Where Can We Find Future K-12 Science and Math Teachers? A Search by Academic Year, Discipline, and Academic Performance Level

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ABSTRACT: Responding to the increasing math and science teacher shortage in the United States, this study intended to determine which science, engineering, and math (SEM) majors during which years in their undergraduate education and from which academic performance levels are most interested in K-12 teaching. Results may aid policymakers and practitioners in making most effective use of this traditional undergraduate candidate pool when designing K-12 science and math teacher recruitment programs. A survey of SEM majors from two research-oriented, urban universities is used to assess participants' interest in K-12 teaching both compared to other career choices and in isolation. Results indicate that the more successful targets for K-12 teacher recruitment include (1) SEM undergraduates in their junior and senior years independent of SEM major, (2) SEM undergraduates with mid-academic performance levels independent of SEM major and academic year, and (3) math majors followed by natural science majors and, as least promising targets, engineering majors. Results remain independent from gender and ethnicity variables. © 2005 Wiley Periodicals, Inc. *Sci Ed* **89:**980–1006, 2005

INTRODUCTION

In the United States, there is a serious shortage of qualified math and science teachers (Clewell & Villegas, 2001; Clewell & Forcier, 2001; Gafney & Weiner, 1995; Shugart & Hounshell, 1995). Nationally, as of 1993 to 1999, 39% of school districts reported math

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and science teacher vacancies, while 19% reported difficulty filling those vacancies (U.S. Department of Education, 1997). According to a nationwide survey released by the National Science Teachers Association in 2000, this trend both continues—61% of high schools and 48% of middle schools experienced difficulty locating qualified science teachers to fill vacancies—and is expected to worsen given that over 30% of current teachers with varying years experience report considering leaving the profession (National Science Teachers Association, 2000). Nearly every region of the United States reported "considerable" teacher shortages in these subjects, identifying most prominently the need for mathematics teachers closely followed by those in physics, chemistry, earth/physical science, and biology; while subjects such as elementary, English/language arts, and social studies are identified as balanced, and physical education and health constitute a surplus (American Association for Employment in Education, 2000, p. 10). The problem is so pronounced that since the early 1990s, in-need districts across the nation have imported thousands of international K-12 math and science teachers (Brulliard, 2004).

Numerous remedies have been attempted to alleviate this teaching shortage. Remedies range from national to local policies and programs and include such approaches as emergency certification and out-of-field assignment to fill vacancies; alternative certification programs to hasten licensure requirements and job placement; tapping nontraditional candidate pools such as paraprofessionals, retired military, or career changers; providing scholarships, signing bonuses, or student loan forgiveness; and establishing partnerships between school districts and teacher preparation institutions to meet staffing needs cooperatively (AAEE, 2000; Clewell & Forcier, 2001; U.S. Department of Education, 2000a). Each remedy has certain costs and some degree of success. However, many remedies must resort to back peddling to meet content knowledge qualifications, calling back to the educational fold those who have already left, or investing in populations who fail to complete licensure. To make most effective use of the most accessible potential recruits—undergraduates who have not yet completed a degree—a lingering question about fertile opportunities comes to the foreground: When during their student careers are science, engineering, and math (henceforth referenced as "SEM") undergraduates most interested in teaching and in which majors and at what academic performance levels? In other words, where ought institutes of higher education focus K-12 SEM teaching recruitment efforts for this traditional candidate pool?

BACKGROUND

Science and Math K-12 Teacher Shortage

During the past four decades, the science and math K-12 teaching field has witnessed a marked decline in recruitment: the number of first year undergraduates pursuing math and science teaching careers has dropped from 22% in 1966 to 5% in 1988 (Green, 1989). According to a longitudinal research study conducted by Seymour and Hewitt (1997), 20% of SEM undergrads at one time consider careers in math or science teaching, although under 8% of them hold to the career interest. Similarly, according to a 1997 Department of Education study, "Progress Through the Teacher Pipeline," though 20% of math, science, and technology undergrads considered teaching, only 5% completed teacher preparation programs and accepted teaching jobs (U.S. Department of Education, 2000c).

Troubled not only by recruitment, the science and math K-12 teaching field also suffers from flagging retention. Only 4% of new math and science teachers report foreseeing teaching as a longer-term career commitment (U.S. Department of Education, 2000c). Almost 200,000 vacancies in secondary math and science are anticipated in the U.S. (National

Research Council, 2002) as a result of the near two-thirds of the nation's experienced educators retiring or leaving the field through the next decade (U.S. Department of Education, 1999). Moreover, even math and science teachers who remain in the field but migrate to other districts register the same but underrecognized effect as those who leave the field entirely: in both cases the district is shouldered with a loss of an experienced, qualified teacher who is increasingly challenging to replace (Ingersoll, 2003).

The drop in recruits to math and science teaching is compounded by a national decline in those pursuing math and science majors and careers (Astin & Astin, 1993). Previous research conducted by NSF found that between freshman and sophomore years, nearly 35% drop their science or math majors (National Science Foundation, 1990). Yet Seymour and Hewitt's (1997) study indicates that undergraduate science and math majors dedicate considerable effort (2.1 years in a range from 1 to 3 years) before switching to an alternative major, and that engineering majors invest even greater time (2.6 years). The majority of these switchers search instead for majors leading to careers that would be nontechnical though inherently motivating or in service to society, even at a material cost. Of undergrads who leave math and science majors, 17% opt for the humanities; over 9% for business; 5% to professional majors such as journalism, library science, communications, law enforcement, home economics, and military science; over 1% to health and medicine; but only 3% choose education majors. Though math/statistics majors are the most likely to switch to education majors—at 17% compared to biology majors (5%), physical science majors (2%), and engineering majors (1.5%)—their numbers fall drastically short of the demand, given math majors constitute approximately 0.7% of national baccalaureate degrees (Seymour & Hewitt, 1997).

Gender and Ethnicity

Addressing the shortage of qualified K-12 math and science teachers must also involve addressing the SEM disciplines' underrepresentation of women and minorities as well as the ethical dilemma posed by their recruiting. From one perspective, women and those of color remain recommended targets for math and science teaching recruitment given their valuable role modeling to underrepresented populations (Cole, 1986; Graham, 1987), especially in the predominantly white, male SEM disciplines (Green, 1989). They are also sought recruits given their higher likelihood of SEM major and career dissatisfaction (Clewell & Forcier, 2001; Seymour & Hewitt, 1997). By another perspective, however, targeting women and those of color to serve this greater good involves asking traditionally exploited populations to forego headway in SEM professions in favor of a lower paying, lower status occupation. Each demographic presents unique issues.

Though the small proportions of minorities who do elect SEM majors is purportedly on the rise, only half of African Americans and of Native Americans, and only one-third of Latinos graduate with those majors (Astin & Astin, 1993). Similarly, while the proportion of minorities entering teacher education is also increasing for African Americans, Latinos, and Native Americans, the number of minority teachers remains low due to high rates of college drop out (Murane et al., 1991; Vegas, Murane, & Willett, 2001). As a result, the racial-ethnic disparity between teachers and students has widened with time. In urban districts, for instance, where minority populations are highest, nearly half of students are of color while less than a third of teachers mirror this diversity (U.S. Department of Education, 1996b). Most states indicate that those of color represent only about 7.5% of math and science educators, urban, suburban, and rural regions averaged (Kloosterman, Woods, & Matkin, 1987). This disparity is expected to worsen nationally unless recruiting programs step up efforts (Darling-Hammond, 1990; Goodwin, 1991).

Popular perspective is that minority rejection of teaching stems from its relative low pay and prestige compared to other professions now within reach of minority students (Dupre, 1986). However, the obstacle for minorities pursuing teaching may actually be disaffection with the educational system: not college but precollege experiences with academically insufficient or culturally invalidating preparation (Gordon, 1994, 2000). K-12 education typically leaves students of color with deficits both in skills necessary for college success (King, 1993; Vegas et al., 2001) and in faith in a system—or a profession—which they may blame for personal failure and from which they will dissuade their community's youth (Gordon, 1994; 2000; Ogbu, 1990). Hence, research indicates that boosting the amount of African American and Latino students who complete high school, enroll in college, and eventually graduate is arguably a means of increasing these population's representation in teaching; furthermore, African American college graduates, even those of high ability, prove greater chance of pursuing teaching than do Caucasian college graduates (Vegas et al., 2001). Such findings parallel others indicating for similar reasons the importance of starting minority teacher recruiting as early as ninth grade (Newby et al., 1995).

Not only is the proportion of women who do elect SEM majors low (26%), but the proportion that switch out of SME majors entirely is high: 72% of women leave math/statistics; 69%, computer science; 57%, biology; 44%, physical sciences; and 37%, engineering. Of switchers, almost 21% of women (compared to 2% of men) elect the traditionally gender-typed education major, 45% of those women having come from math/statistics majors (Seymour & Hewitt, 1997). Despite the expansion of women's professional options over the past 30 years, expectations that SEM female students aspire to more prestigious careers (Tomanek & Cummings, 2000), and the perceived loss of this "captive" population of SEM educators, particularly in math (Green, 1989), data indicate that over half of public math and science educators are still female (U.S. Department of Education, 1997). For some women, electing science and math education may constitute a means of covertly redefining a community that has otherwise excluded them (Barton et al., 1995).

