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An Exploration of the Pay Levels Needed to Attract Students with Mathematics, Science and Technology Skills to a Career in K-12 Teaching

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Abstract

In an exploratory study (Note 1) of the role of salary level and other factors in motivating undergraduate math, science, and technology majors to consider a career as a K-12 teacher, the salary level students said would motivate them to consider a career in teaching was related to the salary expected in their chosen non-teaching occupation, but not to three of the Big 5 personality dimensions of extroversion, agreeableness, and openness, nor concern for others or career risk aversion. An annual starting salary 45% above the local average would attract 48% of the sophomore students and 37% of the juniors. Focus group results suggested that low pay was an important reason for not considering K-12 teaching, but that perceived job demands and abilities and interests were also important reasons for not being attracted to a teaching career.

In a number of states and districts around the country, concerns have been raised about an actual or potential shortage of teachers. Though the often-cited figure of 2 million new teachers needed gives an erroneous picture of a general teacher shortage (Felter, 1997; National Association of State Boards of Education,1998), there are appear to be real local

shortages caused by reforms such as class size reductions (Curran et al, 2000), shortages in poor urban or rural districts (Hirsh, 2001), and shortages in specific subject areas, notably math, science, and special education (Hirsh, 2001; Recruiting New Teachers, 2000; American Federation of Teachers, 1998, Pullen, 1999).

For an individual district, given enough resources, shortages can probably be overcome though the use of standard human resources management techniques such as broader and more intensive recruitment efforts and increasing compensation (directly through wage and benefit increases or indirectly though lighter teaching loads or better working conditions). But from a state or national perspective, in order to increase the total supply of teachers, especially in shortage subjects like math or science, broader policy interventions may be needed. A common policy prescription is raising teacher compensation, both to attract more new entrants to the teacher labor market and to retain teachers (Eastin, 2000, Hare et al, 2001; National Commission on Mathematics and Science Teaching for the 21st Century, 2000). There is evidence that increased compensation does increase the size of the teacher pool. (Murnane et al, 1991; Darling-Hammond et al, 1999; Ferris and Winkler, 1988). But there appears to be little current research on the size of the increase in beginning salaries that would be needed to draw a significantly larger number of entrants to one shortage area, math and science teaching.

A casual comparison of beginning salaries for K-12 teaching to those for occupations that now attract college graduates with the knowledge to teach math and science suggests that beginning salaries for teaching would have to rise substantially to draw workers away from these occupations. A review of average salary offers to new graduates reported by the National Association of Colleges and Employers (2002) shows that median annual salary offers for majors in mathematics, accounting, science (except biological and life science) engineering, or computer science were the low 40's to low 50's. Median offers to elementary and secondary education majors reported by the same source were in the $29-30 thousand per year range (see Appendix Table 1). The American Federation of Teachers (2001) salary survey reported an average teacher beginning salary of $27,989 for 1999-2000, and beginning salaries in math and science related occupations ranging from $37,688 for accounting to $47,112 for engineering. These numbers suggest that substantial increases in beginning salaries would be needed to make teaching competitive for graduates with math or science knowledge, even taking into account the shorter work year. However, these comparisons may overstate the size of the increase in entry salaries needed. It is not necessary that all of those who might otherwise choose one of these careers be attracted to K-12 teaching, only enough to remedy the shortage. But how much is enough?

The salary level needed to attract enough qualified people to eliminate the shortage of math and science teachers depends on the elasticity of the supply of potential new teachers with respect to entry salary. This depends in turn on factors such as the number of people with the necessary skills and abilities, the interests and values of these people, the availability of alternative career opportunities, and the entry salaries in those opportunities. Given enough people with the needed knowledge and skills, personality, interest, and value factors are likely to be important in the success of a policy of increasing beginning salaries, because occupational choice is not just a matter of comparing beginning salaries. The vocational guidance literature (e.g. Holland, 1985, Dawis, 1990) tends to portray occupational choice as heavily influenced by personality, values, and interests. One implication of this is that increasing teaching entry salaries to the level of other occupations may not substantially increase the supply of new math and science teachers because people who have chosen other occupations have done so based on their interests, personality, and values, which are relatively stable and formed early in life. There is some evidence that teachers and those aspiring to be teachers have a different

pattern of values or personality from those pursuing other careers. For example, Ben-Shem and Avi-Itzah (1991) found that Freshmen entering helping professions (including education) tended to be more compassionate, caring, and empathetic than those entering business. Bradley (1983) found that British pre-university students who had chosen teaching put more importance on the opportunity to work with children and the social value of the job while those choosing other occupations indicated that salary and non-routine work were more important. Tusin (1999) reviewed studies of motivations for entering teaching, and concluded that the desire to work with children and provide service to society were important attractors, along with working in a subject of interest and the school time schedule. Teaching may be less attractive to those without these interests and values.

We can think of the pool of people who have the skills but who are not interested in teaching at the current pay levels as containing two stylized types. People of the first type have personalities, interests and values somewhat like those of people who have chosen teaching, but prefer higher salaries. These people would accept a teaching job if the pay were closer to or the same as what is available in alternative math, science, or technology occupations. The second type includes those who have personalities, interests, and values that incline them fairly strongly to non-teaching careers in science, math, and technology. This group would likely require a compensating differential to attract them to teaching, a salary rate *above* the current entry levels for their chosen occupations, other things equal. The policy prescription of raising teacher entry salaries to the level of competing math, science, or technology occupations is more likely to be successful, at lower cost, if there are a substantial number of Type 1 people with the required knowledge and skills and who would like to take a teaching job, but who are deterred primarily by low salaries. But if values, personality traits, and interests largely determine who will choose teaching, and these factors are set relatively early in people's lives, the size of this group is limited, and may be quite small.

As well as influencing the salary level at which a person with the needed skills would consider K-12 math or science teaching, personality, interest, and value factors may also be relevant to the recruitment of potential K-12 math and science teachers. It may be worthwhile to target people with values, interests, and personalities like those of teachers in recruitment messages, as well as to communicate higher pay. Current attempts to encourage students to try teaching seem to emphasize altruism. One example is Teach for America, though the benefits to the student are also emphasized. Also, it is possible that people whose values interests and personalities are more like those who have chosen to teach may be more likely to be good teachers and stay in teaching.

