Assessing Factors that Influence the Recruitment of Majors from Introductory Geology Classes at Northern Arizona University

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ABSTRACT

In order to guide the formulation of strategies for recruiting undergraduates into the geology program at Northern Arizona University, we surveyed 783 students in introductory geology classes and 23 geology majors in their junior and senior years. Our analysis shows that ~7% of students in the introductory classes are possible candidates for recruitment. Influential factors that weigh in favor of majoring in geology include good employability, good salary potential, and opportunities for working outdoors, field work, observing nature, travel, and environmentally friendly employment. In addition, students view a career as a geologist as potentially the most fulfilling of the science occupations and among the more environmentally friendly. However, students perceive geology to be the least difficult of the sciences, and geology occupations to be low-paying and low in prestige relative to the other sciences. These negative perceptions are a problem for recruitment and may be countered by providing information to introductory students showing the salaries of geologists in comparison to other science occupations, and by communicating the rigorous nature of the more advanced geology classes.

INTRODUCTION

In recent years, the subject of recruiting undergraduates into geoscience programs at colleges and universities has received considerable attention. Recruitment has been a focus of workshops sponsored by the National Science Foundation held in 2005, 2007, and 2009 as part of the series "Building Strong Geoscience Departments" (see serc.carlton.edu for summaries of these workshops), and a topical session on recruitment consisting of 16 presentations was held at the 2006 national meeting of the Geological Society of America. In addition, the American Geological Institute is currently conducting research on ways to help academic programs with their recruitment efforts (C. Martinez, personal communication, 2009). These activities come on top of longstanding efforts sponsored by the National Science Foundation to increase the diversity of the geoscience workforce through its program "Opportunities for Enhancing Diversity in the Geosciences." The problem is also a concern internationally (Mazumdar et al., 2006; Shanker, R., 2003; Snieder and Spiers, 2002; Vaidynathan, 1998).

Since the early 1970's, the number of students earning undergraduate geoscience degrees has gone up or down roughly in tandem with oil prices (see Fig. 2 from Rhodes, 2008), giving rise to the expectation that the surge in oil prices that began in 1998 would be met with higher enrollments. However, contrary to expectation, overall enrollments remained essentially flat (Gonzales et al., 2009). This presents a problem for academic geoscience programs, which have relied on periodic upswings in enrollments to justify resources over the long term. At colleges and universities, the number of majors is commonly used as a key metric in determining current and future resource allocations. The use of this or similar metric has the potential for negative impacts on geoscience programs, including reductions in the number of geoscience faculty and even the dissolution of programs (Watson, 2007; Kerr, 2010).

Geoscience programs face the challenge of doing a better job of recruiting majors. Previous studies have identified several impediments to recruitment into undergraduate geoscience degree programs. The comparative lack of exposure of students to geosciences in relation to other science, technology, engineering, and mathematics fields in the public schools has been identified as one important factor (Levine et al., 2007). For example, in the U.S. in 2005, 22% of graduating high school students had taken a geoscience course in high school whereas 92% had taken a biology course (Gonzales et al., 2009). Another challenge is that on most campuses there are no chapters of geoscience societies, whereas society chapters representing the other sciences are generally present (C. Keane, 2009, personal communication). One function of campus-based society chapters is to engage recruits early in their degree programs. In addition, geoscience faculty may possess misconceptions regarding the factors that are important to students in their process of selecting a major, and this can lead to misdirected recruitment efforts (Snieder and Spiers, 2002). Recruitment may also be challenged by the demands of time and resources needed to implement recruitment strategies (e.g., Brock et al., 2006).

We investigated attitudes and perceptions of students in introductory geoscience classes at Northern Arizona University (NAU) with the goals of assessing the potential for recruitment into the geology degree program, and identifying influential factors that weigh in favor of choosing geology as a major. The courses (GLG100, Introduction to Geology; GLG101, Physical Geology; and GLG112, Geologic Disasters) collectively enroll ~600 students each semester. The vast majority of these students are non-majors who take them in order to satisfy a university general education requirement (called Liberal Studies requirements at NAU). Large proportions of the students are freshmen (51%) and sophomores (30%). In addition, 12% (Fig. 1) say they are undecided on a major and almost half (47%) indicate some degree of uncertainty regarding their choice of major, that is, they responded something other than strongly agree to the statement "I

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will not change my major before I graduate." We interpret these data to indicate that there is a large potential for recruitment in these classes.

NAU is classified as a research intensive university and in 2009 enrolled about 14,400 undergraduates and 4,400 graduate students. The main campus is located in Flagstaff, about 140 miles from Phoenix, the nearest major metropolitan area. Our study took place on the main campus.

Previous studies have identified a number of factors important to the recruitment and retention of students into the geosciences, including taking an introductory geoscience course, obtaining information about a geoscience major, using place-based teaching strategies that emphasize the study of local places, and providing extracurricular activities (Brock et al., 2006). Levine et al. (2007) identified several additional factors including outdoor experiences, the geoscience department culture (more cooperative and social than other STEM courses), field trips, and the geoscience job market. Most of these factors were also identified in the current study as important to the recruitment of majors from NAU's introductory geoscience classes.

RECRUITMENT STRATEGIES

Ideas put forward to enhance the recruitment of geoscience majors have to-date been reported mostly in abstracts. These include (1) research projects that involve high school seniors (Cornell and Tapp, 2006), (2) field-intensive introductory geology courses (Keith, 2006; Van Hees and Lemke, 2006), (3) creation of new academic programs that target students whose interests lie at the interface between earth science and another discipline such as education, environmental law, or biology (Bice et al., 2006), (4) recruitment from traditional large-enrollment introductory courses or from introductory topical courses that enroll small numbers of students (Eyles et al., 2006; Kime, 2006; Peters and Zeitler, 2006; Hickson and Lamb, 2006; Trupe, 2006; Tewksbury, 2006; this study), (5) employing senior geology majors as teaching assistants in introductory courses so that they may serve as ambassadors for the program (Hickson and Lamb, 2006; Eyles et al., 2006), (7) recruitment from geology-related "freshman interest groups," which are topic-based groups of two or more related classes that freshmen are encouraged to enroll in (Badger, 2006), (8) summer programs that target pre-freshmen (Cornell, 2006; Hanks et al., 2007; Miller et al., 2007) or science-oriented freshmen and sophomores (Hickey-Vargas et al., 2006), and (9) outreach to high schools through teacher education and classroom visits (Eyles et al., 2006).

