program evaluation	The assessment of large introductory course sequences and data-driven decisionmaking; contributing to teaching reform and assessment at the departmental, college, and university levels; to help the department get started on the path to developing program learning outcomes and a department assessment plan	19
Conducting educational research and broadening departmental research	Research into how students learn; research in education integrated into science department; assistance with research methodologies	18

Table 4. The top four most prevalent categories for three questions are summarized below in three columns. Note the disconnect between the categories in the first column and those in the other two columns.

What would you consider to be three most common reasons that a science department hires a science faculty with education specialty (SFES)? (n = 259)	What are the three most valuable contributions that SFES could make to a science department? (n = 245)	What are the three most valuable contributions that you as an SFES actually make to a science department? (n = 249)
Preparation of future science teachers (40%)	Being a pedagogical resource for the development and reform of faculty teaching (39%)	Course or curriculum development and reform (34%)
Fulfill a particular teaching role in the department (33%)	Course or curriculum development and reform (35%)	Being a pedagogical resource for the development and reform of faculty teaching (32%)
Course or curriculum development and reform (24%)	Cultivate departmental cultural change toward focusing on education in the sciences (29%)	Improve student learning experiences, outcomes, recruitment, and retention (25%)
Improve student learning experiences, outcomes, recruitment, and retention (23%)	Conducting educational research and broadening departmental research (27%)	Cultivate departmental cultural change toward focusing on education in the sciences (22%)

improving undergraduate science education (23%), and contributing to assessment (20%).

When they were asked to share their perceptions about the most valuable contributions that they as SFES actually make to their science departments (table 3; $n = 249$, IRR = 93%), the SFES's responses generally mirrored their responses about contributions that SFES could make (table 2), with some differences in the relative rankings of the categories. Table 3 has one category that is not present in table 2 (modeling innovative and effective science teaching, 21%) and lacks one category that is present in table 2 (generally improving undergraduate science education). Table 3 shows sample quotes from the respondent SFES describing their perceptions of their most valuable contributions.

Interestingly, the perceived reasons for hiring SFES were poorly aligned with the perceived potential and actual contributions reported by the SFES respondents (table 4). Although many of the SFES in our sample pointed out reasons for hiring directed toward preparation of future teachers or the need to fulfill a particular teaching role in the department, the reported potential and actual contributions point, instead, toward SFES roles as pedagogical resources and potential drivers of curriculum reform. Of note, little mention was made of hiring SFES to cultivate departmental

Table 5. Advice offered to beginning SFES in response to "What are the three most important pieces of advice you would offer a beginning SFES [science faculty with education specialty]?" (n = 230).

Advice category	Sample advice	Percentage
Find colleagues, mentors, and advocates	Science education is interdisciplinary, and there is very little that is valuable that you can do alone—seek collaborations wisely; identify a close colleague to act as a mentor or collaborator as being an SFES can be isolating without such a support network; find a mentor who can help you navigate both the science and politics.	45
Obtain clear expectations from department and college	Make sure you and your department agree on expectations; get your expectations in writing when you start; make sure that you, the department, and your college are in agreement about your job expectations and get those expectations in writing—in particular, how does your department value your scholarly activities, and how do they count or not count toward your tenure and promotion?	27
Pursue training and stay current in science and/or science education	Make sure you know your science very well and keep up! Get your doctorate in a traditional science; take all the courses or workshops you can and read the literature.	23
Inform, educate, and highlight your efforts among your faculty colleagues and administrators	Educate colleagues about the significance of your work; help non-SFES see the science street creds you've accumulated; keep your administrators aware of what you are doing-of course they will hear.	22
Have a clear vision of and follow your professional interests	Have a clear vision for your career; do not let the department dictate your research agenda—do what interests you; clearly define your scholarly interests and stick to them.	19

cultural change toward focusing on education in the sciences, but nearly a third of the respondents reported this could be a potential contribution, and over a fifth of the respondents reported this among their three most valuable actual contributions to their department. Similarly, although one in four of the SFES reported that conducting educational research and broadening departmental research was one of their most valuable potential contributions as an SFES, only one out of five reported that SFES are hired to do this, and slightly fewer reported this to be among their most valuable actual contributions.

To determine whether there were associations across the responses from individual respondents, for each category in table 4, we compared the responses from the participants who answered all three questions ($n = 236$). We counted and expressed as percentages the number of SFES who reported actual contributions that were aligned or misaligned with their perceptions of why departments are hiring SFES and the potential contributions of SFES. For example, the misaligned items fail to appear in one or two of the table 4 columns and have a low incidence of alignment across all three questions. Although 10% of the SFES mentioned the preparation of future science teachers as a top contribution across all three questions, 24% perceived this as one of the three most common reasons that a science department hires SFES, even though they did not mention this code among the top three most valuable contributions that they make to their own science department, thus confirming a misalignment. Furthermore, only 2% mentioned cultivating departmental cultural change toward focusing on education in the sciences across all three questions, but 17% mentioned this function as one of the three most valuable contributions that they felt SFES could make to a science department, even though they did not mention this code among the top three contributions that they actually make, themselves. When these comparisons were made, analyses at the individual level consistently confirmed the misalignment patterns shown by the analyses pooled across all of the respondents (table 4).

