

Feature

Approaches to Biology Teaching and Learning

On Hiring Science Faculty with Education Specialties for Your Science (Not Education) Department

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INTRODUCTION

The *CBE—Life Sciences Education (CBE-LSE) Approaches to Biology Teaching and Learning* feature most often focuses on translating research and scholarship in science education into practical, accessible teaching strategies that can support *CBE-LSE* readers in their own efforts as science instructors, primarily at the college and university level. In this column, we highlight an issue in science education facing many university and college science departments: hiring faculty who can bring to the department specialized expertise in science education. With increased attention on the scholarship of teaching and on research on teaching and learning approaches unique to individual science disciplines, many science departments find themselves exploring the hiring of a faculty member who is both a scientist by training and a specialist in science education. Although a relatively recent idea in most biology departments, it is increasingly common to find biology, chemistry, geosciences, and physics educators in science departments in colleges across the country. As the visibility of these positions grows, more administrators and faculty in science departments are posing variations on the following questions: How can our science department hire faculty members with expertise in the teaching and learning of our scientific discipline? What roles could this individual play in our department? What background and training would we expect this individual to have? How would the responsibilities for a “science educator” position in our department compare with those of other faculty members? And how do we begin to facilitate a conversation among our science faculty about hiring a specialist in education for our science department?

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To begin to address these questions, a collaborative team of tenure-track faculty—all of whom are primarily trained in science and have pursued additional professional development to become education specialists within their discipline—have contributed their collective wisdom on this topic. Among this author group alone, we are aware of more than 18 recent failed departmental searches for these types of faculty positions, indicating the challenges departments face in successfully hiring and retaining Science Faculty with Education Specialties (SFES). Many of these searches remain open because of a lack of candidates matching the advertised qualifications and because of disagreements among science faculty about the nature of the person they want to hire. In addition, there are examples of SFES who have been successfully hired but who leave science departments before tenure because of dissatisfaction with the position. The aim of this article is to share a variety of perspectives on the goals for such appointments and the potential roles of the appointed SFES, providing a document to foster and guide conversations among faculty who are considering hiring a science educator for their science department. The authors of this article represent seven universities and occupy different points along the career trajectory as SFES. The author team includes four assistant professors, one associate professor, and two full professors, of whom five are “biology educators” and two are “chemistry educators.” These authors not only bring their own collective professional experiences to bear, but also those of colleagues from other disciplines and universities who have both informally and formally contributed to discussions on this topic in the context of scientific professional societies and science education communities, such as the American Chemical Society, the American Society for Cell Biology, the Ecological Society of America, the American Physiological Society, and MERLOT (Multimedia Educational Resource for Learning Online and Teaching).

In particular, the authors of this article have been informed by conversations around these questions in two key venues. First, the National Academy of Sciences (NAS) held

a Workshop for Discipline-based Science Education Research in December 2005 (NAS, 2006). This meeting brought together administrators who have pioneered the hiring of these positions at their universities and colleges, along with junior faculty who have been recently hired as “science educators” within science departments. The entirety of the meeting’s proceedings can be viewed online (NAS, 2006). In addition, the California State University (CSU), which is the largest university in the country and serves more than 400,000 students on 23 campuses, held a System-wide Colloquium on Science Education in May 2006 to explore a variety of topics, one of which was how to better engage the scientific disciplines in K–16+ science education reform efforts (CSU, 2006). What emerged at this Colloquium on Science Education was the conclusion that the integration of specialists in science education within science departments was a key, yet underdeveloped, approach to that goal. It appeared that a common barrier facing science departments was a lack of clarity about how to design such a position, as well as how to hire, retain, and support these individuals through the tenure and promotion process. Both the NAS Workshop and the CSU Colloquium served to clarify questions and challenges that arise in pioneering these unique positions for scientists who specialize in science education. The issues appear to be similar across scientific disciplines, whether the context is biology, chemistry, geosciences, physics, or even engineering. Therefore, we attempt to provide here a practical resource on the hiring into science departments of SFES by addressing the following questions: What do “SFES” look like? How are these positions similar to and different from other tenure-track faculty positions in science departments? with respect to research? with respect to teaching? with respect to service? Why create these positions within science departments? What are common myths associated with the hiring of new faculty in these positions? What conversations should take place before a department decides to hire an SFES? And, finally, how can you as an individual faculty member broker this conversation in your own department?

WHAT DO SFES LOOK LIKE?

SFES Example 1

George is an assistant professor in the chemistry department. During his doctoral years, George was actively involved in undergraduate teaching and K–12 partnership programs, and he took a variety of science education methods courses and professional development workshops focused on teaching. He now teaches lower-division, nonmajors chemistry courses, an upper-division chemistry majors course, and a methods course for preservice secondary science teachers. George conducts research on the organic photochemistry of carbenes, and in that context he supervises three undergraduate students and collaborates with two of his departmental colleagues.

SFES Example 2

Joel is an assistant professor in the biology department. After receiving his doctoral degree in molecular biology, Joel completed postdoctoral training in science education re-

search. He now teaches lower-division, nonmajors biology courses, two courses that combine methods and subject matter for preservice elementary teachers, and one course that combines methods and subject matter for preservice secondary science teachers. Joel conducts research in biology education by investigating how students interpret static figures and computer animations when learning biology concepts, and he is the first in his department to recruit students into biology education research. He also advises secondary credential students, coordinates the general biology lecture and lab courses, and advises general biology students.