The research described here explored the potential influence of higher entry salaries and personality and value factors on the attractiveness of K-12 teaching to undergraduate college students interested in majors that involve math and science. The specific research questions of interest were:

1. Can math, science, or technology majors be attracted to a career in K-12 teaching by higher starting salaries, given the potential importance of interests, values, and personality traits in occupational choice?

2. How much of an increase in starting salary would motivate a substantial proportion of math, science, or technology majors to consider a career in K-12 teaching?

3. Do personality characteristics and work values influence the salary level that would motivate math, science or technology majors to consider a career in K-12 teaching?

4. Do other characteristics of the teaching job besides salary level reduce its

attractiveness to math, science, and technology majors?

These questions were addressed first by holding a series of focus group discussions with university students expected to have the knowledge to teach math or science, and then by asking such students to respond to a survey on which they were presented with a set of pay levels at which they might find K-12 teaching attractive, as well as personality and value items.

Focus Groups

Method

Focus groups were held to provide background information and explore several issues about the attractiveness of teaching careers to students. The groups were held in the first part of the Spring semester. Each session was scheduled for 90 minutes, but some concluded in less time. One set of four groups was held with students in math, science, applied science, or engineering majors, while another four groups were held with students interested in a teaching career, in order to see if there were any differences in reasons for occupational choice between the two groups.

Participants. Participants were freshmen and sophomores at a large Midwestern research university. Freshmen and sophomores were invited to participate because we wanted the opinions of students who had not yet made a strong commitment to a major, and who could more easily switch to an Education major. At the junior and senior level, switching to an Education major often requires lengthening the time to graduate in order to take required education courses. Most recruitment was done in large math courses required for math, science, and technology majors. With the instructors' permission, a brief presentation was made to the class explaining the basic requirements of participation and the incentive offered ($25). Occupations represented in the math, science, and technology focus groups included actuarial science ,astronomy, chemistry, biochemistry, computer science, engineering (mostly computer engineering), medicine, nursing, pharmacy, and veterinary science. In all 19 students participated. Three groups had five or six participants, and one had three, due to three students not showing up for that session. Of the participating students, 13 were female, six were male. The average age was 18.3 years and the average self-reported GPA was 3.26.

As a contrast, focus groups were also conducted with a group of education and pre-education majors at the same university. Freshman and sophomores who were interested in a teaching career were recruited both from math classes and via an email sent to their university email address. Invitations explained the purpose of the research, the basic requirements of participation, and the incentive offered ($25). Email addresses were obtained from the school of education's student advising department. In all, 23 student participated. All groups had between five and seven participants. Nineteen participants were female, four were male. The average age was 19.7 years and the average self-reported GPA was 3.4.

Focus Group Procedure and Analysis. Prior to beginning the discussions, participants completed a short questionnaire covering demographic information and expected salaries. Discussions were then conducted by a professional facilitator, who asked the students to respond to a set of discussion questions. The discussion protocol began with questions about the occupations the students were interested in pursuing and the reasons for their interest, then introduced questions about preferences for pay for performance systems (for another project), and ended with questions about teaching as a career and the influence of salary level on the attractiveness of a teaching career. The sessions were taped and the

tapes transcribed. Transcripts were content-analyzed by the author to identify and record broad themes in the discussion of the questions.

Results

As expected, students interested in mathematics, science, and technology majors had many and varied reasons for occupational choice. The reasons fit into four broad categories: interest in the content of the occupation (more common with those interested in pure science majors), expectations that the student would like content of the job or be good at it, extrinsic rewards such as pay (more common with those interested in engineering and pharmacy majors), and helping or working with people (more common in the health majors). While altruism was not a primary theme of most participants' comments, several mentioned their chosen occupations as making a contribution to society.

Participants were also asked about their perceptions of the job of a K-12 teacher, and if they had considered K-12 teaching as a career. In every group, the theme of low pay was represented in most participants' comments. Low pay was the reason most often stated for not considering a teaching career, a reason that was stated immediately by many participants. However, in each group, some participants also characterized the job as requiring skills or attributes they did not have, such as patience, enjoyment of working with people, and ability to connect with students. Others mentioned concerns like discomfort being responsible for others, student behavior problems, taking work home, frustration with kids who don't "get it", and the monotony of teaching the same material year after year. While some participants mentioned the opportunity to continue to learn, others appeared to feel that teaching at the K-12 level was an intellectual dead end. An interesting theme, expressed mostly by computer-related majors, was a lack of up-to-date equipment in schools.

Many participants commented on the importance of teaching to society and to students. Most seemed to respect their teachers and teaching as a career choice. Some participants expressed the attitude that they could do better than teaching, and that teachers were somewhat unfortunate to be stuck in that career. A few participants interested in pure science careers indicated that teaching at the K-12 level was a fall-back career for them, and several others said they would consider teaching, but only at the post-secondary level. Teaching at the university levels was perceived as more attractive than at the K-12 level. Interestingly, none of the participants indicated an interest in teaching for a short time before they began their "real" careers, but several indicated they might consider it after they had done well in their current career choice.

The major reasons given for their occupational choice by the prospective teachers during their focus groups were enjoyment of children or working with them, the desire to influence or help children, past success at tutoring or coaching, and a schedule that would accommodate family demands and provide summers off. Many also cited their own teachers as models. Prospective teachers generally recognized that their occupation was not that highly paid. (The median expected first year annual salary was $25,000, quite close to the statewide average starting salary in the area.) Many commented, however, that the benefits (e.g. health insurance, pension, and time-off) and job security were good. Many of the female participants mentioned the convenience of the K-12 teaching schedule for those raising families. Interestingly, many also explicitly stated that teachers should not choose the field for money. Statements expressing the idea that it would be wrong to go into teaching for money were common. One participant went so far as to say that salaries should be kept low to keep people who would be motivated to choose teaching by money out of the profession.