Poor Content Knowledge Preparation

One result of the supply shortage of K-12 science and math teachers is the field's reported decline in content knowledge preparation. Nearly 32% of math and science teachers report majoring in neither math nor science (U.S. Department of Education, 2000c). When disaggregated by discipline at the high school level, as of 1999, those without majors in their subject areas number 37% of biology teachers, 59% of physical science teachers, and 60% of math teachers. These unpromising statistics grow more extreme in middle schools and high-poverty public high schools, especially regarding math and physical sciences instruction (National Science Foundation, 2004). The statistics are especially worrisome given the strong correlation between thorough teacher subject matter preparation and higher student performance (Darling-Hammond, 2000; Goldhaber & Brewer, 1997; Monk & King, 1994).

Lower Academic Performance

Numerous sources indicate that K-12 science and math teaching in particular draws lower performing undergraduates, an issue of dire importance given that teachers' academic skills are closely linked to student learning (U.S. Department of Education, 2000b). For instance, Shugart and Hounshell (1995) concluded that undergraduates who test more competitively in science content were more likely either not to pursue—or pursue only for a short time—a teaching career. Math and science teachers registered, as of 1994, the highest percentages of educators with cumulative undergraduate GPAs in the lowest quartile compared to teachers of all other subjects: 17.2% of math/technology teachers and 15.7% of science teachers registering below 2.74 (or B-average) on a 4.0 scale (U.S. Department of Education, 1996a).

Academic performance, measured as cumulative undergraduate GPA, has been shown to relate to career intent. For example, Green (1989) states that among technology majors, "B" students are more likely to migrate to nonscience fields than are "A" students. Seymour and Hewitt (1997) found that grade-related issues influenced attrition for 23% of SEM majors who switched to non-SEM majors; however, given that a considerable number of SEM major "persisters" also reported problems with grades, they argue that differences in academic performance are insufficient to predict likelihood of attrition. Yet, the report "From bachelor's degree to work" (U.S. Department of Education, 2001) indicates that as GPA declines, so does the likelihood of enrolling in graduate education, a GPA-contingent transition that can largely impact career intent.

Consequences of Shortage

The K-12 qualified math and science teacher shortage perpetuates a vicious cycle in that poor K-12 preparation discourages students from pursuing careers in those disciplines, including K-12 teaching (Gafney & Weiner, 1995). For instance, between 1966 and 1988 the nation witnessed a dramatic drop in freshman planning on SEM majors with the most severe decline evident in those having planned to pursue majors in math (4.6% to 0.6%) and physical sciences (3.3% to 1.5%). Moreover, between 1982 and 1988, freshmen planning majors in engineering dropped by 25% (Green, 1989). The shortage further increased socioeconomic stratification given teacher flight from urban toward suburban jobs (Haberman, 1988; Stoddart, 1990). The shortage of qualified math and science teachers more severely impacts urban districts, with 98% of urban districts reporting immediate demand for science teachers and 95% reporting an immediate demand for math teachers (Recruiting New Teachers and Council of Great City Schools, 2000).

Further repercussions include negative attitudes toward science, lower student academic performance, and declining scientific literacy (Shugart & Hounshell, 1995) to the point that American students are routinely outperformed internationally in math and science (National Research Council, 2002). For instance, according to the 1999 Trends in International Mathematics and Science Study (TIMSS) Assessment results, U.S. 8th graders rank behind seventeen of 38 other nations. Moreover, the 1995 TIMSS assessments revealed that U.S. 12th graders scored below the international average (U.S. Department of Education, 2004a). Given the diminishing numbers of citizens interested and prepared to pursue science- and technologically related professions, consensus points to concern that America's global market competitiveness hangs in the balance (Seymour & Hewitt, 1997).

RESEARCH QUESTIONS

In order to maximize the effectiveness of shortage-inspired teacher recruitment interventions—particularly those targeting the traditional candidate pool of undergraduates—it is important to isolate which SEM undergraduates are most interested or open to the possibility of K-12 teaching careers. Currently, relatively little is known about interest level, even as a function of simple variables such as major, year in degree, or performance level.

To address this lack of knowledge about the predictors of interest in K-12 teaching among SEM undergraduates, this paper focuses on the following questions:

1. What proportion of SEM undergraduates are interested in K-12 teaching careers? Are there differences in K-12 teaching interest by gender or ethnicity?
2. How does interest in K-12 teaching relate to interests in other career objectives?

3. How does interest in K-12 teaching vary through undergraduate education from freshman to senior year?
4. Is the pattern of variation of K-12 teaching interest through undergraduate education similar in all majors? If not, how could we explain variations by major?
5. Is there a relationship between end-of-degree GPA and K-12 teaching interest?

Answers to the questions will be important to policy makers and practitioners held accountable for designing effective K-12 science and math teacher recruitment programs to target most optimally undergraduate populations.

METHODOLOGY OVERVIEW

In this study, we distributed a survey to SEM undergraduate students in two major universities. We collected demographic data, such as academic year, major, gender, ethnicity, and GPA as a proxy for academic performance. The analysis excluded undeclared freshmen, graduate students, and non-SEM majors. Students in or beyond their 5th year of undergraduate education were considered seniors. For dual majors, we considered the first indicated major unless it was a non-SEM major, in which case we considered the second declared major. Physics included astronomy; engineering included all departments of the engineering school (such as chemical engineering or biomedical engineering); life sciences included majors such as neuroscience, animal sciences, agricultural science, and food science; and earth sciences included geography, geology, and atmospheric sciences.

Though Seymour and Hewitt (1997) argue that GPA is an insufficient predictor, their findings apply to the correlation with likelihood of SEM major attrition, not with career intent. We hypothesize that GPA may be a factor affecting career choice for SEM majors (those who both switch and persist) for two reasons. One, the career-promoting option of graduate education is easily accessible for high performers but not so for lower performers. Two, implicit in most any undergraduate career choice is competition with pursuing further education. According to the report "From bachelor's degree to work" (U.S. Department of Education, 2001), academic performance can be interpreted as three tiers of cumulative undergraduate GPA: less than 3.0, 3.0 to 3.49, and 3.5 or higher. Our study parallels this interpretation of GPA as a means to study the relationship between SEM undergraduates' academic performance and teaching career interest. We categorized GPA into four, instead of three, tiers: below 2.70, 2.70–2.99, 3.0–3.49 and 3.50 or higher. We used only the senior subpopulation for GPA analysis given that their GPAs are the closet estimate of end-of-degree GPA.

The survey contained two questions related to SEM undergraduates' K-12 career intent (Likert scale) and percent likelihood of K-12 math and science teaching. To measure participants' math and science K-12 teaching career interest, we used the responses to these two questions and a third measure (ranking of teaching career goals), derived from the percent likelihood measure.

The Direct Measure of *Career Intent*

This measurement estimates the degree of interest in K-12 teaching without comparing it to other alternatives. Using a 4-point Likert scale, we asked respondents to select the choices that best describe them. At University 1, the item read: (a) teaching does not appeal to me, (b) I have a general interest in teaching, (c) I want to find out if teaching is for me, and (d) I am considering becoming a teacher. At University 2, the item was revised to make sure respondents understood that K-12 teaching interest was being measured: (a) K-12 teaching does not appeal to me, (b) I have a general interest in K-12 teaching, (c) I would like to find out if K-12 teaching is for me, and (d) I am considering becoming a K-12 teacher.

A Comparative Measure of *Percent of Likelihood of Pursuing a K-12 Teaching Career* vs. Other Career Pursuits (with the Likelihood of All Career Pursuits Adding up to 100)

An absolute career intent measure could be misleading because students weight their choice of K-12 teaching against other alternatives whose interest levels may also concurrently change. The item read as follows:

> What is the likelihood that you will pursue a career in the following fields? Please apply a percentage to each career goal (percentages should add up to 100%). __% Professor or researcher at a research-intensive college or university, __% Professor or instructor at a teaching-intensive college or university, __% Private sector (industry) researcher/employee, __% K-12 math or science teacher, __% Undecided, __% Other career pursuit(s), please describe ____________.

The advantage of using a percent likelihood of pursuing a given career resides in that it estimates how strongly the respondent feels about pursuing said career and how far apart the choices are; thus it allows for comparisons of an individual's career choices and variations in teaching interest through undergraduate education, between majors, and across academic performance levels.

A Rank Measure of K-12 Teaching as Compared to Other Career Pursuits

The percent likelihood measurement, however, may not be easily comparable between respondents since values could be considered high or low in relation to values an individual assigns to other career choices. To compensate, we ordered each respondent's percentages and assigned K-12 teaching the corresponding priority rank. This measurement does not estimate how strongly an individual aspires to pursue a K-12 teaching career but renders an ordinal scale of comparison among respondents. Independent of the given raw percent, the ranking of K-12 teaching for two respondents may (or may not) be the same. Note that for this measurement, lower numbers (for example first rank) indicate higher priority (first choice). To compute ranking in cases of ties, the options were given the mean value. For example, if a participant indicated as his/her highest choices 30% research and 30% K-12 teaching, both research and K-12 teaching options would be assigned 1.5 ranking. This measurement provides valuable information for low ranks (typically first and second career choices) but becomes blurred for higher ranks (lower priorities) because respondents usually assigned percentages to three or four choices and indicated zero for the remainder.

Validation of the Instrument. We interviewed a group of 14 SEM undergraduates who were enrolled in introductory science teaching courses: four in physics and ten in biology. These undergraduates' responses to items related to teaching career interest were significantly higher than those of the rest of our SEM population. For the percent likelihood question, the subsample mean was 62%, and the rest of the SEM mean was 9% ($p < .001$). For the career intent question, the subsample mean was 1.3, and the rest of the SEM mean was 2.9% ($p < .001$).