SFES Example 3

Maya is an assistant professor in the physics department. After completing a research master’s degree in physics, Maya completed a doctoral degree in physics education research. She now teaches lower-division, nonmajors and majors physics courses, and a physics content course for preservice teachers in a combined lab and lecture course where she models inquiry and other pedagogical strategies for K–12 classrooms. Maya conducts research in science education, often involving physics content, with a focus on reading and writing in science instruction, and she conducts biophysics research in optical microscopy. She supervises one graduate student and four undergraduate students.

These hypothetical profiles of SFES are examples based on real situations in science departments across a variety of colleges and universities. Typically, the SFES is an assistant professor starting as a science department’s first hire of a tenure-track faculty member with a science education specialty. The typical SFES has formal training in scientific research, sometimes at the master’s level and more often at the doctoral level, as well as specialized preparation in science education through graduate training, postgraduate internships, postdoctoral fellowships, or a second research degree. The lack of a clearly defined career trajectory for SFES results in tremendous variation in the professional backgrounds and training of SFES, especially with respect to the nature of their education and experience in science education. As part of their graduate degrees or during their postdoctoral work, SFES may have completed education courses, engaged in extensive undergraduate or K–12 teaching, obtained a science teaching credential, collaborated on curriculum development, coordinated science education partnerships, and/or conducted science education research. So, with such varied backgrounds and professional responsibilities, how are SFES similar to and different from other science faculty, and how do they fit into science departments?

HOW ARE THESE POSITIONS SIMILAR TO AND DIFFERENT FROM OTHER TENURE-TRACK SCIENCE FACULTY POSITIONS?

As tenure-track faculty in science departments, SFES have the same responsibilities for research, teaching, and service as any other traditional tenure-track faculty member. However, the “education specialty” in SFES positions often leads to two major differences from other faculty. First, the distinctions among the three categories of teaching, research,

and service are consistently less obvious for SFES than for their traditional faculty colleagues; the research, teaching, and service activities of SFES more often overlap. Consider an SFES who develops science content workshops for pre-service teachers (undergraduates who aspire to be K–12 teachers) and develops pre- and postassessment surveys to measure gains in their conceptual understanding and identify reasons for those gains. Is this primarily *research* because the assessment data provide insight into how science is learned and the assessment results can be shared in peer-reviewed forums and used to help obtain external funding? Is this primarily *teaching* because the SFES taught the workshops and developed new teaching materials? Or, is this primarily *service* because the broader goal of the project was to increase future teachers' comfort level with and competency in teaching science? Although this overlap can be viewed positively as a synergistic approach to connecting all aspects of one's faculty work, these blurred boundaries among the three categories often raise a major challenge to the science faculty's ability to understand fully the work of the SFES, and thus to be able to evaluate these faculty members for tenure and promotion. In particular, science colleagues often incorrectly assume that this overlap means that SFES will require less time and fewer resources to conduct their teaching, research, and service because they can appear to be doing them all at the same time (see *Myths* below).

As implied by the three example SFES profiles above, the second major difference between SFES and traditional science faculty is the wide breadth of possible job expectations for SFES hires. Because there is no single model for what an SFES position looks like, administrators and department faculty can easily develop divergent views regarding what they want from such a position. The administration may want the new hire primarily to attend to the broader teaching mission of the university by supporting science teacher preparation programs and being the university liaison striving to improve local K–12 science education. The department may want the new hire primarily to institute best teaching practices by coordinating and training instructors in the introductory science courses, whereas the new hire may primarily want to conduct, report, and peer review science education research or basic science research, all the while building networks and establishing credibility with peers. Also, in some cases, SFES may hold a joint appointment, such as a 50/50 split faculty position between a science department and an education department. These joint appointments across colleges or departments lead to an even wider set of possibilities and consequent expectations.

On Research Expectations

SFES research interests and activities are as varied as those of their traditional tenure-track counterparts, but the variety of activities that may be considered scholarly activities for SFES can be extreme. Does SFES scholarship mean core science research, such as Joel's work in photochemistry of carbenes? Does it mean education research strongly connected to the discipline, such as George's studies of visual approaches in biology instruction? Does it mean research more broadly related to science education, such as Maya's investigation of reading and writing in science instruction?

Could scholarly activities be interpreted as assessing and improving teaching practice at the department level, or supporting K–12 teachers in their training and professional development? Grappling with what is meant by SFES scholarly work occurs within the context of a movement toward a broader definition of scholarship in the scientific disciplines, one that also embraces discoveries about teaching and the generation of new knowledge about educational approaches within the discipline (Boyer, 1990). Finding and implementing the best instructional approach fits with other definitions of scholarship, such as the scholarship of integration, the scholarship of application, and the scholarship of teaching (Boyer, 1990). This practical work draws upon the knowledge gained through science education research. In the current funding environment, significantly more support is available for incorporating and disseminating best practices in undergraduate and K–12 science education than for pure discovery projects. In addition, basic science education research is meant purely to create new knowledge, much like basic science research, and is unlikely to take the form of any immediate application, such as a solution to a specific problem in teaching practice. This pure form of science education research often goes unacknowledged by traditional faculty who may assume that an SFES would engage exclusively in research specifically applicable to teaching situations in their own department.

