THE PIPELINE

Science Faculty with Education Specialties

Career dynamics for science faculty with interests in education point the way for developing this nascent career specialty.

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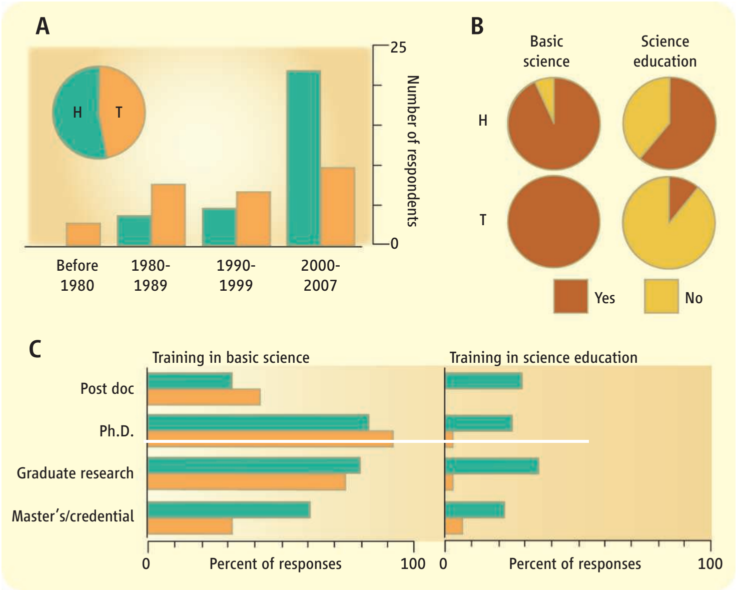
Globally, efforts to improve science education continue (*1*, *2*). In the United States, primary and secondary (K–12) science education lags on international assessments and struggles to sustain qualified K–12 science teachers and to prepare the next generation of scientists and engineers (*2*). At U.S. colleges and universities, more than half of entering science majors leave the sciences, most (90%) complaining of ineffective teaching (*3*). Of those who remain in science, 74% express the same complaint (*3*). Further work is needed within specific science disciplines on how students most effectively learn that discipline (*4*). To address K–12 science education, undergraduate science education, and discipline-specific science education research, one approach is seeding university science departments with Science Faculty with Education Specialties (SFES), scientists who take on specialized science education roles within their discipline (*5*).

We present data on SFES in science departments throughout the 23-campus California State University (CSU) system (*6*), the largest U.S. university system (annual enrollment ~450,000 students). The CSU's primary missions are undergraduate, master's-level graduate, and K–12 teacher education. CSU undergraduates are among the top one-third of their high-school graduating classes. The 23 campuses include institutions that differ substantially in their founding dates, settings, student populations, enrollment sizes, and levels of research orientation. We investigated SFES numbers, characteristics, training, professional activities, and persistence.

We identified, with the aid of deans, 156 CSU faculty as SFES and invited all 156 to complete a 111-question survey (*7*), which we had face-validated using non-CSU faculty. Between December 2007 and January 2008, 103 of the invitees responded (66% response rate), representing 20 of the 23 campuses. We collected data anonymously and excluded surveys that were incomplete (n = 12), submitted by lecturers or non–tenure-track science faculty (n = 10), or lacked informed consent (n = 3). Of the remaining 78 survey respondents, 59 individuals self-identified as SFES, and 19 as not SFES. Our further analyses followed only the 59 tenured/tenure-track science faculty who self-identified as SFES.



Hiring and formal training. (**A**) The pie chart inset shows the proportion of two SFES types, hired-SFES (H) (n = 31) and transitioned-SFES (T) (n = 28). The distribution of hire dates for hired-SFES and transitioned-SFES is shown with bars. (**B** and **C**) The proportions with formal training in basic science and/or science education and the types of formal training reported.