One-way ANOVA test of mean percent likelihood of K-12 teaching career by career intent in both universities separately showed significance; post hoc comparison revealed that all simple main comparisons were significant except for the two intermediate categories, which were associated with nearly identical percent likelihood K-12 teaching ratings. Hence, we regrouped the categories and conducted all subsequent data analyses using only three levels

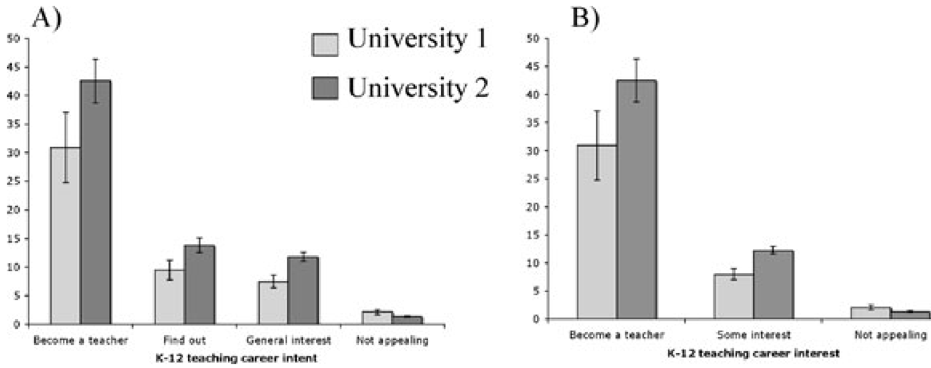

Figure 1. Mean percent likelihood of K-12 teaching career vs. (A) four original teaching career intent categories and (B) final merged categories.

of career intent: become a teacher, some interest, and not appealing. Results are shown in Figure 1, the error bars (in this and subsequent figures) display standard errors of the mean.

We acknowledge both significant linear and quadratic contributions in the equation relating career intent and percent likelihood of K-12 teaching career. A mathematical transformation of variables ($X' = 4^X$ for University 1 and $X' = 3^X$ for University 2) linearized the relationship. The different transformation required in each setting may be due to the different wording in the items or the different populations attending each institution. We chose to present untransformed results in this paper for simplicity; however, we also conducted tests with the transformed variables and obtained parallel results. The correlation coefficients between percent likelihood and career intent, not introducing the quadratic contribution in the equation, were significant in both cases: .47 ($n = 248$) for University 1 and 0.64 ($n = 912$) for University 2.

Predictions. We analyzed the data at three levels, from the more general picture to an increased level of specificity by academic year, major, and academic performance level. There are reasons to suspect variation over the college years. On one hand, we expected to witness a decrease in K-12 teaching interest through undergraduate education due to upper level undergraduates' increased involvement in independent research and internships. But at the same time, SEM undergraduates experience numerous difficulties in their education (Seymour & Hewitt, 1997) that may drive them away from traditional SEM careers and into K-12 teaching. Also, because the educational experiences and characteristics of SEM students may differ across majors, we disaggregated the data by academic year and major. An additional impetus behind analyzing the data by major is to draw connections to the reported K-12 science and math teacher shortage that differentiates by subject area. Finally, given the concern for low academic performance of K-12 math and science teachers, we hypothesized the high achieving SEM major may not be highly interested in pursuing teaching.

STUDY 1

We conducted the first study at University 1, an urban Tier 2 semipublic research university located in an area with a strong industrial heritage and a significant number of corporations. At this North American university, total undergraduate population as of Fall 2003 was

TABLE 1
Distribution of Respondents by Major and Academic Year in Study 1

	Freshmen	Sophomores	Juniors	Seniors	Total
Biology	11	9	11	28	59
Chemistry	4	10	12	10	36
Engineering	29	19	12	15	75
Life sciences	29	6	2	1	38
Mathematics	3	3	2	1	9
Physics	7	6	13	11	37
Total	83	53	52	66	254

slightly above 17,000, evenly distributed in the 4 years of college education (no net drop out) with 16% of the undergraduates from out-of-state. The SEM declared major population at the time of Study 1 was almost 2600.

Methods

Procedure. During the spring term of 2004, we visited several SEM undergraduates' classes and organizations, posted flyers, and rented a table in the engineering department. To all participants, we explained the research, distributed the forms, and paid $5 in compensation. In small meetings (up to 30), almost all students returned the completed survey. In large classes (150 and above), about a third of the students responded to the survey.

Participants. Respondents numbered 254. The sample used for this study, in major by academic year and gender by ethnicity, is shown in Tables 1 and 2.

Instrument. Participants received a 4-page questionnaire including items not relevant to the current analyses. The full questionnaire required about 10 minutes to complete, and the currently analyzed components are described in the Methodology Overview.

Results

Question 1: What Proportion of SEM Undergraduates Are Interested in K-12 Teaching Careers? Are There Differences in K-12 Teaching Interest by Gender or Ethnicity? We found no statistically significant differences in any measurement of K-12 teaching career interest by gender (t-test) or ethnicity (one-way ANOVA test excluding Latinos due to small sample size). As expected, the overall interest in K-12 teaching among undergraduate SEM majors was low.

TABLE 2
Distribution of Respondents by Gender and Ethnicity in Study 1

	Male	Female	Total
Black, non-Hispanic	6	11	17
White, non-Hispanic	128	78	206
Hispanic	1	0	1
Asian or Pacific Islander	5	11	16
American Indian or Alaskan	0	0	0
Other	3	11	14
Total	143	111	254

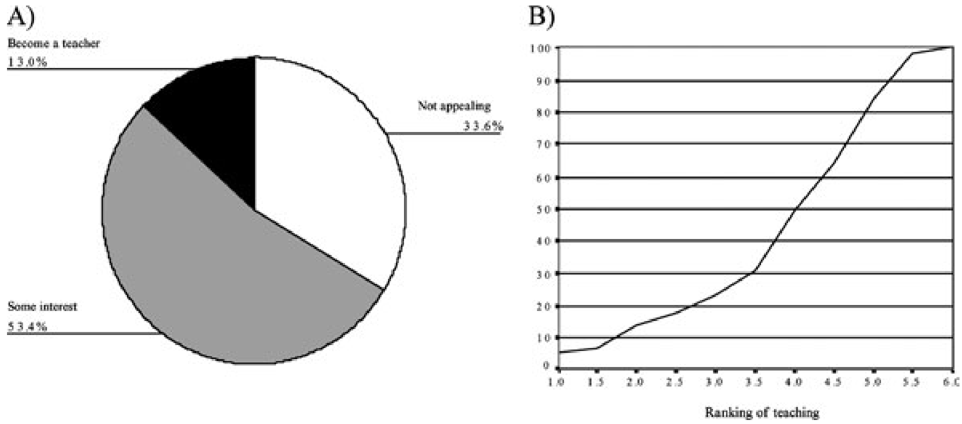

Figure 2. Overall distribution of (A) K-12 teaching career intent and (B) cumulative ranking of K-12 teaching career pursuits at University 1.

Responses to the career intent question (shown in Figure 2A) indicate that the majority of SEM students hold some interest in K-12 teaching seconded by those expressing no interest at all. However, a nonnegligible percentage of SEM majors consider pursuing K-12 teaching careers. Cumulatively ranked responses to likelihood of K-12 teaching careers (shown in Figure 2B) demonstrate that only 8% of respondents indicated a first priority career goal for K-12 teaching (including ties with other career objectives), and that only 30% considered K-12 teaching among their top three career options.

Question 2: How Does Interest in K-12 Teaching Relate to Interests in Other Career Objectives? We found that K-12 teaching career objectives are significantly negatively correlated with private sector/industry careers goals ($r = -.21, n = 250$), with research career goals ($r = -.20, n = 249$), and with "other career" goals ($r = -.18, n = 250$) but not significantly correlated with college instructor goals and indecision.

Subjects provided 135 descriptions of "other careers," which we classified into the following categories: 64 into health-related careers (such as medicine, pharmacy, and physical therapy), 24 into social science careers (such as journalism, business, government, and social work), 23 into technical careers (such engineering and software development), 7 into armed or security forces, and17 dissimilar careers were mentioned only once and omitted. Likelihood of K-12 teaching careers was significantly negatively correlated with health-related careers ($r = -.27, n = 64$) and with armed force career pursuits ($r = -.83, n = 7$) but not significantly correlated with technical or social science careers.

Question 3: How Does Interest in K-12 Teaching Vary Through Undergraduate Education from Freshman to Senior Year? And If So, at the Expense of What Other Career Objectives? Our data indicate that career intent may be influenced by progress through undergraduate education. Figure 3A shows the mean for K-12 teaching career intent by academic year; the frequency distribution of responses is shown in Appendix. Figure 3B shows the percentage of SEM undergraduates who chose K-12 teaching as their first career (including ties) by academic year.