Given the breadth of research that SFES may wish to pursue, three types of SFES research expectations deserve a closer look: basic science research, science education research, and a combination of these two fields. SFES engaging in basic science research, such as George studying carbenes and Maya investigating optical microscopy, may have more common professional ground with their department colleagues in terms of their research questions and methodologies. They will generally have the same external validation expectations and venues in terms of publications and presentations, and the department will likely have a better ability to appreciate and evaluate their research activities. However, maintaining equitable distribution of responsibilities among research, teaching, and service is a challenge here, because the expertise that SFES bring to the department may be less about their research area, and more about their science education background. As mentioned previously, the nature of the education specialty of SFES can easily lead to greater teaching and service commitments than those of other entering faculty, thus overextending the SFES at a critical point in their budding research career.

SFES engaging in science education research, such as Joel and Maya, fit the NAS definition, that SFES positions are science education research positions intended to build knowledge about the teaching and learning of a particular scientific discipline (NAS, 2006). External validation expectations for this group are similar to their traditional tenure-track peers. These expectations include: peer-reviewed dissemination (publication and meeting participation), activity within a science education community, writing competitive science education research grants, and garnering external funding for science education projects. Although SFES build knowledge about the teaching and learning of their particular scientific discipline and in some cases directly (and positively) impact students and faculty, there are several cultural challenges for SFES doing only science education

research in a science department. Many natural scientists are unfamiliar or uncomfortable with social science research, and even suspicious about these endeavors, particularly nonquantitative research methodologies such as interview techniques, case studies, or grounded theory research. Further, they may possess the misconception that science education research is somehow easier, quicker, and cheaper than basic science research. Those SFES engaged in purely science education research face the challenge of building their research program in a context where they have few to no department colleagues with whom they can discuss their research and potentially have colleagues who do not even acknowledge their work as research.

Finally, engaging in both science and science education research can give the individual SFES the greatest latitude in pursuing their research interests. This type of position may be particularly attractive to candidates making the transition from more traditional scientific research paths to science education research careers. However, a significant drawback is the fact that developing one research program that is outstanding and rigorous is challenging enough, let alone attempting to simultaneously develop two different research programs—one in basic science and one in science education. In this situation, SFES, who are usually junior faculty, must grapple with the daunting task of developing two lines of research inquiry, each with its own methodologies, literatures, professional meetings, circles of colleagues, and cultures of external validation that are likely to be nonoverlapping. Finally, when there are possibilities of SFES doing research in two different areas, there is also greater risk of divergent expectations between the department and the SFES hire.

On Teaching Expectations

In some cases, SFES teaching assignments may be similar to those of traditional tenure-track peers, in that they can span the range of a department's offerings from the introductory to the advanced level. However, they can sometimes be very different. SFES commonly teach or supervise large-enrollment courses, such as lower-division introductory courses for science majors and introductory service courses for non-science majors, which primarily may be taught by lecturers at large-enrollment universities. In some instances, SFES teach upper-division courses in the department in the sub-discipline in which they were originally trained (e.g., microbiology). In contrast to their traditional peers, SFES are also frequently asked to teach discipline-specific courses for preservice teachers. These may include broad content survey classes for preservice elementary school teachers and science teaching methods courses for preservice secondary school teachers. Further, some SFES teach courses on science education research methods and discipline-specific teaching methods for upper-division or master's-level students in the department, including teaching assistant training courses. Thus, SFES often teach more large-enrollment courses and a greater variety of courses than their peers. In addition, SFES are frequently expected—implicitly or explicitly—to engage in a greater degree of course, curriculum, and program development and may be heavily relied on by other faculty because of their science education expertise. Finally, it may also be expected that an SFES will somehow transform a

department's overall educational approach or at the least act as a catalyst to affect educational reform within a department. These combined teaching expectations, although all appropriately aligned with the expertise that SFES bring to a department, are in total a heavy load for any junior faculty member developing his or her academic career.

On Service Expectations

Because SFES are usually the only—or at best one of a few—science education specialists in their department or college, they are often tapped to serve on any committee that has even a slight relationship to education, science education, and/or assessment at the department, college, or university level. At larger institutions, many SFES also may have course coordinator roles for introductory majors courses, including the responsibilities of hiring, training, and supporting teaching assistants and adjunct instructors. They may often play a greater role in departmental assessment activities and program review processes and are looked to for immediate leadership on departmental curriculum committees. In addition, SFES may be drafted to take on outreach and partnership responsibilities with local K–12 teachers and schools. They are commonly asked to play major roles in K–12 teacher preparation, recruitment, and retention. Further, they may be expected to contribute to preparing state-mandated teacher preparation accreditation materials, which often involves working with many science faculty to review the department's academic program and its alignment with newly minted teacher preparation standards, a major undertaking. In this same vein, SFES frequently serve as community science education resources, for example, supporting local science fairs or regional and national precollege science competitions. Some SFES have extensive ambassadorial responsibilities, including running campus tours of science facilities or hosting visits from science clubs and student organizations. Again, there is a serious potential problem of overloading a junior faculty member at the start of his/her career.