Students interested in math, science, and technology majors were also asked if they would seriously consider K-12 teaching as a career if it paid 20% more than they expected to be paid for a job in the occupation in which they were currently most interested. Ten of the 19 participants said they would. Of those who indicated they would not, there were two dominant reasons: concerns about job requirements of teaching (e.g. working with children, need for patience) and commitment to the current occupational choice. Many giving the latter reason emphasized that their chosen career was something they had their hearts set on doing. When participants were asked if they would consider K-12 teaching as a career if it paid 50% more than they expected to be paid for a job in their currently-chosen occupation, 13 of the 19 participants said they would. The remaining 6 continued to say either that they did not have the talent or were committed to their current choice.

Discussion

The focus group results suggest both that increasing the pay level of K-12 teaching has the potential for increasing the supply of people with math and science knowledge who would be willing to consider teaching, and that there is a limit to how effective higher salaries might be in attracting new entrants to this occupation. That the majority of participants identified low pay as a reason they would not consider a career in K-12 teaching, and that most would consider a K-12 teaching career if it paid substantially more than their current choice, is consistent with the common wisdom that higher pay would increase supply. That most participants would consider teaching if salaries were higher than they expected to receive in their current occupation of choice suggests that interests, values, and personality factors do get traded-off with salary. These results suggest that K-12 teaching could bid away labor from math, science and technology occupations, given a sufficient pay level or compensating differential. However, the fact that a substantial minority of the participants said they would not consider a career change even to make substantially higher salaries, either because they did not have the needed skills or abilities or because they are committed to another career choice, suggests that even large salary level increases have limitations in expanding the pool of potential K-12 math and science teachers. This latter finding is consistent with the literature that emphasizes the influences of interests, values and personality on career choice. Education and pre-education majors, as expected, expressed more altruistic reasons for their career choice and recognized that they were not preparing for a highly-paid career. They appeared to have chosen teaching in spite of its salary level. This is what one would expect to find given the current salary levels for teaching.

Limitations

Four focus groups of 19 people are too small a sample to do more than suggest how math, science and technology majors might respond to higher teaching salary levels. Also, the salary levels themselves (20% to 50% higher than these students expected to receive in their chosen occupation) are unrealistic as policy options. It also should be recognized that the recruitment for the focus groups probably resulted in participants who were more sure of their future career paths. Because we asked for participants who were interested in math, science and technology majors, we did not get as many of the ‘undecided’ students common in freshman and sophomore classes. There may be many students with interests and abilities in math and science that are not as committed to non-teaching careers, and would be attracted to teaching by salary levels between the current starting level for teaching and the current starting level for math, science and technology jobs.

Survey

Although the focus group results suggest that much higher starting salaries would attract math, science, and technology majors to K-12 teaching, the effect of incrementally higher salaries is more likely to be of interest to policy makers. Therefore, based in part on the focus group results, another study was designed to explore the effect of more realistic higher starting salary levels on the willingness of students in math, science and technology majors to consider a career in K-12 teaching. The study was also designed to collect data on other factors likely to influence the level of salary that these students would find attractive. The most obvious factor is the starting pay level these student expect to earn in jobs within the occupation they have currently chosen. Based on the focus group results, it was also expected that altruism, or concern for others might attract students to teaching, and that students who were concerned about working with people or uncomfortable in front of a classroom would be less attracted. Grade point average might also be important, given the Murname et al (1991) finding that better students were more sensitive to financial incentives in making career choices. Gender, too may play a role, since women expecting to be primary childcare-givers may be more likely to appreciate the time schedule of a K-12 teaching job.

Method

Participants. The sample consisted of sophomores and juniors at a large Midwestern public research university. The choice of university was based on convenience in this exploratory study. The university registrar's office provided a random sample of 1000 juniors and 1000 sophomores with declared pre-majors (sophomores) or majors (juniors) in mathematics, health occupations (e.g. medicine, pharmacy, nursing, medical technology), engineering, the sciences (e.g. chemistry, biochemistry, physics, biology, zoology), and applied science (e.g. bacteriology, computer science). Majors were chosen which required substantial mathematics and/or science coursework, based on the expectation that students in these majors would have the interest and aptitude to acquire the content knowledge needed to teach mathematics and science. From these samples, 358 sophomores and 300 juniors were selected at random to receive invitations to participate. The number of invitations sent was determined by the funds available to provide an incentive to participate. Because students might have changed majors since they declared majors or pre-majors in the Fall, they were asked to list their current major. Respondents who indicated they were no longer majoring in the areas involving math or science knowledge were excluded from the sample. One hundred two sophomores and 106 juniors provided enough data to be included in the analyses, or resulting in a response rate of 28% for the sophomore and 35% for the juniors. The achieved sophomore sample was 60% female, with an average age of 19.3 years. The achieved junior sample was 38% female, with an average age of 20.9 years. Appendix Table 2 shows the self-reported majors of both groups, and the salaries they expect to receive. It should be noted that there were more engineering and fewer science majors in the junior sample, and that the median expected pay was higher in the junior sample.

Procedure. Students in the sample were invited to participate in a study of job choice, job characteristics, and pay in their major field via an email message sent to their university email address. They were asked to log on to a web site and complete a survey, which would take about 30 minutes. They were also told that they would receive $15 for completing the survey. Five days after the initial invitation, students who had not responded received a second invitation. A third and final invitation was sent one week after the second. Sophomores were invited to participate in the Fall, then Juniors in the Spring.

The survey included 159 mostly closed-ended items (including items relevant to another study). Students responded to the items by clicking on the “radio button” associated with the chosen response option. Students were asked to enter the name of the occupation or job they were planning to get when they finished their education. Many of the survey questions were then asked with reference to this occupation.

Measures.