At all but the junior year the mean interest level is low, never above "some interest." At the junior year, however, it peaks at barely above "some interest." A one-way ANOVA test of career intent by academic year shows significant differences ($F_{(3,249)} = 5.8$, $p < .001$) with significant simple main effects between junior and freshman year ($p < .001$) and between

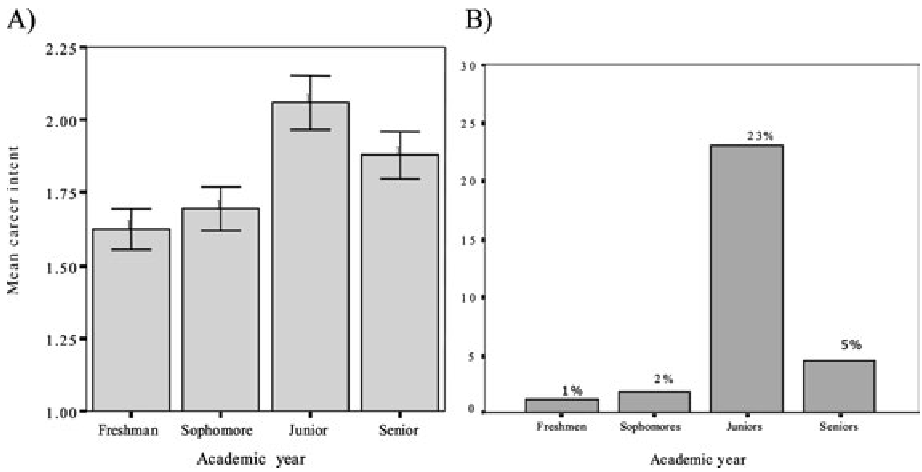

Figure 3. (A) K-12 teaching career intent and (B) percent of students who choose K-12 teaching as their first career choice by academic year at University 1.

junior and sophomore year ($p < .05$). Also at the junior year, the percentage of students who rank teaching as their first priority dramatically peaks but it then drops drastically by the end of their degree, with a net change of five times the proportion of seniors vs. freshmen ranking K-12 teaching as their first priority ($\chi^2(3) = 25.77$, $p < .001$).

The increase and subsequent decrease in K-12 teaching interest must come at the expense of a change in other career interests. Figure 4 shows likelihood of various career pursuits as a function of how far SEM undergraduates have progressed in their undergraduate education.

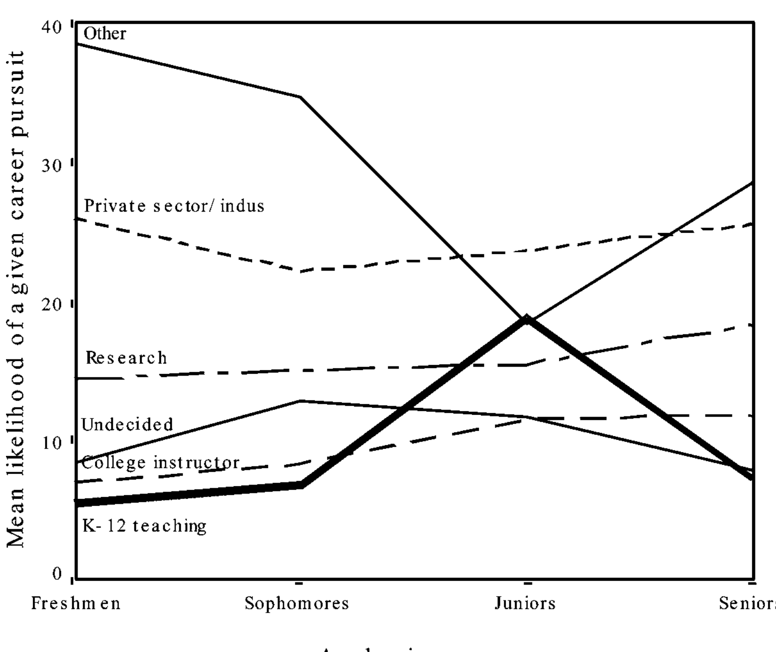

Figure 4. Mean percent likelihood of several career pursuits by academic year at University 1.

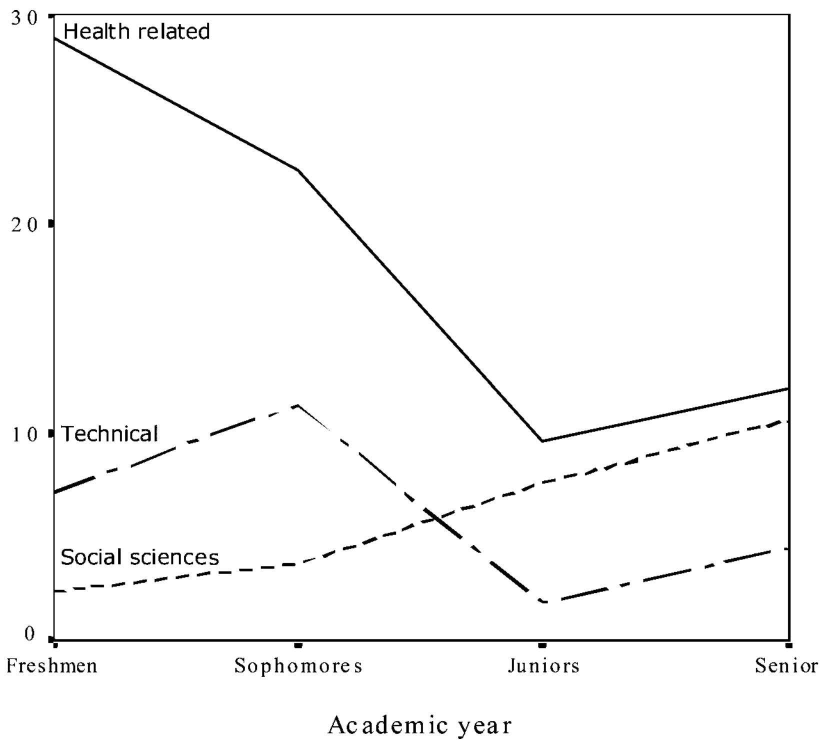

Figure 5. Percent of students who indicated 50% or more likelihood of a given alternative career pursuits by academic year at University 1.

Upon conducting one-way ANOVA tests on percent likelihood of each career option by academic year, only two career options showed significance: likelihood of K-12 teaching ($F_{(3,245)} = 7.7$, $p < .005$) and other career paths ($F_{(3,245)} = 3.5$, $p < .05$). For K-12 teaching, we found significant simple main effects for juniors vs. freshmen ($p < .005$), juniors vs. sophomores ($p < .005$), and juniors vs. seniors ($p < .005$). For other career paths, we found a significant simple main effect for juniors vs. freshmen ($p < .01$).

Consequently, we unpacked the main categories of the "other career pursuits" (health-related careers, social science careers, and technical careers) to determine an area contributing to the change in K-12 teaching career interest. Figure 5 illustrates the percent of students in each given academic year who indicated 50% or more likelihood of a given alternative career goal.

One-way ANOVA tests show no statistically significant differences for social science and technical careers by academic year but statistically significant differences for health-related careers ($F_{(3,250)} = 3.9$, $p < .01$) with significant simple main effect for freshmen vs. juniors ($p < .05$) and freshmen vs. seniors ($p < .05$). Hence, the pattern of shift in likelihood toward K-12 teaching careers is attributable to a shift away from pursuing health-related careers. In other words, students shifted from medical or dental or nursing school plans to teaching plans.

Question 4: Is the Pattern of Variation of K-12 Teaching Interest Through Undergraduate Education Similar in All Majors? If Not, How Could We Explain Variations by Major? We conducted a two-way ANOVA test of likelihood of pursuing K-12 teaching careers by academic year and major and found significant main effects of academic

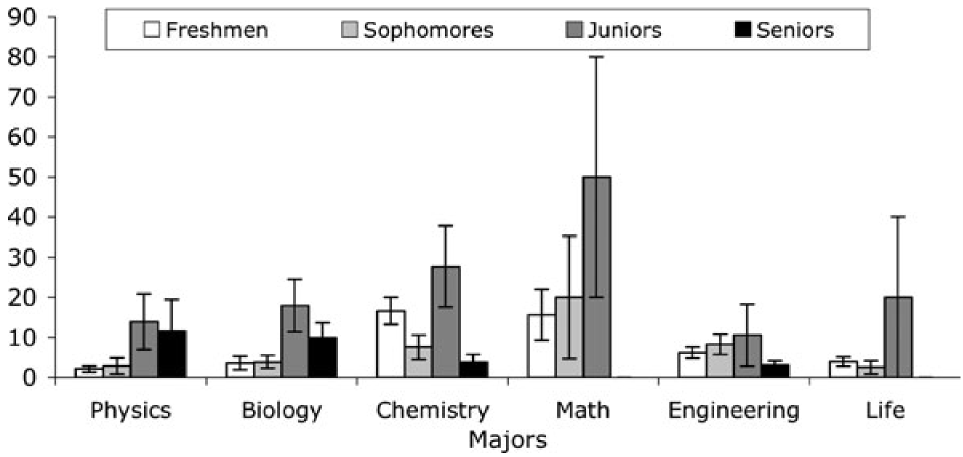

Figure 6. Mean likelihood of pursuing K-12 teaching careers by academic year and major at University 1.

year ($F_{(3,225)} = 6.7$, $p < .001$) but no significant main effect for major and no significant interaction. Figure 6 illustrates the likelihood of pursuing K-12 teaching careers by academic year and major.

In all majors, junior students are significantly more likely to state an intention to pursue K-12 teaching careers than the other academic year students, among whom there were no statistically significant differences. We did not find statistically significant differences among majors for the sample at University 1. This result, though, should be interpreted with caution given small sizes of the academic year-major sub-samples, particularly in mathematics.