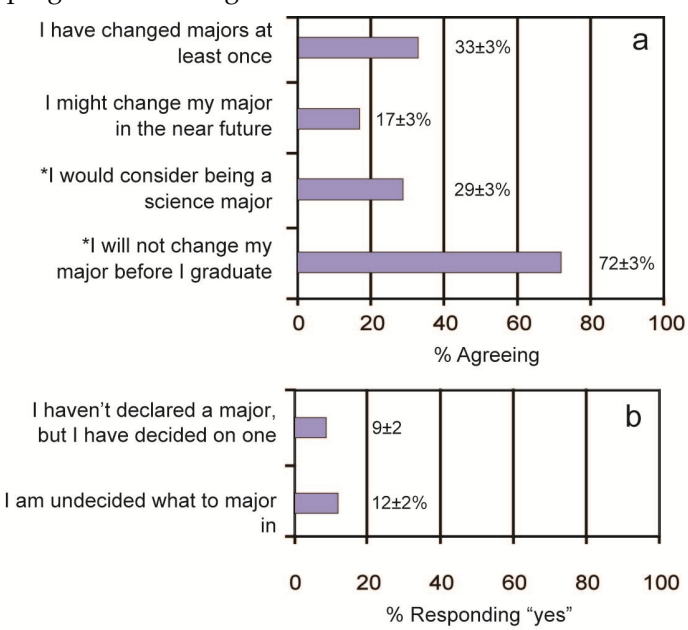

FIGURE 1. Commitment to choice of major. Margins of error at the 95% confidence level (e.g., Kish, 1965) are shown (n=783, all respondents). a: Percentage of respondents answering "strongly agree" or "somewhat agree." Questions marked with asterisks (*) were used to define the target group, as described in the text. b: Percentage of respondents answering "yes."

Although many of these approaches may lead to successful recruiting, rigorous assessment has not been carried out in most cases, and establishing causation, the connection between the approach and the success, can be difficult. One approach where causation appears to have been established is that of recruitment talks given in introductory classes at the University of Southern Georgia (Trupe, 2006). The talks are given by someone other than the instructor of the class, such as another geoscience faculty member, and contain specific content that targets factors influential to the process of deciding a major. The success of this method was demonstrated by a reversal in a declining enrollment trend followed by substantial increases.

MEASURING ATTITUDES

Two methods of gathering data to measure attitudes have been used in previous studies of recruiting and retaining majors in the geosciences. Levine et al. (2007) performed a study of "critical incidents" based on the method of Flanagan (1954). Critical incidents are defined as situations or events that played a critical role in a student's decision to select a major. To perform their study of critical incidents, Levine et al. (2007) interviewed 14 minority geology majors in an open-ended exploratory manner to determine what specific situations or events influenced their choice of major. A second approach is that of Fuhrman et al. (2004), who developed a survey instrument (downloadable from serc.carlton.edu). We developed similar survey instruments to be administered in NAU introductory geology classes. These instruments collect basic demographic information and measure attitudes around areas that we considered were likely to be relevant to the general process of choosing a major and to choosing among the different science programs at NAU.

We administered the first version of our survey instrument (electronic Appendix A) in our introductory classes about five weeks into the fall 2008 semester, just before registration for the spring semester was to begin and just before the start of a two-day field trip mini-course designed to recruit majors. The mini-course was an

elective that was advertised only in the introductory courses. Because one of the survey questions asked students whether they were enrolled in the mini-course, the responses from the mini-course participants could be identified and examined separately. Twenty-eight students responded they had enrolled in the fall mini-course.

The survey administered in the fall 2008 semester consisted of 127 closed-ended questions that were designed to investigate a wide range of possible influences on choosing a major. Questions were asked that investigated whether a student had chosen a major, the degree of commitment a student has toward that major, and the timing of choosing a major. The survey also measured the influence on the choice of major of family, friends, teachers, courses taken prior to coming to NAU, NAU faculty interactions, Gateway (professional) advisor interactions, the use of technology in the classroom, and classroom appearance. Because previous studies had proposed that the degree of prior exposure to a science is an important factor, we queried students on this with respect to biology, chemistry, earth science, environmental science, and physics. The survey also asked students to rate the five sciences in regards to environmental friendliness, prestige, employability, difficulty, and salary, and to rate the importance of these and other factors, including observing nature, working outdoors, and traveling, on choosing a major. In addition, the fall 2008 survey included questions designed to find out whether students hold negative perceptions of geologists that might discourage choosing geology as a major.