Characteristics and Training

These 59 SFES represented four science disciplines [biology (34%), chemistry (24%), geoscience (14%), and physics (25%)], as well as science faculty in centers for science and math education housed in Colleges of Science (3%). They were 46% female, 81% white, across tenure-track faculty ranks (28% assistant, 31% associate, and 41% full professors), and trained extensively as researchers in basic science. We completed Pearson's chi-square and McNemar's tests to compare subpopulations of SFES and to make inferences ($P < 0.05$).

SFES include two subpopulations, those specifically hired as SFES (hired-SFES; n = 31, 53%) and those who transitioned to SFES roles (transitioned-SFES; n = 28, 47%) from their initial faculty roles [see (A) in chart, left]. Transitioned-SFES had hiring dates beginning in 1970, and hired-SFES had dates beginning in 1987 (see chart, left). More hired-SFES were hired after 2000 than in all previous years combined. Transitioned-SFES (17.9% assistant, 28.6% associate, 53.6% full) tended to hold higher faculty ranks than hired-SFES (41.9% assistant, 35.5% associate, 22.6% full; $\chi^2 = 6.8$, df = 1; $P = 0.033$). Half of transitioned-SFES (50.0%), but only a few hired-SFES (9.7%), had tenure before entering SFES roles ($\chi^2 = 11.6$, df = 1; $P = 0.001$).

Both groups had similar and extensive formal training in basic science [see (B) in chart, above], but more hired-SFES (61%; $\chi^2 = 12.7$, df = 1; $P = 0.001$) had formal training in science education than did transitioned-SFES (11%) [see (C) in chart, above]. Although SFES may have various types of training experiences, we defined formal training as post-baccalaureate training, including degrees, teaching credentials, graduate level research, and/or postdoctoral research. Of note, both groups have substantial proportions of individuals lacking these types of formal training in science education.

Professional Activities and Endurance

Examination of the professional activities for which SFES sought funding revealed that they were undertaking efforts in the three key science education arenas of K–12 science education, undergraduate science education, and

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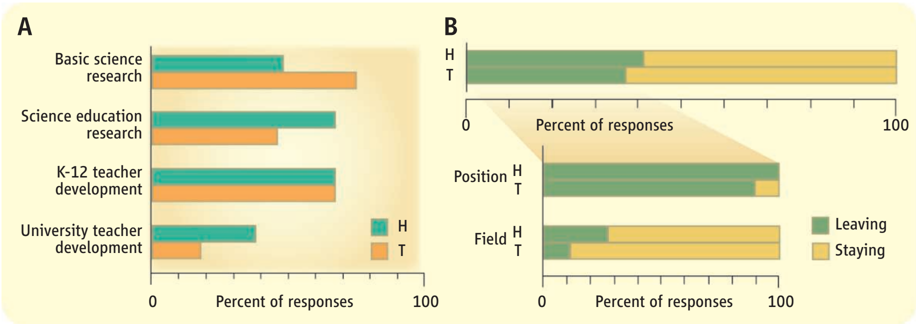
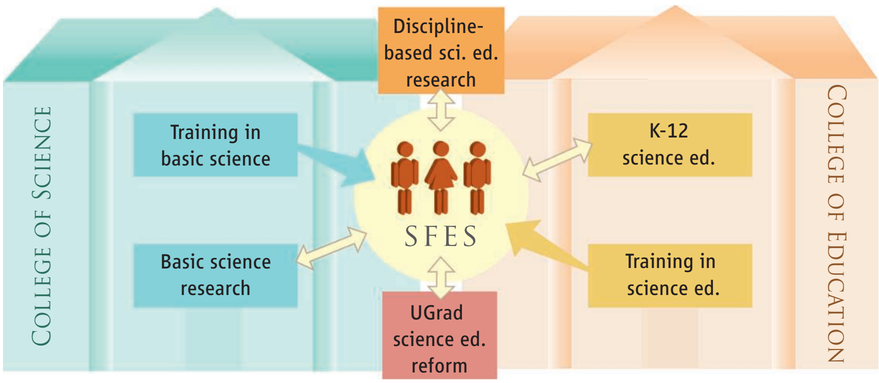