Question 5: Is There a Relationship Between End-of-Degree Academic Performance Level and K-12 Teaching Interest? Figure 7 illustrates the relationship between GPA and likelihood of K-12 teaching career.

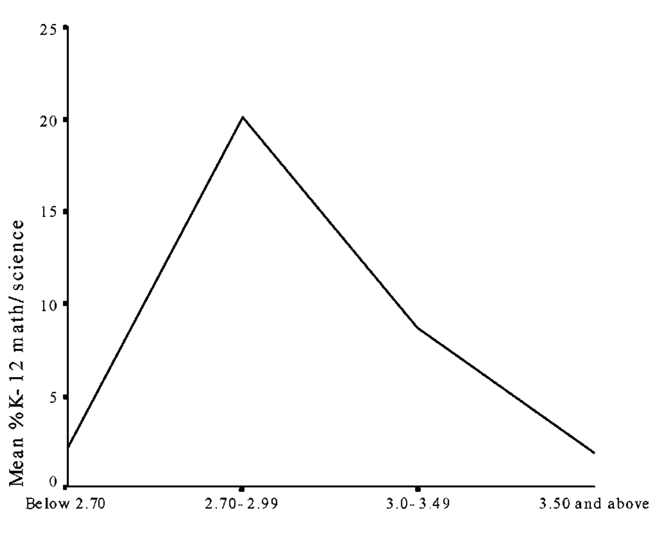

Figure 7. Relationship between GPA and likelihood of K-12 teaching career for seniors at University 1.

Overall, we did not detect statistically significant differences in likelihood of pursuing K-12 teaching by academic performance level. But for seniors with GPAs above 2.7, the correlation coefficient between likelihood of K-12 teaching and GPA $r = -.32$ is significant ($n = 38$). Thus, neither extremely weak nor extremely strong undergraduates were interested in K-12 teaching. No statistically significant differences by academic performance level were found when we analyzed males and females separately. Due to small sub-sample sizes, we did not proceed in analyzing variation in K-12 teaching interest by academic performance level for minority groups and two-way ANOVA analysis by GPA and majors.

STUDY 2

We conducted a second study at University 2 with the purpose of exploring the trends we found at University 1 using different methods and the context of a larger, public university. Study 2 was not intended as a direct comparison to Study 1 because the population characteristics, data collection methods, and instruments differ between studies.

University 2 is an urban research tier 1 public university located in a less industrialized area of the north central part of the country. This North American university has a total undergraduate population of about 28,000 students, 30% of whom are out-of-state. The count of undergraduate students at University 2 markedly increases by academic year, given the net transfer into this university from nearby 2-year colleges.

Methods

Procedure. Toward the end of the 2004 spring term, all SEM-related undergraduates were invited by e-mail to complete an on-line short survey. This methodology allowed us to reach a much larger number of respondents; however, Internet data collection strategies have higher risk of self-selection respondent bias.

Participants. Respondents numbered 1009 from among the 6916 undergraduates who were emailed the questionnaire. Many answers were blank or unusable; the final sample used for this study, in major by academic year and gender by ethnicity, is shown in Tables 3 and 4.

Instrument. The online questionnaire required about 2 min to complete and was described in the Methodology Overview.

TABLE 3
Distribution of Respondents by Major and Academic Year in Study 2

	Freshmen	Sophomores	Juniors	Seniors	Total
Biology	38	49	63	112	262
Chemistry	1	11	7	9	28
Earth sciences	1	3	9	27	40
Engineering	42	69	100	196	407
Life sciences	17	16	36	62	131
Mathematics		5	9	27	41
Physics	1	1	4	7	13
Total	100	154	228	440	922

TABLE 4
Distribution of Respondents by Gender and Ethnicity in Study 2

	Male	Female	Missing	Total
Black, non-Hispanic	3	4	0	7
White, non-Hispanic	427	373	4	804
Hispanic	6	6	0	12
Asian or Pacific Islander	23	33	1	57
American Indian or Alaskan	0	2	0	2
Other	7	4	0	11
Non-resident alien	5	7	0	12
Missing	5	12	0	17
Total	476	441	5	922

Results

Question 1: What Proportion of SEM Undergraduates Are Interested in K-12 Teaching Careers? Are There Differences in K-12 Teaching Interest by Gender or Ethnicity? We found no statistically significant differences in any measurement of K-12 teaching career interest by gender (t-test) or ethnicity (one-way ANOVA test excluding Latinos and American Indians due to small sample size). Figure 8 illustrates the overall responses of SEM undergrads at University 2 to a question about K-12 teaching career intent and the priority selection of K-12 teaching versus other careers.

K-12 teaching was even less appealing to the majority of SEM students at University 2. However, a nonnegligible percentage may consider pursuing or finding out about K-12 teaching careers. About 5% of respondents indicated a first priority K-12 teaching career goal (including ties with other career objectives), and only about 30% considered teaching among their top three career options.

Question 2: How Does Interest in K-12 Teaching Relate to Interests in Other Career Objectives? In the case of University 2, we found that K-12 teaching career objectives are significantly negatively correlated with research career goals ($r = -.15, n = 914$), college instructor goals ($r = -.18, n = 914$), and "other career" goals ($r = -.21, n = 914$), but are not significantly correlated with private sector/industry goals nor with indecision.

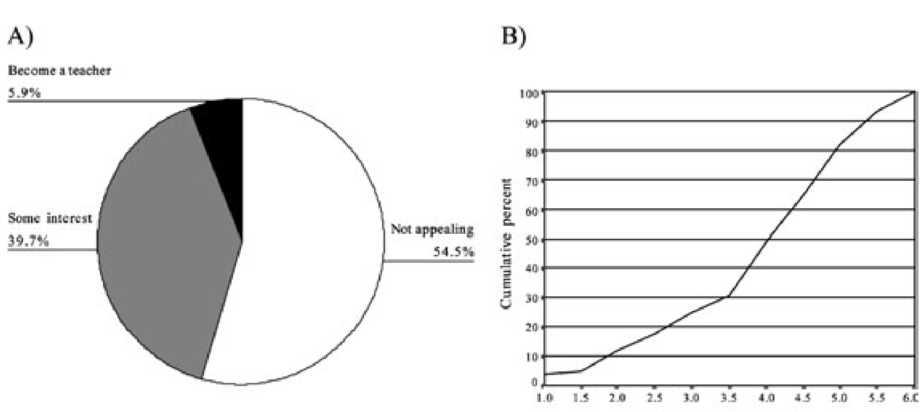

Figure 8. Overall distribution of (A) K-12 teaching career intent and (B) cumulative ranking of K-12 teaching career pursuits at University 2.

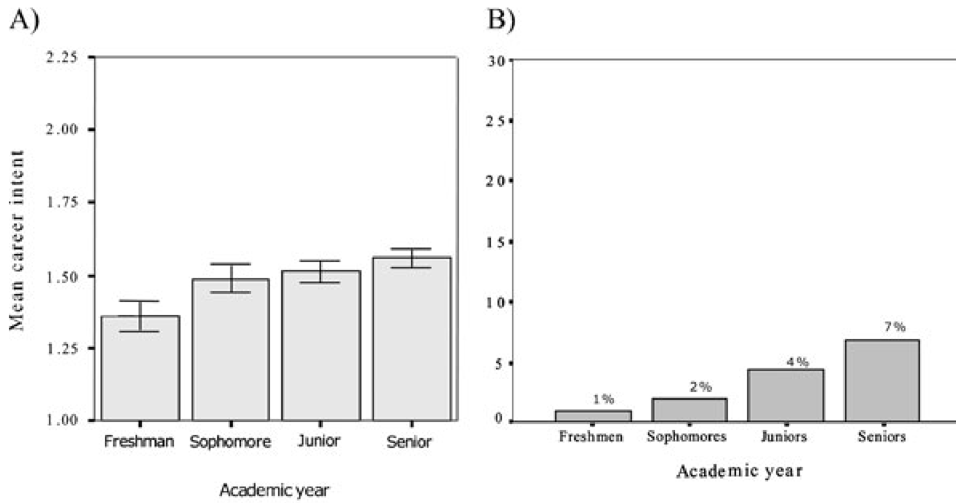

Figure 9. (A) K-12 teaching career intent and (B) percent of students who choose K-12 teaching as their first career choice by academic year at University 2.

Question 3: How Does Interest in K-12 Teaching Vary Through Undergraduate Education from Freshman to Senior Year? And If So, at the Expense of What Other Career Objectives? Figure 9 shows K-12 teaching career interest as a function of how far SEM undergraduates have progressed in their undergraduate education. Figure 9A shows the mean for K-12 teaching career intent by academic year; the frequency distribution of responses is shown in Appendix. Figure 9B shows the percentage of SEM undergraduates who chose K-12 teaching as their first career priority by academic year.

Although the mean SEM interest level in K-12 teaching during any given undergraduate year is low, it slightly and steadily increases through undergraduate years both in strength of the career intent and in the proportion of students indicating K-12 teaching as their first career choice. A one-way ANOVA test on career intent by academic year shows significance ($F_{(3,916)} = 3.1$, $p < .05$) with significant simple main effect between freshmen and seniors. The percentage of students who ranked teaching as their first priority increases steadily and by the end of their degree, registers about seven times higher than those making the same choice at the beginning of their college education ($\chi^2(3) = 9.96$, $p < .05$).