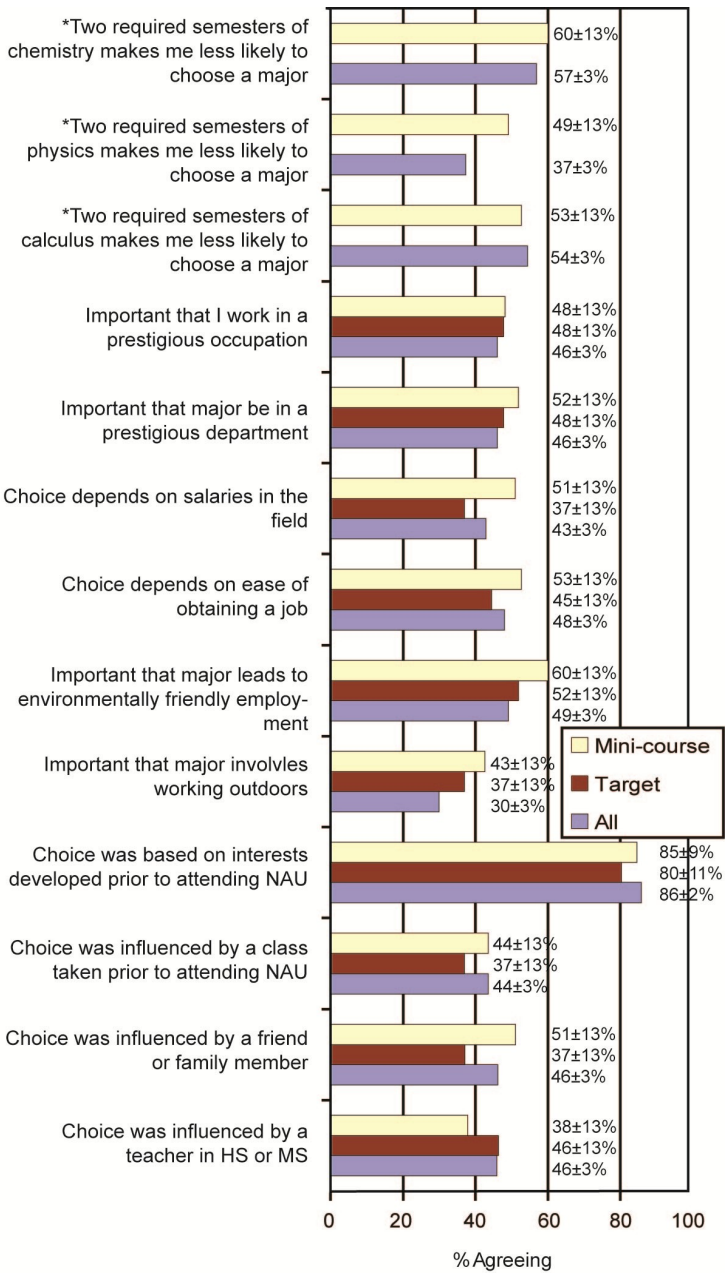

FIGURE 2. Moderate to strong influences on the choice of major. Percentage of respondents answering either "strongly agree" or "somewhat agree" to the question shown. Questions marked with an asterisk (*) were used to define the target group, as described in the text. Sample sizes: n=783 for all respondents, n=54 for the target group, and n=55 for the mini-course group.

A second survey of students in the introductory courses was conducted in the spring 2009 semester. The survey instrument (electronic Appendix B) was a modified version of the one used in the fall and consisted of 123 questions. On this survey, 27 students responded they had enrolled in the spring mini-course.

Also in the spring 2009 semester, we surveyed junior and senior geology majors about what led to their choosing geology as a major and what they think would be influential in persuading other students to do the same. Students provided anonymous written responses to three open-ended questions (discussed in detail later on).

INTRODUCTORY CLASS SURVEY DATA ANALYSIS

Our goals in analyzing the dataset were to determine (1) the number of potential candidates for recruitment, (2) whether the self-selected group of students who elected to take the field trip mini-course were more or less inclined to major in geology than everyone surveyed, (3) what factors influence the choice of major, and (4) what negative perceptions exist toward geologists or geoscience that might discourage students from choosing it as a major.

To determine the number of potential candidates for recruitment, responses from five agree/disagree questions were cross-tabulated. Students were considered to be candidates for recruitment if they indicated any uncertainty about their choice of major, were not put off by the geology program's requirements of two of semesters each of calculus, physics, and chemistry, and indicated a willingness to consider being a science major. This group of students is termed the target group. The precise criteria for defining the target group are given in Appendix C. Of 783 respondents, 54 (6.9%) were classified as belonging to the target group. Although a small percentage, it is a large number of students, in fact more than could be accommodated if they were all to choose to major in geology.

Of the 783 respondents, 25 identified geology as their major, and of these four belonged to the target group.

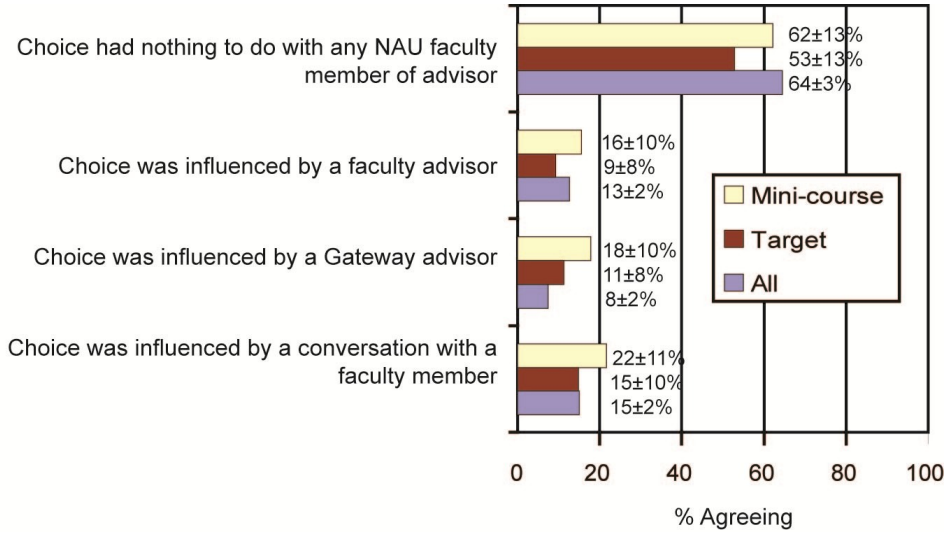

FIGURE 3. Weak influences on the choice of major. Percentage of respondents answering either "strongly agree" or "somewhat agree" to the questions shown.

Eleven geology majors were excluded from the target group because they responded "strongly agree" to the question "I will not change my major before I graduate;" these students had already been recruited. However, ten geology majors were excluded from the target group due to responses given on the other questions used to define it (Appendix C). These students either had issues with some of the program requirements or were not interested in majoring in a science, and were therefore likely candidates for changing their major.

In offering the field trip mini-course, it was theorized that students who were more inclined to major in geology would self-select into the course, and that it would make a positive difference in moving students toward the decision to major in geology. However, of the 55 students who responded they had enrolled in the mini-course, only 3 students (5.6%) were in the target group, essentially no different in proportion than for all 783 respondents. Thus, the premise that potential candidates for recruitment would self-select into the mini-course is untrue, as 51 students in the target group (94%) opted not to take it.