- *Attractive salary.* Students were told that the current average beginning salary for K-12 teachers in the state was $26,500 for a 10 month work year. (This figure was obtained from the state association of school boards, which maintains a data base of teacher pay schedules of state public school districts.) They were also told that this equated to a 12 month salary of $31,800. They were then asked to choose the beginning salary that that would make them seriously consider a career in K-12 teaching. Eleven response categories were provided, the lowest labeled $26,500 and the highest $46,500 or more, with intervening categories labeled in $2,000 increments from the lowest.
- *Expected salary*. Students were asked to enter the annual salary they expected to be paid in their first job in their chosen occupation. They were asked to enter their best guess even if they were not sure what salary to expect.
- *Personality and work-values measures.* To explore the potential impact of personality and interest factors on the salary level at which math, science, and technology majors would find teaching attractive, three of the ‘Big 5’ personality dimensions were measured: extroversion, agreeableness, and openness. (For a discussion of the Big 5, see Mount and Barrick,1995 and Hogan, Hogan, and Roberts, 1996). These dimensions were chosen because according to research by Tokar and Swanson (1995), they can serve as proxies for Holland’s vocational personality typology (Holland, 1985), a commonly-used vocational interest measure. According to the Holland typology, teachers are characterized as social (the primary type) with elements of the artistic and enterprising types. According to Tokar and Swanson’s results, the three Big 5 dimensions chosen correlate with these Holland types and can distinguish among Holland types. In addition, extroversion was also expected to be related to the degree to which study participants would be comfortable working with students and leading classes. One would expect participants who are less extroverted to require a higher salary to consider a career in K-12 teaching. Saucier’s (1994) ‘mini-markers’ of the Big 5 were used. Respondents were required to choose how well each of 40 adjectives (e.g. bold, kind, shy) applies to them. Each personality dimension was represented by 8 adjectives. The response scale ranged from 1 (does not apply to me) to 9 (applies a great deal). Ratings of related adjectives are summed to form the scale for each trait. Work values were measured by the concern for others subscale of the Comparative Emphasis Scale, designed to measure four workplace values: achievement, concern for others, fairness, and honesty (Meglino and Ravlin, 1998; Ravlin and Meglino,1997). This measure has a forced choice format in which respondents are asked to choose which of two statements described the value they felt should receive the greater emphasis if a choice of action were called for. It produces a rank order of the 4 values, or an interval scale value for one dimension when only one value dimension is of interest. In this study, the scale representing the value of concern for others was used to represent altruism, and it was expected that greater concern for others would make it more likely that a student would consider teaching at a lower salary level. In addition, risk aversion in career choice was measured. An 8 item scale developed by Judge and colleagues (Judge et al, 1999; Cable and Judge, 1994) was used. Participants were asked to agree or disagree, on a 5-point Likert scale, with items such as “I am not willing to take risks when choosing a job or company to work for” and “I prefer a

high security job with a steady salary over one offering high risks and high rewards". Risk aversion was included because of the interest in job security expressed by some science and technology majors in the focus groups, and the mention of good job security in the education major focus groups.
Participants were also asked to rate the importance of 13 factors or conditions that might effect a decision to pursue a teaching career, assuming teaching paid as much as they would expect to receive in the occupation they were considering. Among the conditions or factors were the extra work it would take to get a teaching license, the prestige of teaching, problems with student behavior, and the availability of jobs in a desirable location. Based on the focus group results, items were also included referring to whether the respondent would like working with children, whether s/he would be good at teaching, and whether up-to-date equipment or technology is available is schools. The importance of these conditions in making a decision was rated on a 1 (not important) to 5 (very important) scale. The intent of including these items was to try to assess the importance of some of the non-salary factors that might go into a decision to choose a teaching career.

- *Other Variables*. Several other measures were included in the survey as potential controls for statistical analyses. Grade point average was measured by having students report their current GPA by choosing one of 6 categories ranging from below 2.0 to 3.7-4.0. Respondents were also asked to indicate their gender, age and whether they planned to go to graduate school before beginning their first job in their chosen occupation.

Treatment of Missing Values. Though participants were asked to complete all items, sporadic missing values occurred for several of the questions of this somewhat long survey. Missing values in the personality and value measures were imputed using the method of adjusted mean substitution described by Raaijmakers (1999). Data were imputed for 3 cases in the junior group and 5 cases in the sophomore group. In one case in the sophomore group, the expected salary was imputed based on the median for the major.

Results

Panel 1 of Table 1 shows the number of participants who chose each salary level when asked to choose which would make them seriously consider a career in K-12 teaching. It also attempts to represent a sort of supply curve by showing the cumulative percent of each group that would be willing to consider teaching at each higher salary level. (This assumes that those who would consider teaching at one salary level would also consider it at the higher levels.) Figure 1 plots the cumulative percent against the attractive salary for the combined group of participants.

Table 1
Number and Cumulative Percent of Participants Who Would Consider a Teaching Career at Various Teaching Salary Levels

I. All Participants

Attractive Annual Salary Level	No. of Sophomores	Cumulative Percent of Sophs.	No. of Juniors	Cumulative Percent of Juniors
26,500	12	11.8%	4	3.8%
28,500	1	12.7%	1	4.7%

30,500	4	16.7%	6	10.4%
32,500 (+23%)	7	23.5%	8	17.9%
34,500	6	29.4%	5	22.6%
36,500	9	38.2%	10	32.1%
38,500 (+45%)	10	48.0%	6	37.7%
40,500	19	66.7%	20	56.6%
42,500	4	70.6%.	5	61.3%
44,500	5	75.5%	8	68.9%
46,500+	25	100.0%	33	100.0%
Total:	102		106	

II. Engineering & Science/Applied Science Participants

Attractive Annual Salary Level	Engineering Soph. & Jr.	Cumulative Percent	Science & Applied Sci. Soph. & Jr.	Cumulative Percent
26,500	2	3.3%	10	11.4%
28,500	0	3.3%	2	13.6%
30,500	2	6.7%	4	18.2%
32,500 (+23%)	4	13.3%	6	25.0%
34,500	4	20.0%	3	28.4%
36,500	4	26.7%	9	38.6%
38,500 (+45%)	4	33.3%	8	47.7%
40,500	14	56.7%	11	60.2%
42,500	3	61.7%.	5	65.9%
44,500	58	75.0%	4	70.5%
46,500+	15	100.0%	26	100.0%
Total:	60		88	