Finally, the SFES were asked to offer advice to current or aspiring SFES. Perhaps not surprising, given the varied nature of SFES roles, they put forward a wide range of suggestions (table 5; $n = 230$, IRR = 91%). The most prevalent piece of advice offered was to find colleagues, mentors, and advocates both within and outside their institution (45%). Four other prevalent categories of advice were to obtain clear position expectations from their department and college (27%); to pursue training and to stay current in science or science education (23%); to inform, educate, and highlight their efforts among stakeholders at their institution (22%); and to have a clear vision of their professional interests (19%).

Conclusions

Our findings reveal SFES perspectives on the motivations for their hiring, provide insights on potential versus actual SFES professional contributions, and offer advice for current and aspiring SFES. Below, these findings are considered in relation to common assertions about SFES, as well as in terms of the lack of alignment between the reasons for hiring SFES and their potential and actual contributions.

SFES's perceptions about why science departments are hiring SFES. Interestingly, no singular reason for SFES hiring was cited by a majority of the SFES in this study, which suggests that the SFES hiring increase is being driven by a range of interests at academic institutions. Hiring because of a need for teacher education specialists was most reported and may relate to the teaching and service needs of departments. Future studies may clarify whether this teacher education hiring motivation is more prevalent in particular institution types. Our evidence also supported the common assertion that departments hire SFES primarily to fill a particular teaching role—often, a teaching role not embraced by current departmental faculty. Less often mentioned motivations for hiring SFES—centered around improving undergraduate science education—could be encouraging, because, as Meizlish and Kaplan (2008) suggested, the culture of teaching within science departments needs improvement. Surprisingly, SFES hiring was not perceived to be driven primarily by the desire to hire discipline-based education researchers, which was reported by only 19% of the respondents. The hiring of SFES appears to address a variety of departmental needs (Coppola 2011), not only expanding departmental research to include education research within STEM disciplinary departments (Rovner 2008, Bodner and Towns 2010, Singer et al. 2012, Rutledge 2013).

The SFES's perceptions about the most valuable contributions that SFES could make. These findings indicate that SFES can potentially contribute to a wide variety of science education needs. Intriguingly, no single contribution was mentioned by even half of the participants in this study. Apparently, SFES collectively do not espouse a single ideal or dominant conception of the most valuable contributions that SFES could be making to science education efforts. However, the SFES respondents perceived a strong potential role for SFES in the arena of undergraduate science education. This finding aligns with previous proposals about science faculty roles in advancing science education (Petersen 1959, Del Giorno 1969, Klopfer and Champagne 1990, Gess-Newsome et al. 2003, Russell 2004, Bralower et al. 2008, Rovner 2008, Robson and Huckfeldt 2012, Anderson et al. 2011). Importantly, the SFES reported that cultivating departmental cultural change toward a focus on science education is one of the most valuable contributions that SFES could make, as has been previously suggested (Coppola 2011). The SFES also reported that a valuable contribution that they could make would be in the arena of discipline-based education research, as has previously been noted (Arons and Karplus 1976, APS 1999, Zubrick et al. 2001, Ebert-May et al. 2003, Bauer et al. 2008, Bodner and Towns 2010, Libarkin and Ording 2012, Singer et al. 2012, GSA 2012, ACS 2013). However, an SFES role in discipline-based education research was more likely to emerge in these data as a potential SFES contribution, rather than as a rationale for SFES hiring or a prevalent valuable contribution that SFES are actually making. Interestingly, potential SFES contributions in the arena of K–12 education were mentioned in proportions similar to those of discipline-based education research activities.

The SFES's perceptions about the most valuable contributions that they are actually making. Again, the SFES varied in their perceptions about the most valuable contributions that SFES actually make in their science departments. The two most commonly reported actual SFES contributions, reported by about a third of the SFES, were again in the arena of undergraduate science education—namely, efforts to contribute to curriculum development and reform (34%) and to serve as a pedagogical resource to fellow faculty members (32%). In fact, the majority of emergent categories were related in some way to undergraduate science education reform. Of note, fewer than 20% of the SFES reported disciplined-based education research as one of the most valuable contributions that SFES actually make. As such, many actual contributions that the SFES perceived to be most valuable may not be considered by science departments to be research. Overall, the SFES's perceptions about their most valuable potential professional contributions were well aligned with their ideas about their most valuable actual professional contributions, with three of the top four categories overlapping in these two analyses (table 4).