The surveys identified a number of influences on the choice of major (Fig. 2). Weak influences include faculty advisors, Gateway (professional) advisors, and conversations with NAU faculty, whereas moderate to strong influences include friends, family, school teachers, and courses taken before coming to NAU (Fig. 3). This is consistent with the study of Trend (2009), who found that family and social pressures exert a dominant influence on the choice of major. In addition, the surveys identified a number of factors that are potentially beneficial to recruitment in the geosciences. Students generally like

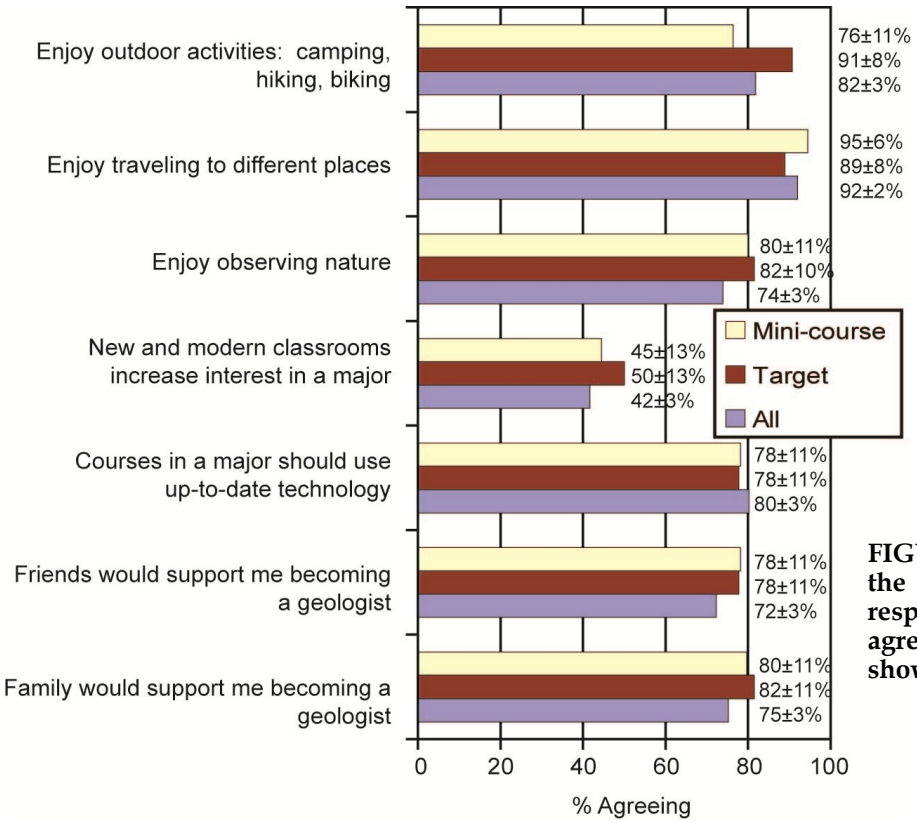

FIGURE 4. Others factors that may influence the choice of major. Percentage of respondents answering either "strongly agree" or "somewhat agree" to the questions shown.

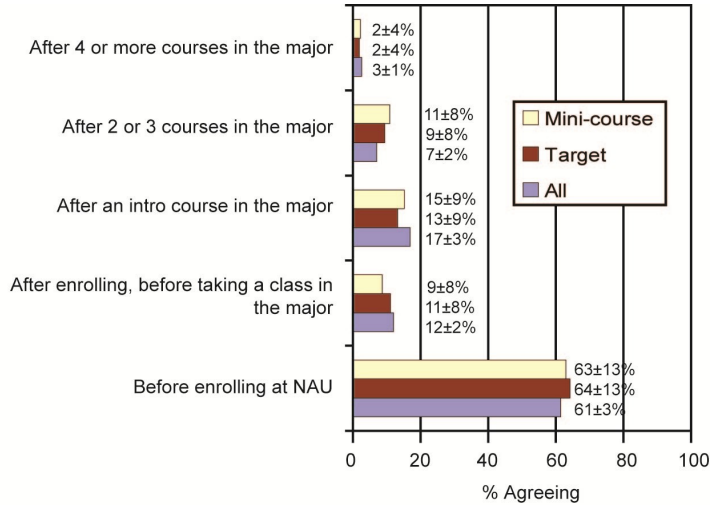

FIGURE 5. When the major was chosen. Percentage of respondents answering "strongly agree" or "somewhat agree" to the question "Which of the following best describes when you chose your major?"

outdoor activities, traveling, and observing nature, and many consider it important that their major be employable, lead to environmentally friendly employment, have good salary potential, and be in a prestigious field and prestigious academic department. In previous studies, earnings expectation and the potential wage returns for different types of knowledge were identified as key factors in choosing a major (Berger, 1988; Freeman and Hirsch, 2008; Montmarquette et al., 2002). In addition, students generally felt that courses taught in new and modern-looking classrooms increase interest in a major, and that courses in the major should use up-to-date technology (Fig. 4), although no data were taken in this study to determine where students stood on these questions in regard to NAU's geology program.

Questions were asked that probed when students chose their majors and how committed they are to their choices (Fig. 1, 2, 5 and 6). Some notable findings include the fact that 84% chose their major based on interests they developed before coming to NAU and 73% chose their major before taking a class in the major at NAU. The degree of commitment to the choice of major and the extent to which classes taken at NAU influenced that choice vary with class level (Fig. 6). In general, the higher the class level, the more certain students become regarding their choice of major and the more influence NAU classes had in that choice. For example, 22% of freshmen indicated they might change their major in the near future, whereas this was true of only 7% of seniors (Fig. 6). Also, 22% of freshmen said that an NAU class was influential in their choice of major, whereas this was true of 36% of seniors. In addition, 43% of seniors indicated they had changed majors at least once. Overall, these results indicate that although most students chose their majors before coming to NAU, many are uncertain about their choice and will opt to change it before they graduate, and by their senior year more than a third will have been influenced by classes they took at NAU. These are positive factors for recruitment potential from introductory classes.

PERCEPTIONS OF THE DIFFERENT SCIENCES

A large proportion of students rated employability, starting salary potential, and prestige as important factors in their choice of majors (Fig. 2). Questions were asked that measured perceptions of prestige of the different science occupations and of the academic departments that offer the degree programs (Fig. 7). The ratings of prestige of the different science departments are similar to the ratings of the science occupations. Both indicate that geology is the least prestigious of the science fields. When asked about starting salaries, students indicated that geologists earn the least of the different science professions (Fig. 8). In spite of these negative perceptions, students rated a career in geology as having the most potential for personal fulfillment relative to the other sciences (Fig. 9), with both target and mini-course groups diverging to higher ratings for all sciences, and the target group giving an especially high rating for geology (64% either strongly or somewhat agreeing that "I think working in a career related to geology would be personally fulfilling").