WHY CREATE THESE POSITIONS WITHIN SCIENCE DEPARTMENTS?

Although a common initial reason for hiring SFES in science departments is to benefit the department's own curriculum (particularly improving lower-division courses), undergraduate teaching and curriculum needs are only one of several rationales for hiring SFES. Because the rationale for hiring an SFES will begin to dictate the expectations the department sets for this individual, clarity on why an SFES is being hired into a science department is critical. The four most prevalent rationales for hiring SFES in a science department are summarized below.

1. Education research on the teaching and learning of a discipline is an important area of study within that discipline, for example, research in biology education is a subdiscipline of biology. Such research builds discipline-specific knowledge about effective teaching and learning of that discipline. The mental pathways and models underlying deep conceptual understanding of biology are different from those underlying understanding of geol-

- ogy, which are different from those underlying understanding of physics, etc. Misconceptions that challenge students in a particular discipline are best studied by faculty with deep understanding of the content and methods of the discipline. Faculty based in colleges of education often focus less on research that is informed by advanced knowledge of a science subspecialty area; their research tends to focus, instead, on cross-cutting issues such as equity, the nature of science, and assessment, that is, topics that are not specific to biology, chemistry, etc.
2. Close contact with SFES can enhance collaboration in the department among faculty contributing to advancement of undergraduate science education and can improve funding prospects. The importance of discipline-based knowledge in science education has led the National

Science Foundation (NSF) to fund grants that broadly impact teaching and learning (see Table 1), and so opportunities exist for all faculty to share and apply their expertise in curriculum development. To merit NSF funding, all proposals must meet two basic criteria: intellectual merit and broader impact. SFES typically have training in addressing both with special expertise in broader impact. Of the 40,000 proposals submitted to NSF each year for research, education, and training projects, approximately 11,000 are funded. For every 100 proposals received, ~80 have good ideas (intellectual merit), but only ~25 have good ideas, are well written, and have a good realization of broader impacts. To show broader impacts, NSF-funded research should “advance discovery and understanding while promoting teaching, train-

Table 1. Selected funding sources for science education research

Agency	RFP grant title	Grant duration	Funding level
NSF	Research and Evaluation on Education in Science and Engineering (REESE) ^a	Synthesis research: 1–3 yr Empirical research: 3–5 yr	Up to \$200K Up to \$1 million
NSF	Nanotechnology Undergraduate Education Course, Curriculum, and Laboratory Improvement (CCLI)	2 yr	Up to \$200K
NSF	Informal Science Education ^a	Phase 1: 1–3 yr Phase 2: 2–4 yr Phase 3: 3–5 yr	\$150–200K Up to \$500K Up to \$2 million
NSF	Faculty Early Career Development Program (CAREER) ^a	Project grants: 1–5 yr Planning grants: 1–2 yr Workshop grants: 1–2 yr	\$100K to \$3M Up to \$75K \$50–200K \$400K+
NSF	Research on Gender in Science and Engineering	5 yr	
NSF	Discovery Research K–12 (Applied Research, Development of Resources and Tools, and Capacity Building) ^a	Research awards: 1–3 yr Dissemination awards: 1–3 yr Extension services: 5 yr Conference: 2 yr	\$500K/yr \$200K/yr \$500K/yr Up to \$100K
NIH: NCRR (Natl. Center for Research Resources)	Science Education Partnership Awards	Exploratory study: 3 yr Full-scale study: 5 yr	Up to \$300K \$1.5–3 million
Knowles Foundation	Knowles Scholar Awards	Phase 1: 3 yr Phase 2: 2 yr Phases 1 and 2: 5 yr	Direct costs up to \$250K/yr
Institute of Education Sciences	Math and Science Education Research Awards	2 yr	\$110K
Department of Education	FIPSE Comprehensive Program	Up to 4 yr	\$150K–\$750K
Department of Education	The Mathematics and Science Partnership (MSP) Program	3 yr	\$150K–\$600K
Department of Education	Academic Improvement and Teacher Quality Programs	The state agency for higher education provides competitive awards made to partnerships to improve teacher knowledge in mathematics and science.	Determined by state agency ^b
		The state agency for higher education provides competitive grants to partnerships comprising, at a minimum, schools of education and arts and sciences along with one or more high-need local educational agencies.	Determined by state agency ^b

^a For fiscal year 2007, the NSF Divisions that administer these programs (Research, Evaluation, and Communication [REC] and Elementary, Secondary, and Informal Education [ESIE]) are scheduled to be combined into a single division, Research on Learning in Formal and Informal Settings (DRL).

^b To identify your state MSP coordinator, see <http://www.ed.gov/programs/mathsci/faq.html>, and for information on Academic Improvement and Teacher Quality Programs (AITQ), see <http://www.ed.gov/about/offices/list/oese/aitq/aboutus.html>.