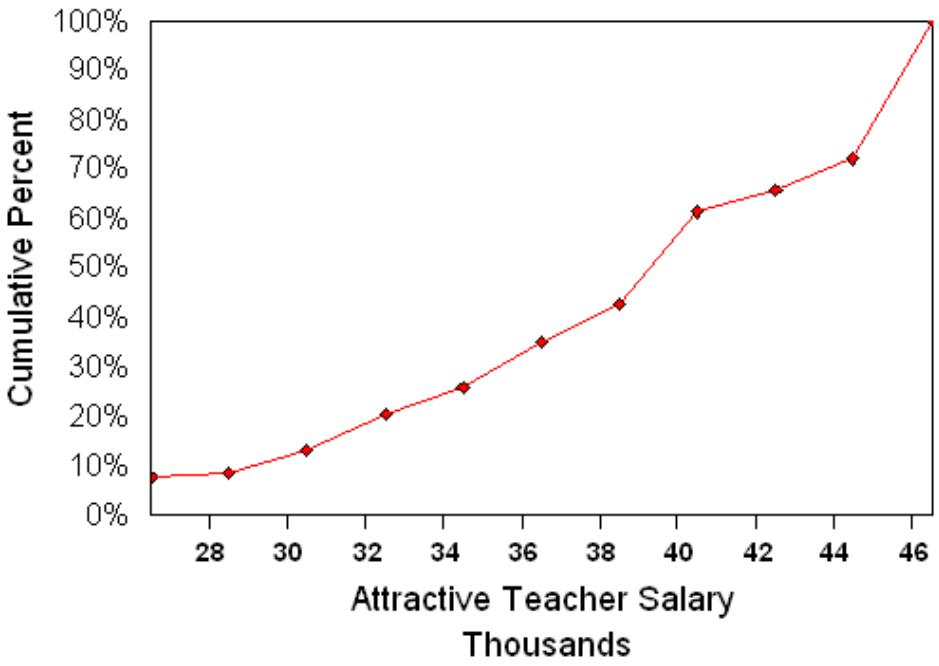

Figure 1. Cumulative Percent of Respondents Who Would Consider a Teaching Career at Various Salary Levels (Sophomore and Junior Respondents Combined).

These data give some idea of the increase in starting salaries that would be needed to attract a substantial number students majoring in math, science, or technology to K-12 teaching.

A 23% increase in starting salary would be needed to attract about 23% of the sophomore participants and about 18% of the juniors. A 45% increase would be needed to attract 48% of the sophomore participants and about 37% of the juniors. Looking at Figure 1, if one can consider the range of annual salaries from $28,500 to $38,500 as representing a plausible range of salaries a state or the nation might be likely to fund (increases of 7.5 to 45%), there is a fairly linear relationship between salary increases and the increase in the percent of participants who would consider teaching. Each $1,000 salary increase is associated with an increase of 3.4 percentage points in the proportion of respondents willing to consider a career in K-12 teaching. (Note that if plotted separately, the sophomore curve would be lower and the junior curve higher than that of the two groups combined, but the curves are very close to parallel in the $28,500 to $38,500 range.)

Panel 2 of Table 1 shows the number of participants who chose each salary level as attractive for the two largest groups in the sample, engineering students and pure and applied science students. A 23% increase in starting salary would attract about 13% of the engineering student participants and about 25% of the pure and applied science participants. A 45% increase would attract about 33% of the engineering students and about 48% of the pure and applied science students. In the range of annual salaries from $28,500 to $38,500, each $1,000 salary increase is associated with an increase of 3.1 percentage points in the proportion of respondents willing to consider a career in K-12 teaching for the engineering students and 3.4% for the pure and applied science students.

The salary respondents expected to be paid in their first job in their chosen non-teaching occupation was expected to influence the salary that would attract them to teaching. Figures 2 and 3 plot the natural log of the attractive salary against the natural log of the expected salary for the sophomore and junior participants, respectively. The vertical line

parallel to the Y axis is set at the value of the teaching minimum salary level. The “fitted” line is the lowess smoothing of attractive on expected salary. These figures show a relationship between expected salary and attractive salary that is not as simple as was expected.

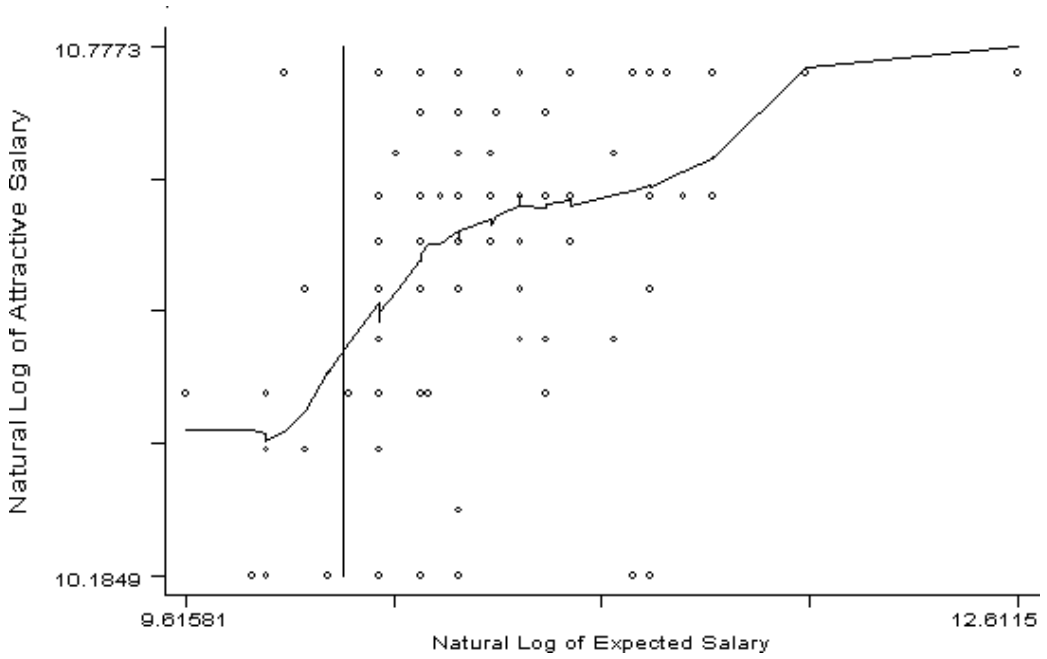

Figure 2. Relationship Between the Natural Logarithms of Expected Beginning Salary and the Teaching Beginning Salary Respondents Chose as Attractive – Sophomore Respondents