Though small, the increase of interest in K-12 teaching necessarily has to come at the expense of a change in interest pursuing other careers. Figure 10 shows likelihood of various career pursuits as a function of how far along SEM undergraduates have progressed through undergraduate education at University 2.

Data indicate a marginal increase in the percent of likelihood of pursuing K-12 teaching careers by academic year ($F_{(3,\ 910)} = 2.1$, $p < .1$) that comes at the expense of a decrease in indecision ($F_{(3,\ 910)} = 2.7$, $p < .05$).

Question 4: Is the Pattern of Variation of K-12 Teaching Interest Through Undergraduate Education Similar in All Majors? If Not, How Could We Explain Variations by Major? Figure 11 illustrates the likelihood of pursuing K-12 teaching careers by academic year and major. Freshmen were excluded from the analysis because of low numbers.

A two-way ANOVA test of likelihood of K-12 teaching career by academic year and major shows significance for major main effect ($F_{(6,795)} = 2.6$, $p < .05$) but no significance

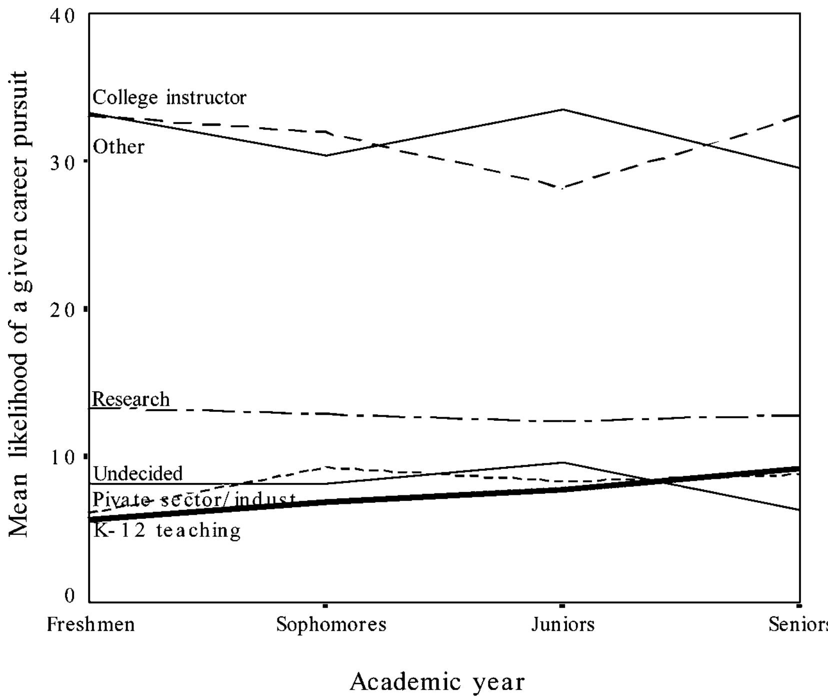

Figure 10. Percent of likelihood of several career pursuits by academic year at University 2.

for academic year (sophomores through seniors) and no significant interaction. Tukey post hoc comparisons revealed significant simple main effects for earth science majors (the most likely to pursue K-12 teaching careers) versus life, biology, chemistry, and engineering majors in descending order of likelihood and for math majors (the second most likely to pursue K-12 teaching careers) versus life, biology, and engineering majors also in descending order of likelihood.

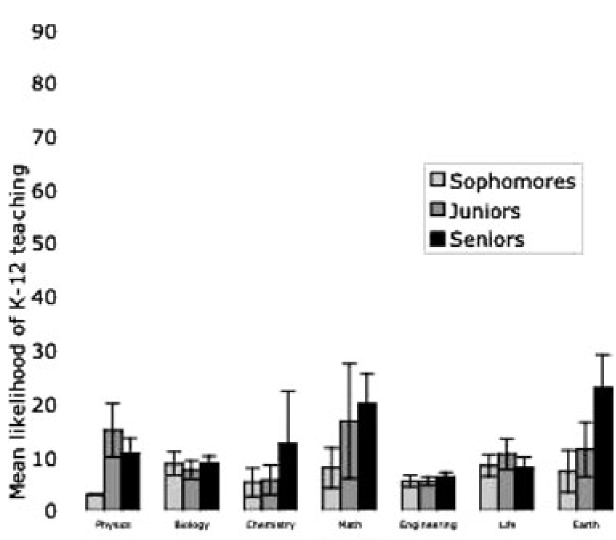

Figure 11. Likelihood of pursuing K-12 teaching careers by academic year and major at University 2.

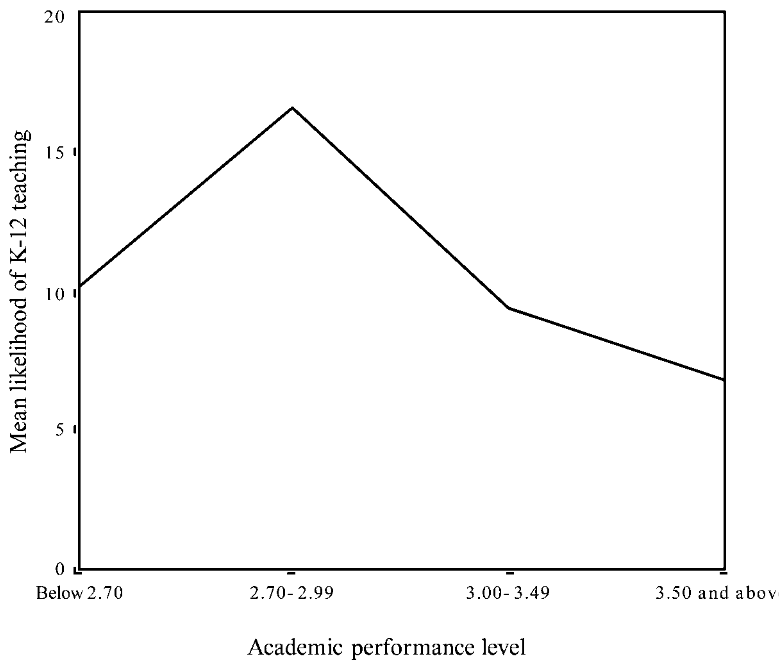

Figure 12. Relationship between GPA and likelihood of K-12 teaching career for seniors at University 2.

Since we found that math majors are significantly more likely to pursue K-12 teaching, we investigated if this finding was driven by the "captive" population of female math teachers, as described by Green (1989). In order to compare K-12 teaching career interest for math undergraduates by gender, we first tested for associations between gender vs. academic year and for gender vs. academic performance level using a set of χ^2 tests and found no significant association. We then proceeded with t-tests and found no statistically significant differences between male and females math majors in any measure of K-12 teaching career interest.

Question 5: Is There a Relationship Between End-of-Degree Academic Performance Level and K-12 Teaching Interest? Figure 12 illustrates the relationship between GPA and likelihood of K-12 teaching career at University 2 for all seniors; similar patterns were obtained when the senior sample was further subdivided by gender and by minority status.

One-way ANOVA test by GPA showed significant differences ($F_{(3,417)} = 4.3$, $p < .005$) and Tukey post-hoc tests revealed that seniors with GPAs in the range 2.70–2.99 were statistically significantly more likely to pursue K-12 teaching than their higher achieving peers.

For seniors with GPAs above 2.7, the correlation coefficient between likelihood of K-12 teaching and GPA $r = -.13$ is significant ($n = 421$).

For the analysis by major we excluded seniors with GPAs below 2.70 due to empty cells for physics and chemistry. We conducted a two-way ANOVA test of likelihood of pursuing K-12 teaching careers by major and GPA. We found significant main effects for academic performance level ($F_{(2,371)} = 3.3$, $p < .05$) and for major ($F_{(6,371)} = 6.9$, $p < .001$); the interaction term was not significant ($F_{(12,371)} = 1.4$, $p > .10$). Students with GPAs in the range 2.70–2.99 expressed significantly higher likelihood of pursuing K-12 teaching than their higher achieving peers in all majors. Earth science students expressed significantly

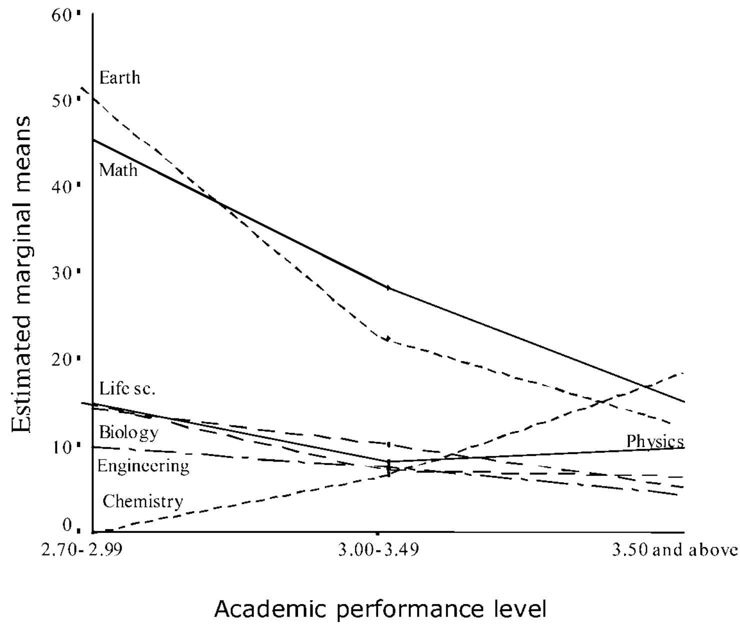

Figure 13. Marginal means of likelihood of pursuing K-12 teaching careers by academic performance level and major for seniors at University 2.

higher likelihood of pursuing K-12 teaching than biology, life science, and engineering students; math students expressed significantly higher likelihood of pursuing K-12 teaching than engineering students. Figure 13 illustrates the effect of GPA in various majors for the senior subsample. Although the interaction of GPA by major is not significant, Figure 13 suggests that the negative correlation of interest by GPA may not be strongest in math and earth science majors, and this trend should be examined further in future research.