With regard to employability, students rated physics as significantly less employable than the other sciences, but there was little difference among the ratings of geology, biology, environmental science, and chemistry (Fig. 10). The target and mini-course groups had different views of employability than all students, rating all sciences much more employable and rating physics about the same as geology, chemistry and biology. The target group rated environmental science as much more employable than the others, whereas the mini-course group rated it about the same as the others (Fig. 10).

We asked students their perceptions of the difficulty of the different science degree programs (Fig. 11).

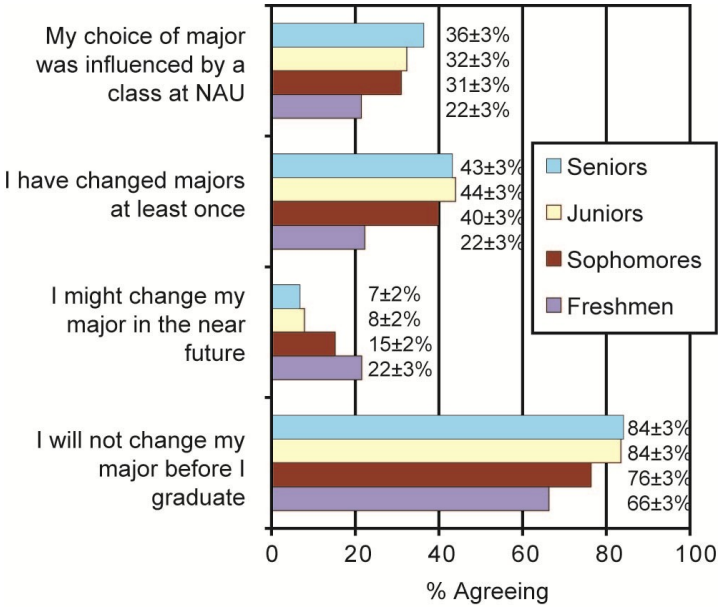

FIGURE 6. Questions whose responses correlate with class level. Percentage of respondents answering "strongly agree" or "somewhat agree" for the questions indicated broken down by class level for all students surveyed.

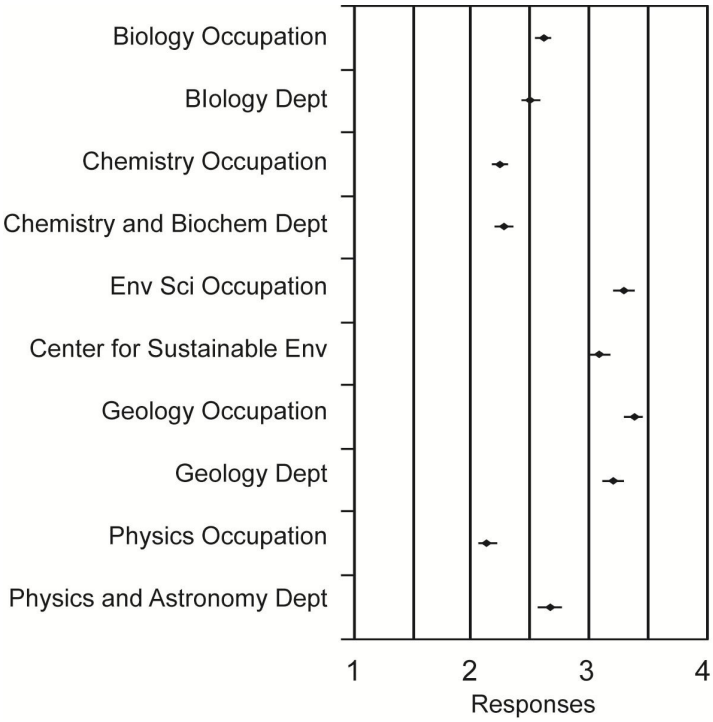

FIGURE 7. Perceptions of prestige of the sciences. Means and t-tests (95% confidence level) for all responses to the questions "Rate the prestige of each occupation" and "Rate the prestige of each science department," where the choices were 1=Extremely prestigious, 2=Very prestigious, 3=Somewhat prestigious, 4=Not very prestigious, 5=Not at all prestigious.

Geology was rated the least difficult and physics the most difficult. In 2009, both enroll small numbers of majors at NAU, whereas the biology program, which was rated intermediate in difficulty, enrolled about 10 times the number of geology majors. The ranking of perceived difficulty of a science is identical to the ranking of occupational prestige and starting salaries (Figs. 7, 8 and 11), the more difficult the more prestigious and the higher the expected starting salary. Following the method of Libarkin and Kurdziel (2001), the correlations among perceptions of difficulty, prestige and salary are further supported by calculated correlation coefficients (Table 1). Perceptions of prestige and difficulty are positively correlated. Salary expectations are also correlated with prestige and difficulty, the negative values of the correlation coefficients arising from the order of the salary categories on the questionnaire (1=lowest, 7=highest) in relation to the order of the difficulty categories (1=most difficult, 5=least difficult) and prestige categories (1=most prestigious, 5=least prestigious).

Herein lies a conundrum – 46% of students agree that the prestige of an occupation is important to their choice of major, but the above observations suggest that the difficulty of a science major, which correlates to prestige, is not. The explanation for this may be that these factors affect the choice of major in ways that are more complicated than the data show. For instance, the perceived difficulty of the physics program may be a deterrent to majoring in physics, but it is possible that the converse, a perceived lack of difficulty, is not an incentive for majoring in geology. Rather, it may be a disincentive due to the low prestige and low salary expectations that go along with a lack of difficulty. It appears that the optimal position with regard to difficulty and prestige for a science to attract large numbers of majors is to be in the middle.

We asked questions to determine how much exposure students had to the different sciences prior to coming to NAU (Fig. 12). As has been noted in previous studies (e.g., Gonzales et al., 2009), students receive less exposure to geology (or earth science) than biology, physics and chemistry in the public schools. This is consistent with our data, which show that students had higher levels of exposure to chemistry (98%) and biology (92%) than geology/earth science (65%) prior to coming to NAU. However, the undergraduate biology degree programs enroll about four times the number of majors as chemistry at NAU in 2009, which suggests that the relationship between prior exposure and choice of major is not straightforward.