Key misalignments between SFES hiring motivations and their most valuable potential and actual contributions. Strikingly, the SFES respondents' perceptions about why they are being hired were not well aligned with their perceptions about their most valuable potential and actual professional contributions. Four misalignments are particularly important to note. First, teacher education was the rationale for SFES hiring reported by the most respondents in our study (40%), but only half as many respondents (20%) identified teacher education as one of their most valuable actual contributions as SFES. Second, 33% of the SFES respondents cited the need for faculty members to fulfill a particular teaching role as a common reason for SFES hires, but only a small proportion of the respondents (12%; data not shown) identified this teaching role as one of their most valuable actual contributions as an SFES. Third, and contrary to many assertions about SFES, conducting educational research was reported neither as a top reason for SFES hiring nor as one of the most valuable contributions that the SFES perceived that they are actually making. Involvement in discipline-based education research appeared to be aspirational for some of the SFES respondents, with 27% identifying this as a valuable contribution that SFES could make. Fourth, and perhaps most exciting, is that, although many of the SFES did not perceive that SFES are being hired to cultivate departmental cultural change toward a focus on science education, many did perceive this as a valuable contribution that they could make (29%), and one that they feel they are actually making (22%). Importantly, these misalignments between hiring rationales and potential and actual contributions may be driving the high percentages of SFES who have reported that they are seriously considering leaving their current positions both in the California State University system (Bush et al. 2008, 2011) and in institutions across the United States (Bush et al. 2013). In addition, these misalignments may also be behind SFES reports of feeling underappreciated, out of step with their department or university, and that they are not doing what they aspired to be doing in their current positions (Bush et al. 2013). Finally, these misalignments may be driving the second most prevalent piece of advice from the SFES, which is that clear position expectations should be obtained (table 5).

The SFES respondents' advice for current and aspiring SFES. Although it is useful on its own as advice, the wisdom that the SFES offered to hypothetical beginning SFES yields insights into the realities of and challenges associated with SFES positions. The top two pieces of advice clearly indicate that SFES are often pioneers whose positions are fraught with potential misalignments (table 5). The importance that the SFES placed on finding colleagues, mentors, and advocates suggests that beginning SFES may find themselves isolated either from their departmental peers or from the greater SFES community. In addition, the press for advocacy suggests that the work that SFES engage in may not be well understood or valued by their non-SFES peers. The importance that the SFES placed on obtaining clear expectations suggests that departments may not have a well-developed vision of how the teaching, service, and scholarship of SFES fit into their program. This potential mismatch is consistent with the misalignments shown in table 4 and discussed above. Furthermore, these findings support the need to clarify expectations and to negotiate to reach a shared vision between SFES and those who hire them (Bretz 2002, 2009, Bush et al. 2006, Bauer et al. 2008). Clear expectations could also affect the criteria for SFES retention and promotion (Scantlebury 2002, Coppola 2011, Singer et al. 2012). Perhaps most noteworthy is the sheer breadth of advice that the SFES offered. This belies the diversity in SFES experiences and further suggests that there is likely not a singular SFES phenomenon across the United States.

Implications. Misalignments among the reasons for hiring SFES, their potential contributions, and their actual contributions may have pronounced negative consequences for national efforts to advance science education in the United States. Such misalignments could be a factor in nearly the one-third of US SFES who are considering leaving their current position (Bush et al. 2013) and the increased rates of hiring SFES may, in part, be a reflection of high attrition rates (Bush et al. 2013). After the most common advice to find colleagues, mentors, and advocates, the next most common advice offered by the respondent SFES to beginning SFES is to obtain clear expectations for the position during the hiring process, which is advice that has been presented in previous reports (e.g., Bauer et al. 2008). These recommendations are potentially crucial to addressing science education needs from within science departments by promoting the success of people in SFES positions. If science departments are primarily addressing science education needs through SFES positions, these recommendations are crucial to the success of individual faculty members and, more significant, the advancement of national science education reform efforts.

Perhaps, the misalignments result from the extremely wide divergence in the activities being undertaken by SFES across the United States. With no singular or even dominant conception of what it means to be a science education specialist in a science department, misalignments may be a natural consequence. The relative dearth of formal training in science education among SFES (Bush et al. 2008, 2013) may also cause misalignments as departments hire SFES whose training and potential contributions may not match the departmental reasons for which they were hired.

Misalignments in how science departments value SFES professional activities and how these activities count or do not count toward career advancement may also require a revision of promotion or tenure expectations to reconcile the wide divergence in SFES activities. Such revision may require new models for translating what a department values about a faculty position into realistic and equitable professional expectations.

More significant, misalignments may be contributing to ineffectual science education reform efforts across the United States. The findings presented here suggest that effective and lasting science education reform seemingly requires a fortunate confluence of the right SFES, at the right time, in the right environment. To maximize the impact of the SFES phenomenon, research is needed to characterize the nature of the specific academic contexts in which SFES thrive and successfully address science education needs from within science departments. In particular, future studies are needed to determine whether the SFES perceptions presented here correspond with those of departmental and institutional stakeholders, including both administrators and non-SFES faculty peers.

Finally, the evidence presented here can help frame and inform the ongoing conversations about why science departments hire SFES and how to support and maximize the actual contributions of SFES. Furthermore, the findings can be of value to current and aspiring SFES, their employing science departments and institutions, and policymakers interested in science education reform from within the scientific disciplines.

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