DISCUSSION

Summary

Overall, in both universities, we found that a nonnegligible proportion of SEM undergraduates possess an interest in K-12 teaching: a potential source of new recruits that could alleviate the shortage of qualified math and science teachers. The proportion of students indicating high K-12 teaching career intention, however, differed in each university. The difference may be due to slight variations in the wording of the career intent question or more likely due to differences in the population attending each institution. For instance, the Monitoring School Quality report (U.S. Department of Education, 2000b) established that undergraduates attending more selective institutions, such as University 2, tend to be less interested in pursuing K-12 teaching careers. That is indeed our case: 13% of students at University 1 and about 6% at University 2 indicated intention to become a teacher, while 8% and 5% at Universities 1 and 2 respectively chose K-12 teaching as their first career choice.

With the caveat that our samples included only a small proportion of minority students, in neither sample of SEM undergraduates at these two research universities did we find statistically significant differences in interest in K-12 math and science teaching by gender or ethnicity. This finding contradicts prevailing literature emphasizing the propensity of Caucasian females dominating science and math teaching interest samples.

Also in both universities we found significantly negative correlations of about the same magnitude between likelihood of K-12 teaching and research career pursuits. At University 1, significantly negative correlations were also found between K-12 teaching and health-related careers, armed/security forces careers, and private sector/industry careers. We speculate that this last finding reflects University 1's geographical region, which lays claim to a strong industrial heritage and a large medical school. At University 2, beyond the negative correlation with research careers, we found a significantly negative correlation between K-12 teaching and college instructor careers and with other career pursuits (although no description of the other careers was provided).

Further investigating the pattern of variation in interest in various career choices through the years of undergraduate education, it seems that the particularly well-renowned medical school at University 1 attracts a great number of freshmen who intend to pursue medical careers. At some point during college, some of them switch to teaching as an alternative career. At University 2, a well-reputed tier 1 research institution in all disciplines, the increase in teaching career interest in the later years of college education seems to come as the result of previously undecided students making a career decision. It should be stressed that in neither case does K-12 teaching interest "steal" potential candidates from basic research careers or private sector/industry.

As a particularly novel finding, our studies indicate that upper level SEM undergraduates constitute a more reliable target for K-12 teacher recruitment efforts within this traditional candidate pool. Both university settings exhibited a significant increase in interest in math and science K-12 teaching in the later academic years of college education.

Our results suggest that earth science and math majors tend to be the undergraduate SEM subpopulation most interested in K-12 teaching across academic years and performance levels; this increased interest is driven by neither female nor male math majors. Next in K-12 teaching interest are the students in biology, life sciences, chemistry, and physics. Finally engineers proved the least interested in K-12 teaching.

With respect to interest in K-12 teaching and end-of-degree academic performance of SEM seniors, it appears that high achievers, whose high GPA allows them to opt for many careers, are not so inclined to pursue K-12 teaching careers as compared to students with mid-GPAs in the range 2.70–2.99. In both settings we found a statistically significant negative correlation, although moderately low, between GPA and likelihood of pursuing K-12 teaching careers for seniors with GPAs 2.70 and above. We found this trend to be true across all majors, for both whole samples, and for the subsamples by gender and ethnicity. Seniors with GPAs below 2.70 expressed very low likelihood of teaching careers. We advance two possible explanations: these seniors lack career goals and therefore perform poorly, or their low performance discourages them from pursuing further studies.

Conclusion

In this study, we explore a few of the factors that may shape potential undergraduate SEM recruits' interest in K-12 teaching. Results prove highly informative for recruitment efforts: SEM undergraduates in their later years of college education should constitute a more successful, reliable target, while additional action to attract high performance students to K-12 teaching careers is warranted. SEM undergraduates interested in research careers are not plausible candidates since their interests persevere. However, undergraduates with pre-med ambitions or those as of yet undecided may prove most amenable to considering K-12 math &and science teaching.

Undisputed is that the overall proportion of undergraduates interested in pursuing math and science teaching is low, most arguably due to the interplay of two factors: low interest in SEM careers and low interest in teaching careers. The overall low interest in pursuing or remaining in math and science majors has been well documented (Green, 1989; Seymour & Hewitt, 1997). As to why our study demonstrated no statistically significant differences according to ethnicity, we hypothesize that—both nationally and within our study's sampled universities—as the literature suggests, the pronounced shortage of minority math and science teachers may be attributed not to less interest in K-12 teaching but rather to a smaller proportion of minorities whose precollege education provided sufficient cultural capital to negotiate college entrance and graduation let alone to inspire SEM pursuits. In our samples, minorities constitute 8% of respondents in University 1 and 3% in University 2, suggesting that the ethnicity gap occurs either in the path to college or the path to SEM majors at major research universities, but not in the path to teaching.

It is interesting to note that while the highest teacher shortage is reported for mathematics (American Association for Employment in Education, 2000), our study indicates that math students are the most interested in K-12 teaching. The answer to this paradox lay in that undergraduate math departments register the lowest number of enrollees and the highest number of switchers (Seymour & Hewitt, 1997).

For seniors with GPAs 2.70 and above, the direction of causality between interest in K-12 teaching and GPA can be interpreted in two ways. For one, students considering pursuing K-12 teaching careers may not be motivated to study subject matter to a depth beyond what they perceive as required to teach high school (a level lower than what is required in college) and therefore perform only at a satisfactory level without excelling. An alternative explanation is that seniors with GPAs below 3.5 face difficult admission to graduate study at well-reputed universities and may begin considering alternative math and science related careers, K-12 teaching among them.

The low level of teaching interest among SEM undergraduates and the small proportion of freshmen pursuing SEM careers, coupled with our finding that the math and science teacher pipeline does not "steal" aspirants from basic scientific research nor from the private sector/industry illuminates an important conclusion of this study. Since the science, technology, and educational sectors face a common problem—lack of candidates—a solution may be more promptly discovered by uniting efforts to increase enrollment in SEM careers. Higher education SEM departments, furthermore, could rest assured that advocating K-12 teaching careers will not impact their enrollment. This promising additional strategy will in turn render more well-qualified aspirants to K-12 math and science teaching.

Later Undergraduate Teaching Interest. Of high priority is understanding later undergraduate interest in K-12 teaching careers. Given the novelty of this research, we draw from existing literature regarding undergraduate SEM attrition to infer possible explanations for late K-12 teaching interest. Seymour and Hewitt (1997) argue that academic performance does not significantly explain the pattern of leaving or persisting in SEM majors, a phenomena better understood in light of family or social pressures and the existence (or absence) of the support necessary to succeed in "weed out" courses. Our rationale is that the reasons inducing some to leave SEM majors may also explain changes in career aspirations among those who persist. Seymour and Hewitt report that organic chemistry, calculus, and several early physics courses are typical "weed out" courses, all typically taken sophomore year, precisely after which we observed changes in career goals for those who persisted. Green (1989) reports that many aspiring bioscience majors are in fact pre-med students who ultimately abandon their medical career aspirations when confronted by organic chemistry, a career-shaping course for many undergraduates. This observation supports our finding that increased K-12 teaching interest correlates with health-related career interest during junior year.

Moreover, Seymour and Hewitt (1997) document that before dropping or switching, SEM undergraduates persist in their majors, often into junior year, coinciding with our finding of increased interest in K-12 teaching in junior year. They claim that many SEM undergraduates experience a downward spiral of disaffection with their majors that begins as soon as freshman year and continues beyond basic preparation even into senior year. They argue that this downward spiral is in part propelled by SEM majors' increasing awareness that career choice is also lifestyle choice and by resulting resistance to adopting the perceived scientists' or mathematicians' lifestyle. These dawning realizations, coupled with their commitment to the discipline despite curricular disaffection, we argue, may encourage SEM undergraduates to persist with their majors and consider alternative career objectives that include science but involve a more flexible lifestyle, as would teaching.

SEM major attrition also causes a selection effect contributing to an apparent increase in later undergraduate K-12 teaching interest. Students with early undergraduate K-12 teaching interest may more likely persist in their majors, perceiving the "hardness of science" (coined by Seymour and Hewitt, 1997) as a temporary stage in their formation rather than as an adopted lifestyle. SEM undergraduates interested in K-12 teaching may represent a small proportion in freshmen and sophomore years, but as other students drop out, this proportion (but not the number) increases. In other words, it is reasonable to assume that the composition of SEM undergraduates in early and later years cause the reporting of different career objectives and may explain different findings. Indeed, Seymour and Hewitt contend that the SEM "weed out" process operates in such a way as to "discard enough students to match departmental resources by the start of junior year" (p. 157).