We asked students their perceptions of the environmental friendliness of the different sciences (Fig. 13). Geologists fared well in comparison to the other sciences, being second highest in the perception of involvement in mitigating environmental problems (highest is environmental science), and low in involvement with polluting industries (very slightly higher than biologists and physicists, and much lower than chemists and environmental scientists). Thus, student perceptions of the environmental friendliness of geologists are on the whole positive relative to the other sciences.

ADDITIONAL CORRELATIONS WITHIN THE DATASET

Examining correlations among responses to questions is a useful tool for interpreting attitudes from survey data (Libarkin and Kurdziel, 2001, and Table 1). For example, correlations among the responses to the agree/disagree questions, "I am or will be a scientist," and "Before I came to NAU, I had learned a lot about biology [or chemistry,

TABLE 1. CALCULATED CORRELATION COEFFICIENTS AMONG PERCEPTIONS OF PRESTIGE, SALARY EXPECTATION, AND DIFFICULTY

	Occupational prestige*	Starting salary expectation*
Starting salary expectation*	-0.245**	
Difficulty*	0.431**	-0.188**

*Each question was asked for biology, chemistry, geology, environmental science, and physics. The questions were "Rank the difficulty of each type of academic major at NAU," "Rank the prestige of each occupation," and "Select which income range you think represents the average entry level salary for a graduate with a bachelor's degree in each field" (see Appendices A and B). The responses for all sciences were merged in these calculations.
**Correlation is significant at the 0.01 level (2-tailed)

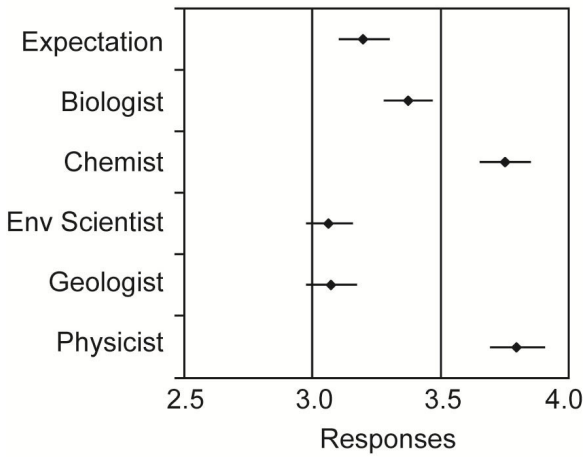

FIGURE 8. Perceptions of entry level salaries of the sciences and minimum salary expectations. Means and t-tests (95% confidence levels) for all responses to the questions "Select which income range you think represents the average entry level salary for a graduate with a bachelor's degree in each field", and "Which one of the following describes the minimum entry-level salary you would be satisfied with upon graduating with a bachelor's degree" (labeled "Expectation" on the plot), where the choices were: 1=less than $30,000, 2=$30,000-39,999, 3=$40,000-49,999, 4=$50,000-59,999, 5=$60,000-69,999, 6=$70,000-79,999, 7=>$80,000.

geology, environmental science, physics]" are useful in understanding the relationship between prior exposure to science and interest in becoming a scientist. Recalling that most students surveyed are freshmen or sophomores, correlations should be expected because it makes sense that a student who intends to become a scientist would have developed good knowledge of science prior to coming to NAU, whereas a student who arrives with little knowledge of science would probably not be planning a career as a scientist, at least not yet. As expected, students who agreed that "I am or will be a scientist" tended to also agree that they had learned a lot about science (generally all five sciences) prior to coming to NAU.

A number of correlations are informative on the subject of recruitment potential. Students who agreed with "I have changed majors at least once" also tended to agree that their choice of major was influenced by a class they took at NAU, by a conversation with faculty member, and by a conversation with a Gateway (professional) advisor. Students who agreed that their choice of major was made prior to coming to NAU tended to agree that their choice was influenced by a class taken prior to NAU and by a teacher in high school or middle school. Students who agreed that it is important that their major involves working outdoors tended to also agree that they are inspired to continue studies in geology by the lectures and labs of their geology class, would consider being a science major, consider it important that their major lead to environmentally employment, enjoy observing nature, enjoy outdoor activities, and that friends and family would support them becoming geologists. In addition, students who agreed that is it important to them that they work in a prestigious occupation and that their major be in a prestigious department also tended to agree that old-looking classrooms are a "turn-off" to a major and that new and modern classrooms increase interest in a major. Thus, for some students, the impression of prestige is influenced by the appearance of the classroom.

PERCEPTIONS OF GEOLOGISTS

The survey administered in fall 2008 asked students to rate geologists on 27 different attributes, to determine if geologists are perceived in ways that might discourage students from enrolling in the major. Ratings were from

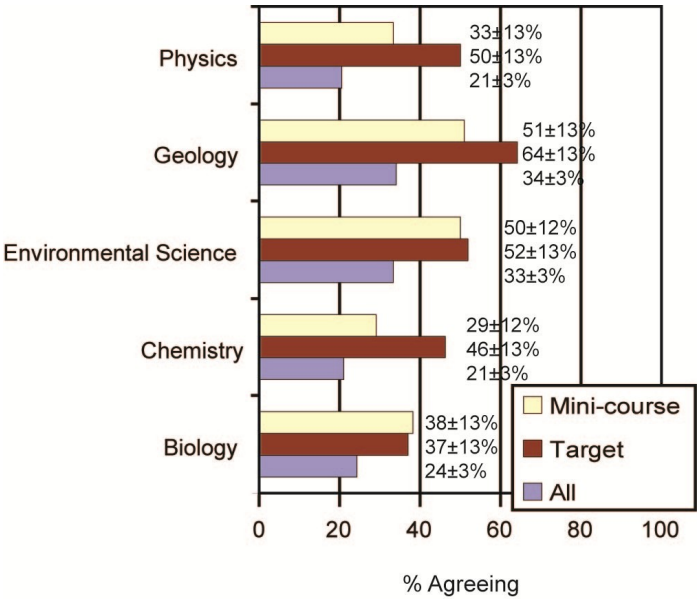

FIGURE 9. Perceptions of science careers. Percentage of respondents answering "strongly agree" or "somewhat agree" for the question "I think working in a career related to … would be personally fulfilling."