- ing, and learning” (NSF, 2004, p. 39). Projects funded by the Division of Undergraduate Education devote part of their budget toward evaluation to document any behavioral changes in faculty or students that have led to more successful learning of science material. Proposals from a department with faculty (e.g., SFES faculty) who are able to conduct this evaluative research on outcomes from activities associated with proposals for equipment or basic research grant proposals are more likely to be viewed as meritorious, especially if the documented behavioral changes from prior projects have proved to be sustainable. SFES in science departments may additionally use their experience with social science research methods to identify ways to broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.) and enhance the infrastructure for research and education through networks and partnerships.
3. Faculty in science departments are ultimately the ones responsible for the science knowledge of K–12 teachers, yet science departments are often unhappy with the quality of K–12 science teaching. University faculty set the standards for the entire educational system, and if science faculty aspire to improve K–12 science education, they must identify and adapt instructional strategies that engage and support the diversity of students in college classrooms. In other words, science faculty can specifically support science education by how they teach future science teachers. SFES can foster connections between science faculty and K–12 science education through training components for preservice teachers, including methods courses and student advising.
 4. SFES bring expertise to a science department’s program review, curricular reform, and accreditation processes. The special expertise of science faculty who understand how people learn science and how to use formative assessment and rubrics to help students meet goals, how to clearly define objectives, and who are aware of challenges faced by diverse learners is essential if we value equitable access to the knowledge of science. This is a huge topic for any campus faced with program review or regional accreditation, because addressing the needs of diverse populations of students and institutionalizing program assessments have become important foci of the accreditation process.

COMMON MYTHS ABOUT SFES POSITIONS

Up to this point, we have considered what SFES look like and why departments should hire such faculty. Efforts by many science departments to bring science education specialists into the science disciplines have been successful. However, for every successful integration of an SFES into a department, there appears to be an unsuccessful situation, in which either no SFES was hired from a search or an SFES was hired but left the positions because of various difficulties. The authors of this article have observed that a common set of incorrect assumptions about the nature of SFES positions may seriously hinder successful hiring and integration of SFES into science departments. Addressing these assumptions is critical if scientists are to embrace science education within their discipline. We highlight six myths we find to be

pervasive that can derail the hiring and support of SFES. Our descriptions are modeled after the Bower report (Bower, 2005), written to highlight common myths about K–12 education based on an 11-year collaborative partnership between Caltech and the Pasadena Unified School District.

Myth 1

The new science faculty we hire who specialize in science education will develop new courses and add innovations to existing courses that will solve the problems incurred in teaching nonscience majors who are deficient in their understanding of basic science.

Developing curriculum is a huge and time-intensive endeavor. James Bower, a pioneer SFES, admits the following (Bower, 2005):

The most important personal consequence of my involvement with science education reform has been a growing awareness of how poorly I have taught my own students (cf.). . . . After 10 years of involvement with precollege science, I have become profoundly aware of the negative effect the poor teaching of science in colleges and universities has on the rest of the educational system.

If nonscience majors are deficient in their understanding of science, one course with science curriculum designed by one person has little potential to alter the cycle of ignorance. Science education reform requires a concerted effort by groups of faculty who work together over time. For example, integration of lab activities with lecture components of courses that serve large groups of nonscience majors will happen only if large and diverse groups of faculty collaborate to improve the courses. Some experienced science faculty who are thoroughly familiar with the needs and motivations of local students may not be open to innovations meant to involve students with content in ways that are meaningful and relevant. Not all SFES are interested in or qualified to conduct faculty professional development to assist even receptive colleagues to rethink the way they teach, let alone more resistant ones. However, although it may be a myth that SFES can make all the changes needed to help remediate all students’ deficiencies, they can play a vital role by providing their insights to departmental curriculum reform efforts.

Myth 2

New faculty who specialize in science education can replace senior faculty who have dedicated their careers to teaching and furthering the causes of science education.

Senior faculty who specialize in science education work under very different conditions than junior faculty who are hired as SFES. First, from their experience, such senior faculty know local students’ motivations, cultural context, and limitations. Second, senior faculty are typically tenured and supported by a network of colleagues in their discipline who provide access to knowledge and instructional resources. After spending years working on instructional problems, they have found resources about topics they are expected to teach that may not have been dealt with in their own re-

search or educational training. They have most likely introduced innovations that match the needs of the particular students in their courses. Junior faculty who specialize in science education have the same need as other faculty to conduct and peer review research in order to build faculty support networks that they can access when they encounter problems with diverse new teaching experiences. Given the chance to build academic networks, careers can develop over time leading to a position where the SFES can continue to learn and contribute. It is unreasonable to expect knowledge of science education research to cause some faculty to start out with the local expertise of senior faculty who chose to specialize in science education and have gained years of teaching experience.

Myth 3

By designing and teaching a few courses that align goals with appropriate activities and assessments for students who will complete teacher certification programs, faculty who specialize in science education can become responsible for the science training of future K–12 science teachers.

The science knowledge, skills, habits of mind, and experiences expected for outstanding K–12 science teachers are not trivial. Every science faculty member has a stake in producing good K–12 teachers, and it is unreasonable to think that this goal will be met by modeling appropriate teaching strategies in just a small subset of undergraduate courses. SFES may be highly qualified to help other faculty set goals for the science elements of a teacher credential program. They can assist in matching goals to appropriate instructional activities with both formative and summative assessments to make sure teacher accreditation standards are met. However, it should be up to each individual faculty member to define specific instructional activities and objectives to help teacher candidates meet science education goals, including familiarity with conceptual understandings, scientific investigation, lab skills, problem solving, communication strategies, teamwork building, practical reasoning, and positive attitudes toward science. Although it is unreasonable to have one faculty member take charge of all the instructional components appropriate for teacher credential candidates, a science department will be enriched by having a colleague who understands teacher credential requirements and who can model appropriate pedagogy for future K–12 teachers in science content courses.