Activities and satisfaction. (**A**) The percentages of those who sought funding for scholarly activities in four areas. (**B**) (Top) The percentage of SFES ($n = 56$; three nonresponders) who were seriously considering leaving their job. (Bottom) Their inclination to leave the position ($n = 21$; one nonresponder) and/or field ($n = 20$; two nonresponders).

discipline-based science education research, as well as continuing basic science research [see (A) in chart, above]. More transitioned-SFES (75%; $\chi^2 = 4.4$, df = 1; $P = 0.036$) pursued basic science research funding compared with hired-SFES (48%), whereas more hired-SFES (68%; $\chi^2 = 2.7$, df = 1; $P = 0.098$) applied for science education research funding compared with transitioned-SFES (46%). Both groups applied at equal rates (68%) for funding to support K–12 teacher development. SFES pursued funding for university teacher development the least, although twice the percentage of hired-SFES (39%; $\chi^2 = 3.1$, df = 1; $P = 0.077$) did so compared with transitioned-SFES (18%). Overall, 41% of respondents had obtained total external funding exceeding \$500,000, including 15% who had received total external funding of over \$1,000,000.

For their professional activities, most SFES (71%) reported spending "about the same amount" of time on teaching as did their non-SFES department faculty. Nearly all SFES (90%) perceived soliciting external grant funding and publishing peer-reviewed articles as being "essential for obtaining tenure and/or promotion." Fewer than 10% of SFES perceived an equivalent academic infrastructure—undergraduate or graduate courses and degree programs within their science departments—supporting scholarship in science education as compared with supporting scholarship in basic science. Of those with departmental graduate programs, most SFES (79%) reported having less access to graduate student researchers than non-SFES science faculty had. Furthermore, 34% of SFES reported being the only SFES in their department.



Almost 40% of the 59 SFES were "seriously considering leaving" their current jobs [see (B) in chart above], including 41% of hired-SFES and 37% of transitioned-SFES. Of those who specified, nearly all (95%) were considering leaving their particular position. Some (20%) were considering leaving the field entirely [see (B) in chart above]. Results of McNemar's test ($\chi^2 = 13.1$, df = 1; $P < 0.001$) imply most SFES are dedicated to and invested in the field of science education, but find themselves in faculty appointments that they find professionally unacceptable. Although similar proportions of hired-SFES and transitioned-SFES were considering leaving, analysis of open-ended item responses revealed differences. Hired-SFES most commonly reported that they were considering leaving because their science education efforts were not valued or understood. Transitioned-SFES, in contrast, reported being overworked and burned out.

Conclusions

SFES occupy tenured or tenure-track faculty positions across all science disciplines, at all faculty ranks, and across the wide variety of campuses within the CSU. SFES are engaged broadly in science education as well as in basic science research. Hired-SFES and transitioned-SFES share similarities, but show four statistically significant differences. Greater proportions of hired-SFES are untenured faculty, are recent hires, and have formal post-baccalaureate training in science education. A greater proportion of transitioned-SFES sought basic science research funding. As a whole, SFES pursue funding for science education and basic science research and do not simply occupy teaching positions, as most report teaching about the same amount as their non-SFES colleagues. Our results quantify increased rates of hiring for SFES but also suggest potentially high attrition from these positions.

The SFES model appears both promising and challenging (see diagram, left). SFES in university and college science departments have the potential to drive science education reform at K–12 and postsecondary institutions. Our data suggest that science education would benefit from (i) increased training opportunities to develop SFES, (ii) reduced professional isolation for SFES, and (iii) improved academic infrastructure to support SFES research and professional activities. Attention to the issues raised by SFES in this study would likely strengthen the impact of SFES on K–12 science education, undergraduate science education, and science education research within the disciplines.

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7. Materials and methods are available as supporting material on *Science* Online.

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