Figure 3. Relationship Between the Natural Logarithms of Expected Beginning Salary and the Teaching Beginning Salary Respondents Chose as Attractive – Junior Respondents

The figures show that expected pay level was not as strong a predictor of the attractive pay

level as might be expected. The correlations between the natural log of the attractive and expected beginning salaries were .41 for the sophomores and .21 for the juniors. The figures show that at most levels of expected salary, there was a wide range of attractive teaching salaries. While in the middle range of both variables the relationship between has the expected upward slope (Note 2), there are two interesting anomalous groups of participants. In the upper left corners, one group of participants had low expected salaries but claimed to be attracted to teaching only by much higher teaching salaries (higher than their expected salaries). In the lower center, another group had relatively high expected salaries (compared to teaching) but chose the current average teacher minimum as the salary that would attract them to teaching.

Drawing on the focus group results, the first group may represent students who would require a large premium or compensating differential to consider teaching because they do not have the skills or personality traits they perceived to be required, because they regarded some of the job characteristics of teaching as disagreeable, or because they placed a high value on their current career choice. The second group, those with expected salaries above the teaching starting salary but who would be willing to consider teaching at its current salary level, are somewhat harder to speculate about. Some may be students who would consider teaching as a back-up career plan, or be highly altruistic. One would, however, have expected the altruists to have already chosen teaching. Some may have thought teaching paid even less than the minimum they were given, and would consider teaching at the level given in the survey. Of course, some students in this group could simply have given erroneous or unconsidered responses.

These results support distinguishing between two stylized ‘types’ of participant: those who would be willing to consider teaching at a lower salary than they expected to receive in their current choice, and those willing to consider teaching only for a higher salary than expected. The first type might be thought of as those willing to trade some of the salary difference between their current choice and teaching for a shorter work year, a work schedule more convenient for raising children, or the opportunity to work in a job satisfying needs for altruism. The second type includes those requiring a compensating differential to teach at the K-12 level. Of the sophomore participants, 41% reported an attractive salary for teaching that was above their expected salary. For the juniors, the corresponding percentage was 31%.

In order to explore the roles of personality and work values, and the effect of gender and grade point average on the salary level participants chose as required to get them to consider K-12 teaching, Tobit models were estimated. The 2 limit Tobit model was used because of the censoring of high and low values of the dependant variable, due to the use of fixed response options beginning at $26,500 and ending at $46,500. It was expected that participants with higher scores on concern for others, higher scores on extroversion, and higher scores for career risk aversion would choose lower attractive salary levels. In addition, participants who were female and had lower grade point averages were also expected to choose lower attractive salary levels. Gender (female =1) and intent to go to graduate school before stating the career (intent =1) were represented by dummy variables. The reported GPA was represented by the numeric value of the response category encompassing a student’s GPA. One outlier was removed from the junior sample. The results are shown in Table 2. (Means, standard deviations, and correlations are shown in Appendix Tables 3 and 4.)

Table 2
Tobit Prediction of Attractive Salary for Sophomore and Junior Samples

	Sophomore Sample		Junior Sample	
Independent Variable	Coefficient	Standard Error	Coefficient	Standard Error
Natural Log, Expected Salary	.23805*	.05798	.20801*	.07389
Female	-.04763	.05214	.04694	.05131
Intend to Attend Grad School	.00119	.05158	.05500	.04684
Grade Point Average	.01472	.01342	.00878	.01292
Career Risk Aversion	-.05187	.05171	-.03231	.04558
Extroversion	.00037	.00238	.00045	.00205
Openness	.00137	.00309	-.00215	.00287
Agreeableness	-.00299	.00377	-.00281	.00302
Concern for Others	-.02361*	.01154	.00232	.01038
Chi-square/prob. (9 d.f.)	31.10/.000		15.43/0.080	

* Statistically significant at .05 level or beyond.

Expected salary was a significant predictor of the attractive salary in both samples. Concern for others is negatively related to attractive salary, as expected, in the sophomore sample, but the coefficient is close to 0 and not significant in the junior sample. None of the other predictors had statistically significant coefficients. The extroversion measure, though its coefficient had the expected sign, was barely larger than its standard error in the sophomore sample and smaller in the junior sample. The model fit the data better for the sophomore sample. Additional analyses using an ordered logit approach showed the same results in terms of the pattern of significant coefficients, with higher chi-square and pseudo-R-squared values for the sophomore than the junior sample.

As mentioned above, participants were also presented with a list of 13 factors or conditions that might effect a decision to pursue a teaching career, and asked to rate the importance of each factor on a 1 (not important) to 5 (very important) scale, assuming teaching paid as much as they would expect to receive in the occupation they were considering. Table 3 shows the means and standard deviations of the ratings of these factors for each sample.

Table 3
Importance of Factors Other Than Pay in Deciding to Pursue a Career in Teaching

	Sophomores		Juniors	
Reason	Mean	Standard Deviation	Mean	Standard Deviation
Whether would like working with children	4.57	0.76	4.52	0.75
Whether would be good at teaching	4.41	0.84	4.42	0.77

Need to give up current career plan	4.11	1.14	4.18	1.10
Ability to continue to work in discipline	3.80	1.08	3.96	1.00
How easy to find job in teaching	3.48	1.00	3.64	1.02
Jobs available in desired location	3.58	1.17	3.72	1.13
Level of benefits	3.78	0.94	3.86	0.83
Opportunities for advancement	3.38	1.19	3.28	1.08
Problems with student behavior	3.14	1.13	3.07	1.14
Availability of up-to-date equipment or technology	3.11	1.07	2.98	1.00
Extra work needed to get license	2.87	1.15	2.65	1.16
Status or prestige of teaching	2.43	1.22	2.37	1.13
Approval of parents or important others	2.40	1.13	2.13	1.14

These results tend to be consistent with some of the focus group results. The high ratings for concerns about being good at teaching and enjoying working with children, giving up the current career choice and being able to continue in the discipline were expected given that these themes were mentioned in the focus groups. Prestige and parental approval were rated as less important (perhaps reflecting social desirability). These respondents appear to be more concerned about the aspects of teaching that relate to their interests and abilities than with some of the 'extrinsic' features such as benefits and prestige. These results do not, of course, suggest that other factors like ease of finding a job or level of benefits are not important, but only that in these samples respondents less concerned about prestige are more likely to be interested in a teaching career at a lower beginning salary level.