Myth 4

Faculty who specialize in science education can teach and provide service to the department without the need for resources (time and space) to do research because their research is conducted as they teach their classes.

Rigorous education research requires a representative sample of students that is not often provided by the students in one's own classes. When research is conducted in a "convenience sample" of students in one's own course, then extensive qualitative work is required to document the student demographics so that others will know to what degree results are of interest and can be generalized to other situations with different student populations. Sample size is another problem. The academic year can be a severe limitation

when an entire year must go by before a study can be replicated. Thus, it is a myth that SFES need only limited time and space for research. Any faculty who are denied the time and resources to conduct research, including SFES, will be limited in the research they can do and in their development as a scholar, which will in turn impede their effectiveness in teaching and serving the department. As such, resources for SFES research can be seen as an investment that leads to local educational expertise within the faculty.

Myth 5

The problem with science education in general is that social science research methods and science education theory lack the rigor of basic science.

Few basic science faculty have much experience with qualitative data and the social science methods used to answer important questions in science education, and so they are not highly qualified to judge the academic rigor of science education studies. When investigating science education, random assignment of students to treatment groups is often not feasible and can even be unethical. In some cases, focus group discussions or solicitations of student input through surveys or interviews can be much more rigorous and effective than conducting experimental education research. Methods such as triangulation, bricolage, and other research techniques provide rigor for the empirical basis of science education theory that is supported by vast bodies of evidence. Examples of the use of these research methods to solve important instructional problems are apparent from a Google Scholar search of the terms. Among education researchers, the rigor of education research methods has recently been a topic of some debate. (For a summary of the issues, refer to Pellegrino and Goldman, 2002; Shulman *et al.*, 2006.) To help faculty navigate the complexity and assess the controversy surrounding results from social science research methods, reports such as "How People Learn" from the National Academies have been cautiously written using standards of empirical evidence meant to report only consensus ideas about how people learn (National Research Council, 2000). Having a faculty member in the science department who keeps up with advances in science education research can help maintain a departmental focus on proven methods while protecting the department from failed innovations resulting from unproven fads or political directives.

Myth 6

An SFES will be the best teacher in a science department and will have nothing to learn from the teaching experiences of senior science faculty.

The majority of SFES are junior faculty who have just emerged from some specialized educational training after a traditional graduate research experience in their home scientific discipline. Although these individuals may have taught for several years, they cannot bring to the department the decades of classroom experience that many senior science faculty (albeit with no special training in science education) have accumulated. That said, a common myth that is pervasive and divisive is the assumption that SFES can and will immediately outperform experienced faculty and

emerge as the best teacher in the department. Not only is this unlikely, it sets up a false dynamic that does not acknowledge the science teaching strengths of the basic science faculty, and at the same time it puts unreasonable expectations on these young faculty members who are at the beginning of their pedagogical careers. Experienced science faculty should not feel threatened by these new “teaching experts.” In fact, experienced science faculty and new SFES faculty have complementary expertise that, when shared, will be mutually beneficial and open up conversations about teaching and learning that may not have previously occurred within a department.

Although we share concerns about these six myths, it should be noted that behind each myth is a kernel of truth about what a colleague who specializes in science education can actually do for a science department. A department that hires such an individual can expect that individual to help the department to engage and serve the needs of diverse students and to examine and improve instruction to better meet department goals. SFES can participate in faculty collaborations to improve courses and programs for K–12 science teachers to break the cycle of ignorance. As more teachers understand how people learn science, increasing numbers of children will be empowered by the knowledge of that discipline. SFES can help build strong collaborations among faculty who continually innovate with instructional methods to make the science discipline more deeply meaningful to students. They just can’t do it all at once!

WHAT CONVERSATIONS DOES A DEPARTMENT SEEKING TO HIRE A SCIENCE FACULTY MEMBER WITH AN EDUCATION SPECIALTY NEED TO HAVE?

As emphasized in the introduction, there are few to no resources available to aid science departments and colleges of science aspiring to hire a scientist who specializes in science education (NAS, 2006). With more departments opening searches for these SFES, there is an emerging need for guidelines for departments embarking on discussions of how to define and search for someone to fill such a position in their discipline. Given the dearth of guidelines, we have developed a tool to aid departments in beginning these conversations, a *Departmental Guide for Discussions on Hiring SFES*, which is available in the Supplementary Material. This guide poses questions that we believe can aid science departments in engaging in conversations that: 1) establish the goal(s) of hiring one or more SFES; 2) articulate both the science and science education background and training desired in an SFES; 3) delineate expectations for research, teaching, and service for an SFES; and 4) anticipate what implications the hiring of SFES has for the department’s future curriculum, hiring plan, and academic programs and degrees. These points for departmental conversations, described in more detail below, are not intended to be complete, but rather to be the starting points for discussion.