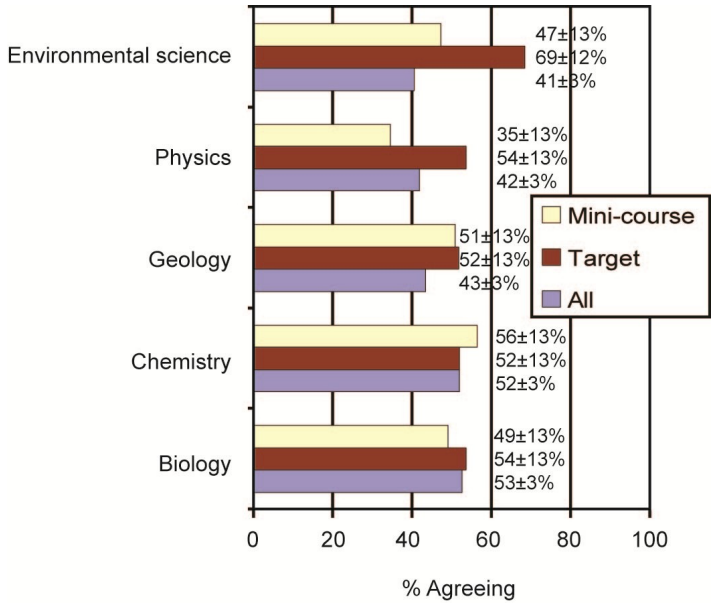

FIGURE 10. Perceptions of employability of the sciences. Percentage of respondents answering "strongly agree" or "somewhat agree" for the question "It is easy to get a job with a degree in …".

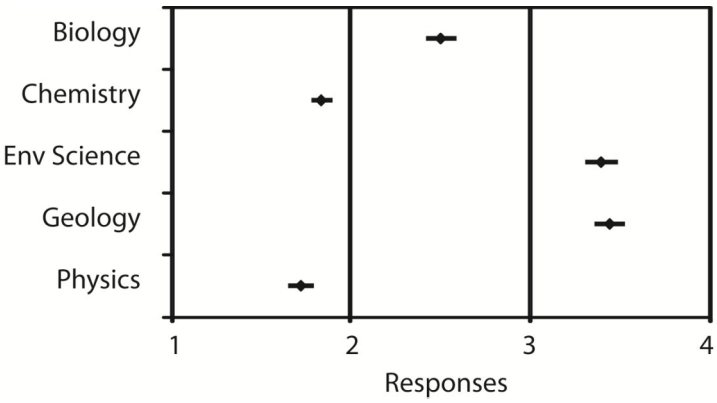

FIGURE 11. Perceptions of difficulty of science degree programs. Means and t-tests (95% confidence level) for all responses to the question "Rate the difficulty of each type of academic major at NAU" where the choices were: 1=Extremely difficult, 2=Very difficult, 3=Somewhat difficult, 4=Not very difficult, 5=Not at all difficult.

one to four, where 1=This adjective describes geologists very well, 2=This adjective describes geologists somewhat well, 3=This adjective does not describe geologists very well, and 4=This adjective does not describe geologists at all. According to the results, the adjectives that best describe geologists, in order from the strongest consensus to almost neutral, are intellectual, adventurous, hard-working, practical, patient, healthy, confident, outgoing, kind, funny, creative, sensible, fun-loving, liberal, nerdy, athletic, humble, cool, and awkward. The adjectives that do NOT describe geologists, in order from almost neutral to strong consensus, are artistic, spiritual, attractive, loner, religious, popular, clean-cut, and greedy. Of these results, the negatives are that geologists are strongly perceived to be not popular or clean-cut and mildly perceived to be nerdy and unattractive. Nevertheless, it was strongly agreed among the students that friends and family would support them becoming geologists (Fig. 4). It is unclear whether the negative factors are a problem for recruitment, considering the large number of contradictory positive factors.

SURVEY OF CURRENT MAJORS

During the spring 2009 semester we asked current junior and senior geology majors to provide anonymous voluntary written responses to three open-ended questions: (1) Describe what led to your choosing to become a geology major, (2) Describe the most compelling reasons for majoring in geology, and (3) What would you tell another student about the geology major that you think might influence them to consider majoring in geology? Twenty-three of 37 junior and senior geology majors provided responses. The responses were varied, but several themes arose.

To the first question, the most common responses were choice was inspired by an introductory class (9), interest in outdoor activities (7), interest in the earth (5), and interest in science (4). Others responses mentioned fewer than four times include interest in nature, interest in combining all the sciences, interest in fossils (especially dinosaurs), close relative is a geologist, interest in rocks, interest in oil and gas, interest in geologic disasters, and interest in the planets.

The most common responses to the second question were similar to the first: interest in field trips (8), interest in the earth (7), employment/career potential (6), interest in outdoor activities (6), interest in science (4), and interest in traveling (4). Others responses mentioned fewer than four times include interest in combining all the sciences, interest in fossils (especially dinosaurs), close relative is a geologist, interest in rocks, interest in geologic disasters, interest in the planets, opportunities for research, small class sizes, fun and helpful faculty, good and interesting classes, and a way to make a positive difference in the world.

The most common responses to the third question were to tell other students that the major involves outdoor activities (8), that geology has good employment/career potential (7), and involves field trips (5). Other responses mentioned fewer than four times are that the major is a good choice for someone interested in nature, science, the earth, rocks, and geologic disasters, and that the local area is ideal for studying geology. In addition, they mentioned telling other students that in the Geology Department there are good research opportunities, fun and helpful