Finally, the observed drastic change in K-12 teaching career intent during junior year is very likely an effect of a shift in the undergraduate SEM curriculum in that year. During junior year, SEM majors pursue research projects and co-op internships, experiences crucial in deciding career path. When these experiences prove positive, majors' interest in the career typically increases; however, when they prove negative, undergraduates may drop the SEM major or persist but seek alternative career options. Focusing K-12 teacher recruitment efforts on SEM majors—especially those exploring alterative careers—during these later undergraduate years could prove highly effective. Recruiters address potential math and science teachers who are already well prepared in content and less likely to opt out of teacher preparation, as are students during earlier undergraduate years. Moreover, efforts to sustain and reinforce that interest until SEM graduates enter the teacher pipeline may be less costly—to institutions and students alike—especially if institutions encourage baccalaureate teacher certification as opposed to separate, post-baccalaureate teacher preparation such as fifth year certification or master's programs. Perhaps the most useful aspect of this study, especially for policymakers and practitioners, is that data indeed exists in support of steering K-12 math and science teacher undergraduate recruitment programs to target SEM juniors and seniors.

Cycles in Teaching Career Interest. As to the interest in math and science K-12 teaching over the last decades, measurements taken at the beginning of college education seem to produce different results than do those taken at the end. Green (1989) documented that nationwide, freshmen interest in teaching careers peaked at 23.5% in 1968, dropped to 4.7% in 1982, and regained momentum at 8.8% in 1988. In our study, only 4.9% of freshman expressed high interest in teaching and only 1.1% teaching as a first career choice. These figures imply that cycles of freshman interest in K-12 math and science teaching may parallel cycles of educational reform in high school math and science education. We hypothesize that the swing among various reform-based movements in secondary math and science education may significantly impact the swing of interest (or disinterest) in math and science teaching among those college students most recently affected: SEM-oriented college freshman and sophomores. Whether that is indeed the case and if so, how it operates, is of crucial importance for recruitment into SEM and math and science teaching careers and undoubtedly necessitates further investigation.

It may also be that the economy plays a role in career intent cycles—both for freshmen and seniors, and especially among engineering majors, given their characteristically higher financial aspirations. The fluctuations are sometimes noticeable even within a short period of time. For instance, during the 3 years of their study (1990–1993), Seymour and Hewitt (1997) perceived among college seniors increasing doubts about the material rewards of postgraduate job prospects, causing some to drop engineering in favor of more financially promising career options, K-12 teaching certainly not among them. Likewise, but using data from freshmen, Green (1989) accounts that during the early 1970s, engineering enrollment fell precipitously immediately following the moon landing, the termination of numerous large government contracts, and the media's showcasing of unemployed engineers across the nation. When later, between 1977 and 1983, the science and technology fields became the few promises in an otherwise depressed economy, freshmen engineering enrollment skyrocketed. But by the late 1980s, he continues, as employment options improved, many SEM undergraduates (particularly "B" students), migrated to other fields, particularly business, a career intent that more than doubled among freshman. Among other fields drawing SEM migrants these years, the K-12 teaching field fails to register.

Disciplinary Differences. Also of priority is exploring why undergraduates in certain disciplines express K-12 teaching interest to a greater—or, as with engineering majors, lesser—extent. In studying factors contributing to SEM major attrition, Seymour and Hewitt (1997) found that although all disciplines complained about SEM faculty's poor teaching skills, 86% of persisting engineering majors reported concerns vs. 64% of persisting math and science majors, which may emphatically convey to engineers that teaching is not a valuable endeavor. Moreover, the authors report that engineering majors, more than math or science majors, see themselves, even from freshman year, as able to command reasonably impressive jobs and salaries as reward for hard work during undergraduate education. By contrast, math and science majors focus more on their disciplines than on career options or anticipated material rewards. Green (1989) documents that engineering majors place second only to business majors in endorsing the "money factor" as the prime motivator for attending college. Clearly, low paying jobs that engineers are unlikely to consider include K-12 teaching.

Science and, more pronouncedly, math majors may remain more anxious about limited job prospects and nonacademic job options than are engineering majors. In the Seymour and Hewitt (1997) study, math majors consistently reported difficulty in locating information about career options. Hence these students may consider K-12 teaching, a familiar career alternative given their own experience in school, in greater proportion due to lack of knowledge of other options.

According to University 2 results, earth science majors along with math majors appear to be more interested in K-12 teaching than science and engineer majors. While the reasons for this phenomenon remain elusive, this finding should also be received with caution and subjected to replication since it is based on a self-selected sample of only 39 from among 250 sophomores to senior students (a 15% response rate) in only one of the universities.

Comparisons to Previous Studies. While Seymour and Hewitt's (1997) study involving 335 high-performing undergraduates from seven diverse institutions of higher education indicated a decline in interest in teaching between freshman and senior years (from 18.4%

to 6.6%.), our combined findings indicate the opposite trend. In our study, to iterate, while only 4.9% of freshman indicated teaching interest, 8.9% of seniors report serious consideration of teaching goals, and 6.5% indicate teaching as their first career choice. We speculate that currently, freshmen enter college education with very low esteem for the teaching profession. Then as they are exposed to college-level instruction and possibly some early teaching experience (in K-12 classrooms, while tutoring, or in the form of college-teaching assistantships), they regain an appreciation for teaching. The factors and mechanisms by which the traditional pool of SEM undergraduates develop an interest in pursuing teaching careers in an issue of dire importance for recruitment efforts and merit further attention from science and math educational researchers.

Some caution should be exercised when comparing findings from such divergent data pools. For example, Green (1989) reports data from more than 600 institutions. In contrast, Seymour and Hewitt (1997) sample seven public and private institutions of various caliber. Narrowing the scope, we focused our attention on two major urban research universities.

Differing research techniques may prove of further significance when exploring why our findings contradict those of Seymour and Hewitt (1997), rendering the discrepancy only apparent. In their study, Seymour and Hewitt focused exclusively on high ability SEM undergraduates: those scoring 650 or higher on the math S.A.T. who are expected to be capable of handling the course work. Too, their measure of teaching interest's decline through college years is based solely on high ability, nonswitching seniors' recollections of whether they had interest in becoming a teacher when they entered college education. This select group of successful seniors constitutes a small proportion of senior SEM majors and even a smaller proportion of the original freshmen population who was likewise highly enthused about math and science and maintained their SEM majors through college. Moreover, for these high achievers, coming right after high school, K-12 teaching was likely their closest contact with math and science and therefore, their interest in teaching the disciplines was high during freshman year. Perhaps as they progressed through the SEM college experience, they learned of alternate and more appealing career options within math and science, which consequently decreased their K-12 teaching career interest.

This differential research technique may further explain why—in contrast to Seymour and Hewitt's findings—our results revealed no statistically significant differences in teaching interest between males and females and more closely reflect national norms of a gender-balanced K-12 math and science teaching force.

Overall, our study's results differ so dramatically from Seymour and Hewitt's landmark findings because our study employed a cross-sectional design to survey not only high, but also mid- and low-achieving SEM undergraduates and not only seniors, but also those in each of the four undergraduate academic years. Hence, our study surveyed a broader continuum. Also since our study's objective focused primarily on undergraduates' math and science teaching career interest, not on undergraduates' abandoning of SEM majors (as was Seymour and Hewitt's study), our methods did not distinguish those who would later switch out of SME majors or drop out of college entirely. In this manner, we found an increased interest in K-12 teaching in the later years of undergraduate education.

Limitations

This study has the limitation of all cross-sectional studies: the assumption that the group of subjects at one end of the scale would, with time, become equivalent to the group at the other end. In college educational research, this assumption presents problems. Astin and Astin (1993) report an average college dropout rate of 40%. The universities of our study, however, do not demonstrate net dropout but to the contrary, indicate a steady population or an increased population of undergraduates through college years. We suspect that both well-reputed universities experience an effective transfer-in of students from other institutions that compensates or surpasses the number of dropouts. As a result, the composition of lower level undergraduates (in terms of the academics and career goals) may not perfectly mirror that of upper level undergraduates in our study.

Although these selection artifacts may cloud the causality of change over time, selection artifacts cannot cloud the practically important results of this conclusive study: overall interest in K-12 teaching is low, no differential interest by gender or ethnicity surfaces, switching to teaching careers does not come at the expense of loss in research or private sector candidates, and upper class undergraduates (including transfer students), math majors, earth science majors and mid-academic performance level students are more interested in K-12 teaching than lower class undergraduates. Further limitations of the study relate to potential bias in data collection procedures due to access to classes at University 1 or to self-selection to participate in an online survey at University 2.

Finally, this study was conducted in two major research universities. The characteristics of the populations at these settings may differ from the characteristics of attendees at other institutions of higher education, especially regarding gender and race-ethnicity variables. For this reason, this study warrants replication at other more demographically diverse universities or colleges, especially those serving urban school districts.

APPENDIX

Frequency Distribution of Respondents' Teaching Career Intent by Academic Year

University 1

	Teaching Career Intent			
	Teaching Not Appealing	Some Interest	Considering Becoming a Teacher	Total
Freshman	38	38	7	83
Sophomores	18	32	2	52
Juniors	10	29	13	52
Seniors	19	36	11	66
Totals	85	135	33	253

University 2

	Teaching Career Intent			
	Teaching Not Appealing	Some Interest	Considering Becoming a Teacher	Total
Freshman	66	32	2	100
Sophomores	88	57	9	154
Juniors	120	99	9	228
Seniors	227	177	34	438
Totals	501	365	54	920

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