Establish the Goal(s) of Hiring One or More SFES

In evaluating potential new colleagues in traditional areas of research in a science discipline, science faculty often share

common visions about expectations in research, teaching, and service. However, faculty have much less experience in hiring SFES who are scientists by training but who also specialize in science education. Search committees, and departments as a whole, need to articulate their goals in hiring an SFES and clarify the responsibilities of SFES hires in their departments before the hiring process and to be prepared to communicate these expectations explicitly to SFES candidates. Brainstorm early about goals for hiring an SFES and define department needs well before writing any job description. Being able to articulate goals can lead a faculty to their ideal job description and will allow hiring committees to both explicate the hiring criteria and also begin to discuss the evaluation process for what is, in most cases, a novel position. The process of developing a consensus on goals should also lead to realistic expectations.

Once the goals of hiring an SFES are somewhat defined, take the time to reach consensus and review these goals with all departmental faculty and administrators. A process of collaboration and consensus building about the nature and goals of an SFES position among administrators and faculty will highlight the valuable contributions such a colleague can bring to a science department and dispel incorrect assumptions, such as the six myths described above. In addition, widespread agreement on the goals of hiring an SFES from the outset will help departments to avoid the unfortunate situations in which 1) the search committee has an idea of the “ideal candidate” that doesn’t match the ideas of the rest of the interviewing faculty or 2) where the “ideal candidate” is hired, based on the search committee’s criteria, but other departmental colleagues have different criteria in mind, causing discord later in the tenure and promotion process.

Articulate Both the Science and Science Education Background and Training Desired in an SFES

Depending on the goals of the department for an SFES position, the background desired may differ substantially. In crafting an SFES position and job description, indicate the types of science and science education training that are most desired by the department—whether it be master’s-level or Ph.D.-level basic research training, extensive undergraduate teaching experience, formal education research training, or experience interacting with the K–12 school system. Also, depending on the desired SFES qualifications, departments may be well served by inviting external stakeholders into the discussion and perhaps asking them to serve as members of the search committee. Potential stakeholders to include in the dialogue include SFES already at the university in other science departments, faculty in the College of Education who are potential colleagues of this new SFES, and leaders from the local K–12 school systems.

Delineate Expectations for Research, Teaching, and Service for an SFES

As stated earlier, a wide range of expectations exist for SFES, so departments must carefully consider their goals and delineate expectations that a new faculty member can reasonably achieve. The questions in the Supplementary Material aim to push departments to do so and to explicitly discuss how these SFES expectations will compare with those for

department colleagues. Departments should also consider SFES needs for space, equipment, and startup funds and how these might compare with other faculty hires. SFES research programs can be, and often should be, as large as any other research program in the department. This is necessary to attract funding through national grants for education, which can be considerable (Table 1). Finally, when the research, teaching, and service expectations are clearly defined, then the evaluation process should be aligned with those criteria.

Anticipate the Implications of the Hiring of an SFES for the Department's Future

In crafting SFES positions, science departments may find their expectations far exceed the capacity of one SFES position. A plan for hiring multiple SFES over a period of time may aid the department in prioritizing its goals for the initial and subsequent SFES hires. These departmental discussions would likely move toward how the hiring of one SFES may affect many aspects of the department in the future. Future implications include defining SFES tenure and promotion criteria and establishing undergraduate and graduate curricula and programs in science education, including science education research.

In using the *Departmental Guide for Discussions on Hiring SFES* (Supplementary Material), we hope that science faculty will be able to openly examine the many options for defining these positions and explore how SFES can enhance the connections between the scholarship of science teaching and learning and the science disciplines on their campus.

MOVING FORWARD

In closing, we encourage you, the reader, to consider how the information contained in this article could be shared with your departmental colleagues and to reflect on how you might support the integration of an SFES in your department.

- Educate yourself and prepare to validate the expertise of your department's SFES, especially if you notice that other faculty in your department make incorrect assumptions about their science education expertise or the ways in which their time should be spent.
- Help your department distribute service equitably (or in line with the original, stated expectations) so that faculty members hired as SFES are not unexpectedly asked to assume more service requirements than faculty who do basic research in your discipline.
- Advocate for science education research time and space so that science faculty who specialize in education can create new knowledge and subject their work to peer review as they interact with and establish their credibility among peers.
- Find opportunities to collaborate on courses directed by faculty who specialize in science education. In the process you may learn about innovative science teaching approaches, and you can contribute your disciplinary expertise to improve the courses.
- Encourage all faculty in your department to participate in science education reform at all levels by working together

to define goals, identify activities appropriate for specific objectives, and create assessments to measure the degree to which your students master the elements of knowing and doing science, including conceptual understanding, scientific investigation and lab skills, problem solving, communication, teamwork, safety, practical reasoning, and positive attitudes toward science.

Finally, we hope that you are able to use the ideas presented in this article to encourage a conversation in your own department about hiring, retaining, and supporting SFES. If your department finds that more support, guidance, and leadership is needed from higher levels, such as the university administration or the professional societies in your discipline, use your voice to help clarify the opportunities and needs we have illustrated here. The increased hiring of SFES we have described holds great promise to enrich science departments and contribute to improved science education in a variety of ways, but only if departments are successful in crafting appropriate positions and hiring, supporting, and retaining these science faculty with education specialties.