Discussion

This study attempted to explore the questions of whether undergraduate students with knowledge and interests in math, science, or technology could be attracted to a career in K-12 teaching by higher starting salaries, what salary levels might be needed to get more of these students into K-12 teaching, whether personality and work values would influence the salary level that would attract these students to teaching, and what other characteristics of the teaching job reduce its attractiveness to these students.

The findings suggest that students with knowledge and interests in math, science, or technology could be attracted to K-12 teaching by higher starting salaries, but that interest and ability factors limit the attractive effects of higher pay. The focus group results suggest that math, science, and technology majors see teaching as a low paid field, that pay level was a significant factor making a career as a K-12 math or science teacher less attractive, and that many would consider it if it paid substantially more than their current occupational choice. These results also show that students have a variety of reasons for not being attracted to teaching beyond low salaries. These include strong attachment to another career choice, doubts about their ability to be good teachers and discomfort with aspects of the job such as being responsible for others or standing in front of a class. For a significant minority of these students, even very large increases in entry pay are not likely to attract them to teaching. This was illustrated by one focus group member who claimed she would not be interested in teaching even by a salary 50% higher than that she

expected from her relatively low paying field of astronomy.

The survey results suggest that the entry salaries for math and science teachers would not have to be raised to the same levels as engineering, computer science, or the higher-paid health occupations to attract some of these students. But the increases have to be greater than 5-10% to attract a substantial proportion of them. A beginning salary increase of about 25% would be needed to attract about 20% of the respondents. The amount of increase does differ by student major, with higher increases needed to attract more engineering students than pure and applied science students. This is likely due to the higher salaries the former are expecting to receive in an engineering career.

As expected, the entry salary level at which these students would consider a teaching career was related to the entry salary they thought they would receive in the non-teaching occupation they intended to enter. Evidence for the influence of personality traits and work values on the salary level at which these students would be willing to consider a teaching career was mixed. Focus group results suggested that personality and interest factors were important for some students in determining the attractiveness of K-12 teaching, and implied that a compensating differential (a salary level above what was expected for their current occupational choice) would be needed to attract a substantial minority of these students. Survey results did not, however, find a consistent effect of personality factors and work values on the salary level at which respondents were willing to consider a K-12 teaching career.

Other factors that besides low pay did appear to reduce the attractiveness of a career in K-12 teaching. Focus group participants identified difficulties in dealing with children, taking work home, perceived intellectual monotony, and lack of up-to-date equipment in schools as unattractive aspects of teaching, but these were not as frequently expressed as concerns about lack of ability or interest in teaching. Survey participants rated whether they would like or be good at teaching as more important considerations in deciding to pursue a K-12 teaching career were the pay equal to what they expected to receive in their chosen occupation than problems with student behavior, lack of equipment, the extra work needed to get a license, and low status. While it may be that many of the study participants did not know enough about K-12 teaching to identify specific unattractive factors, these results suggest that interests and abilities might be more important than working conditions factors in influencing the choice of teaching as a career if salaries were increased.

There are three implications of this study that those interested in attracting math, science, and technology majors to K-12 teaching by raising entry salaries may want to consider. First, significant increases in entry salary (e.g. 25%) would be needed to attract a substantial proportion of these students, though entry salaries would not have to be as high as in many alternative careers. Interests, personality, and values do not completely determine who will teach and do not completely restrict the supply of labor. Second, it would make sense to target majors in fields that are not as highly paid, or where students are not expecting as high entry salaries. In this sample, this would include pure science and heath-related majors. It is probably less efficient to target engineering students, who in this sample on the average had higher pay expectations. Third, it is important to remember that some students are not going to be attracted to K-12 teaching by the higher salary levels that realistically could be implemented. Some of these students would require a premium over what they expect to earn in their current career choice to consider teaching, due to commitments to another career and concerns about their ability to teach. These are not likely to be worth trying to attract, both because of the potential need to pay much higher salaries and because these students may not make good teachers.

While common sense still suggests that targeting those with personalities, interests, and

values similar to those of students who have chosen teaching would be productive, this research did not find a consistent effect of these factors on attractive pay level. While the sophomore students in the survey sample with a stronger value of concern for others indicated they would consider teaching at a lower entry salary, this relationship did not show up in the junior sample. The lack of a relationship between career risk aversion and attractive salary does not suggest that emphasizing the job security of K-12 teaching would be promising.

Limitations

The major limitation of this study is the uncertain generalizability of the results to all U.S. math, science, and technology majors due to the use of a sample from only one university and one point in time. The studies' participants constitute only a small sample of those college students in the U.S. who have the knowledge base to teach science and math. Students at different universities in different parts of the country may face different career options, different teacher beginning salaries, and have received different socialization. The research was also conducted before the dot com boom had bust, and in a period of economic expansion. Under different economic conditions, some students would not be expecting such high beginning salaries and may see the potential job security of teaching as more attractive. The results are in need of replication before they can provide solid guidance to policy makers about pay levels needed to attract students to math and science teaching.

Another limitation is that the conclusions about the exact size of the entry salary increase that would be needed to attract a substantial number of students to K-12 teaching is influenced by the composition of the sample. The proportions of students in different majors influences the estimate of the proportion of students that would find teaching attractive at each salary level. Students with different majors have different expected salary levels and in samples with a different mix of majors this will result in different estimates of py levels needed to attract certain percentages of these students. Though the slope of the 'supply curve' was fairly similar for engineering students, pure and applied science students, and the participant group as a whole, it may be better to try to estimate the pay-supply relationship separately for different majors, but in this study the sample size was not large enough to do so for any but the two most common majors. Ideally, one would also like to have much bigger sample sizes to ensure a more trustworthy estimation of this relationship.