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REFERENCES

- Bower, J. M. (2005). Scientists and science education reform: myths, methods, and madness. Resources for Involving Scientists in Education (RISE). National Academies of Science. <http://www.nationalacademies.org/rise/backg2a.htm> (accessed 12 October 2006).
- Boyer, E. (1990). *Scholarship Reconsidered: Priorities of the Professorate*. Stanford, CA: The Carnegie Foundation for the Advancement of Teaching.
- California State University (CSU) (2006). System-wide Science Education Colloquium, May 5–6, 2006. http://scied.fullerton.edu/csuscied/May5_6CSUsciedAgenda06.PDF (accessed 12 October 2006).
- National Academy of Sciences (NAS) (2006). Workshop for Discipline-based Science Education Research. http://www7.nationalacademies.org/cfe/STEM_Disciplines_Agenda.html (accessed 12 October 2006).
- National Research Council (2000). *How People Learn: Brain, Mind, Experience, and School*. Washington, DC: National Academy Press.
- National Science Foundation (NSF) (2004). *Grant Proposal Guide 04-23*. Arlington, VA: National Science Foundation.
- Pellegrino, J., and Goldman, S. R. (2002). Be careful what you wish for—you may get it: educational research in the spotlight. *Educ. Res.* 3(8), 15–17. <http://www.aera.net/publications/?id=438> (accessed 12 October 2006).
- Shulman, L. S., Golde, C. M., Conklin Bueschel, A., and Garabedian, K. J. (2006). Reclaiming education's doctorates: a critique and a proposal. *Educ. Res.* 35(6), 25–32. <http://www.aera.net/publications/?id=1197> (accessed 12 October 2006).

Appendix I: Departmental Guide for Discussions on Hiring Science Faculty with Education Specialties (SFES)

Articulating Goals

1. What are the department's short-term and long-term goals associated with this new position?
2. Is this position tenure-track? Will it be advertised at the assistant, associate, or full professor level?
3. How will the starting salary of this position compare with those of contemporary faculty hires in the department? If different, why?

Preferred Training and Work Experience

4. What degree will be expected/preferred?
 - PhD in Science, PhD in Science Education, PhD in Curriculum & Instruction, EdD?
 - If a PhD in Science, what additional training in education will be expected?
 - If an EdD or PhD in Curriculum & Instruction, what additional training in science will be expected?
5. To what extent is work experience in K-12 education expected or preferred?

Criteria for Retention, Promotion, Tenure

Research and Scholarly Activity Expectations

6. To what extent will this individual's research be expected to be focused on basic science, science education, or a combination of both?
7. How are scholarly expectations for this individual similar to or different from those of other colleagues in the department? If different, why?
8. How will startup funds and opportunities for release time for this individual compare with those of other colleagues in the department? If different, why?
9. How might the available pool of student researchers for this individual be similar to or different from department colleagues? If different, how should this be addressed?

Teaching Expectations

10. To what extent will this individual be required to teach? How will the teaching load for this position compare with teaching loads of other faculty in the department? If different, why?
11. What types of classes will this individual be expected to teach? What types of classes will this person be discouraged from teaching?
 - Non-majors/ General Education courses
 - Lower division courses required for majors
 - Upper division courses required for majors
 - Elective courses for majors
 - Credential program required courses
 - Credential program electives
 - Graduate courses required for degree

- Graduate elective courses
 - Science education teaching methods courses for science majors
 - Science education research methods/seminars for graduate students
 - Other courses?
12. To what extent would this person be expected to be involved in course or laboratory coordination roles?
 13. How will course or laboratory coordination roles be considered in the tenure and promotion process, e.g., as teaching or as service? Will this individual receive release time for performing coordination duties?

Service Expectations

14. What academic advising/coaching/mentoring roles are expected of this person?
 - Teaching Assistant or part-time instructor/lecturer training
 - Academic advising of majors, credential students, or service course students
 - Pre-professional program advising
 - Career advising
 - Recruitment
 - Outreach and Partnership with local schools
 - Service learning course development
 - Students engaged in research
 - Professional development for faculty in your department
 - Professional development for faculty beyond your department
15. Will this person be responsible for Multiple- or Single-Subject Credential Programs beyond academic advising of credential students? If so, in what ways?
 - Classroom observations as university supervisor
 - Recruitment and retention of master teachers
 - Preparation of master teachers
 - Classroom placement of pre-service teachers
 - Interviewing candidates for credential programs
16. To what extent will this person be expected to serve on departmental and university-wide committees? Will committee responsibilities be similar to or different from those of department colleagues?
17. To what extent will this person be expected to serve as a liaison between the science department and the education department? with the K-12 education community?
18. How will this person's service responsibilities compare to those of department colleagues?

Planning for the Future

19. Are science education courses and/or undergraduate degrees in science education available in the department? How open is the department to the development of these types of courses or degrees?
20. Are advanced degrees in science education available in the department? How open is the department to the development of these graduate programs? Are/will advanced degrees be conferred by the science department or the education department?

21. Are additional hires in science education planned by the department? How will subsequent hires interact with the initial hire? How will the newly hired individual(s) change the role of the person initially hired?