There are also several limitations related to the measures used. First, a more comprehensive measure of vocational interests might have shown a stronger relationship with attractive teaching salary than the dimensions from the Big 5 personality theory that were used. According to Dawis (1991), standard interest inventories are generally strong predictors of occupational choice, and might have had a stronger relation with attractive teaching pay. Second, the extroversion measure may not have been specific enough to represent the abilities required to be comfortably face the challenges of standing in front of a class or interacting with students that some of focus group participants identified as reasons for not teaching. It may be that more specific personality traits would have been more strongly related to the attractive teaching salary. Third, it is possible that, due to the length of the questionnaire, respondents became somewhat careless in there responses to the work values and personality items. This might be the reason that these did not show a consistent relationship with attractive teaching salary. Lastly, the use of a limited range of categories of teaching beginning salaries restricted the variance of the attractive salary variable. Had students been allowed to enter the dollar amount they would require to seriously consider K-12 teaching, the attractive salary would not have been censored from above and more information would have been available for those in this study who chose

the top category.

Future Research

To provide more generalizable information about the beginning salary levels needed to attract students with knowledge and interests in math, science, and technology to K-12 teaching, this research would need to be repeated at other universities. Improved and additional measures of personality and interests could be added. It might also be useful to explore more thoroughly the non-monetary reasons people might not want to teach, and how they trade-off these factors with pay. Characteristics like low status, lack of up-to-date technology, and an image of teaching as boring or an intellectual dead end could be changed, and it might be interesting to see if doing so would attract students more or less effectively as higher pay. One approach might be to present students with a series of scenarios which varied salary and other characteristics in a classic 'policy capturing' design, in order to assess the relative importance of higher salaries and other conditions in attracting interest in teaching.

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Notes

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2. Because the attractive salary response options ended at $46,500, there is a ceiling effect on the relationship. The attractive salaries are censored from above. There is also a floor effect (or censoring from below) because the lowest attractive salary response option presented was $25,500. This is clear in the sophomore group, but somewhat obscured in the junior group by two apparent outliers for which expected salaries are low, but attractive salaries are at the upper limit.

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Appendix Table 1
Beginning Salary Offers for Selected Occupations from Spring 2001 National Association of Colleges and Employers Salary Survey

Major	Median Offers,	Number of Offers
Mathematics	46,000	197
Chemistry	40,000	91
Biological & Life Sciences	27,600	320
Physics	52,000	49
Engineering – Civil	40,300	1184
Engineering – Chemical	52,000	1305
Engineering- Electrical/Electronic	52,000	1883
Engineering- Mechanical	49,000	2225
Computer Science	52,100	1428
Accounting	40,000	1807
Elementary Education	30,000	480
Secondary Education	28,700	204

Appendix Table 2
Median Expected Annual Beginning Salaries and Attractive Teaching Salaries, Students Interested in Math and Science, and Technology Majors

Sample and Major	Number	Expected Salary	Attractive Salary	Attractive 12 Month =
Sophomores				
Business (e.g. Accounting)	6	37,500	36,500	43,800
Engineering	18	42,500	40,500	48,600
Health Related	20	38,750	38,500	46,200
Math & Computer	6	52,500	45,500	54,600
Science	52	40,000	39,500	47,400
All	102	40,000	40,500	48,600
Juniors				
Business (e.g. Accounting)	1	50,000	46,500+	55,800
Engineering	42	45,000	41,500	49,800
Health Related	13	35,000	40,500	48,600
Math & Computer	14	50,000	40,500	48,600

Science	36	40,000	40,500	48,600
All	106	45,000	40,500	48,600

Appendix Table 3
Means, Standard Deviations, and Correlations of Variables Used in Tobit Analyses, Sophomore Sample

N=102

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9
1. Natural Log, Attractive Salary	10.5463	0.1821									
2. Natural Log, Expected Salary	10.6685	0.4674	.414								
3. Female	0.598	0.493	-.175	-.150							
4. Intend to Attend Grad School	0.647	0.480	.126	.172	.022						
5. Grade Point Average[a]	5.20	1.851	.092	.091	-.010	.268					
6. Career Risk Aversion	2.51	0.499	-.047	.236	.010	-.019	.048				
7. Extroversion	10.406	11.238	-.022	-.048	.216	-.054	.095	-.199			
8. Openness	19.536	7.799	.059	-.018	-.071	.103	-.005	-.218	.045		
9. Agreeableness	21.049	7.881	-.227	-.153	.344	-.074	.137	-.152	.433	.146	
10. Concern for Others	6.461	2.228	-.278	-.078	.017	-.078	.170	.196	-.049	-.058	.290

(a) This is the average of the ordered categories chosen. It corresponded to the GPA category of 3.0-3.2.

Appendix Table 4
Means, Standard Deviations, and Correlations of Variables Used in Tobit Analyses, Junior Sample

N=105

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9
1. Natural Log, Attractive Salary	10.5877	0.1584									

2. Natural Log, Expected Salary	10.7103	0.3435	.276								
3. Female	0.371	0.486	-.008	-.325							
4. Intend to Attend Grad School	0.429	0.497	.174	.204	.171						
5. Grade Point Average[a]	5.290	1.763	.134	.151	.077	.167					
6. Career Risk Aversion	2.445	0.536	-.075	-.034	.045	-.157	.070				
7. Extroversion	5.876	11.655	.022	.068	.124	.134	-.054	-.152			
8. Openness	19.333	8.277	-.065	.074	-.024	.044	-.026	-.282	.347		
9. Agreeableness	20.019	8.296	-.106	-.047	.225	.014	.151	.128	.306	.222	
10. Concern for Others	5.190	2.232	-.072	-.120	-.013	-.152	.008	.350	-.036	-.123	.172

(a) This is the average of the ordered categories chosen. It corresponded to the GPA category of 3.0-3.2.

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