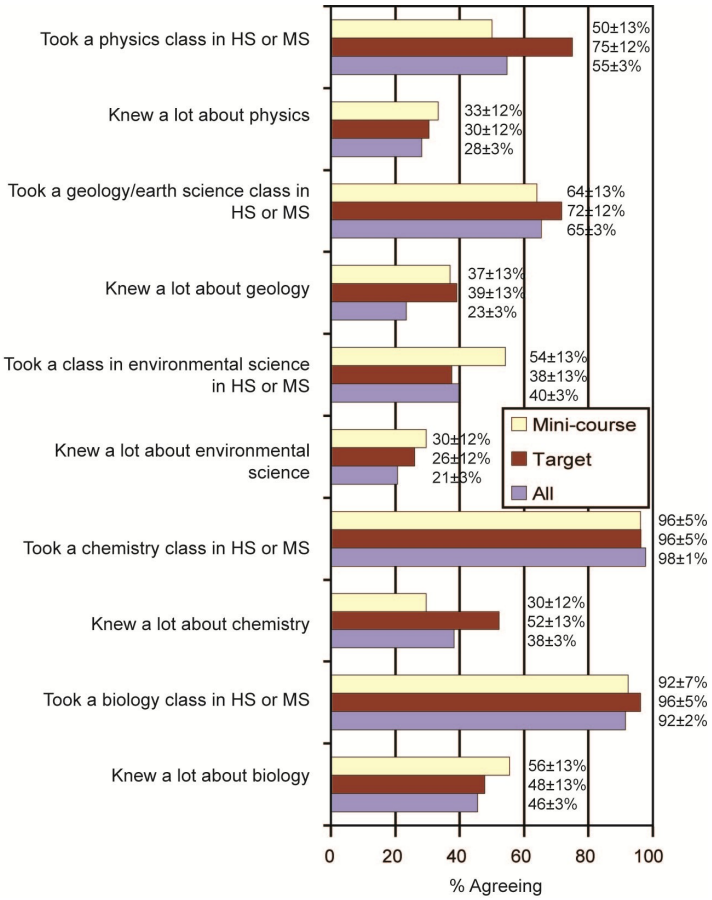

FIGURE 12. Prior familiarity with the sciences. Percentage of respondents answering "strongly agree" or "somewhat agree" for the question "Before I came to NAU, I had learned a lot about…", and the number of respondents answering "yes" to the question "I took a … class in high school or middle school."

faculty, good and interesting classes, that the major is good preparation for making a positive difference in the world, and that geoscience careers involve opportunities for travel.

The responses obtained from the survey of majors are broadly consistent with results of the survey of students in the introductory classes. According to the survey of majors as described above, the most influential factors are outdoor activities and field trips, interest in the earth, employment and career potential, and interest in traveling. With the exception of interest in the earth, which was not explicitly covered in the introductory class surveys, these factors were also of great interest or importance to students in the introductory classes (Figs. 2 and 4).

APPLICABILITY OF THIS STUDY TO OTHER INSTITUTIONS

To determine whether the results of this study are broadly applicable outside of NAU, similar studies will need to be conducted at other institutions. It is likely that the proportion of students belonging to the target group will vary at different institutions due to differences in admission standards, program requirements, and other factors. It is also likely that the factors that influence recruitment from introductory classes will vary at different institutions due to differences in the student populations, and vary over time due to changes in societal attitudes.

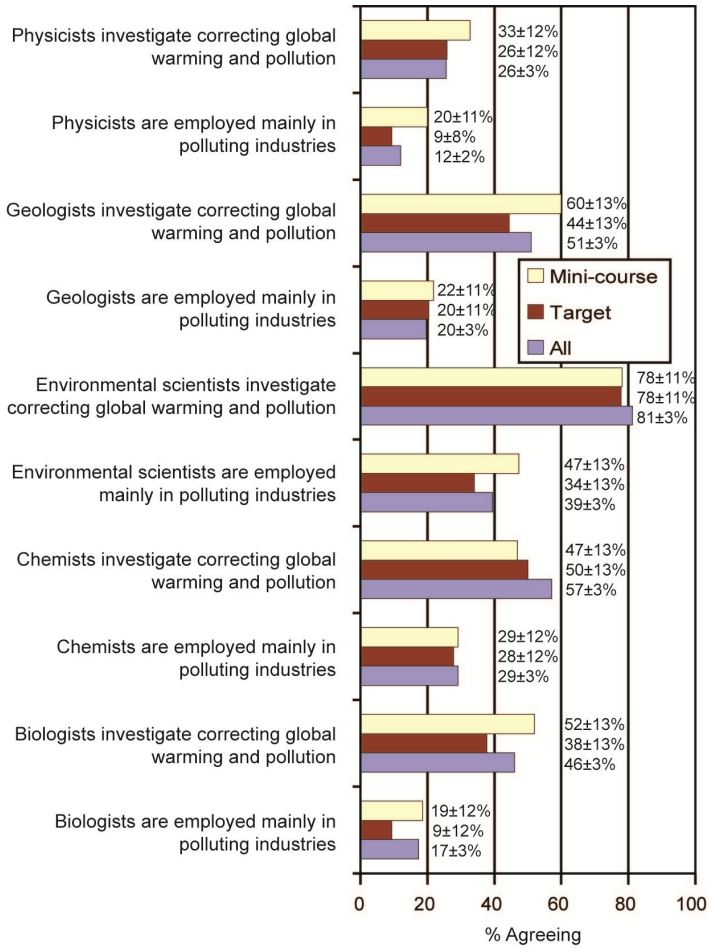

FIGURE 13. Perceptions of environmental friendliness of the sciences. Percentage of respondents answering "strongly agree" or "somewhat agree" for the questions "… investigate ways to correct global warming and pollution of the environment" and "… are employed mainly in polluting industries."

In order to make use of the survey instruments from this study at other institutions, the survey instruments (electronic Appendices A and B) will need to be adapted by altering or deleting certain questions. A number of questions are location-specific, referring to NAU, Flagstaff or Arizona – these will need to be modified to reflect the appropriate locations. If the requirements of the geology degree program differ from NAU's in regards to chemistry, mathematics, and physics (NAU's geology degree program requires two semesters each of chemistry, physics and calculus), then the questions that ask students whether these requirements make them less likely to major in a subject will need to be modified. The surveys ask students to compare their perceptions of five sciences degree programs offered at NAU, these being biology, chemistry, geology, environmental science, and physics. If the institution at which the survey is being conducted offers different degree programs, then these questions will need to be modified. In addition, the fall 2008 survey (Appendix A) asked students to identify the introductory geoscience course they were enrolled in, and the spring 2009 (Appendix B) instead asked students to identify their instructor. These questions will need to be either deleted or changed. Also, the question that asks whether students are enrolled in GLG208 will need to be deleted.

CONCLUSIONS

It was the goal of this study to identify factors, both positive and negative, that are important to formulating strategies for recruiting geology majors from large enrollment introductory geoscience classes at Northern Arizona University. Positive factors include good employability, good salary potential, and opportunities for working outdoors, field work, observing nature, travel, and environmentally friendly employment. In addition, although most students in the introductory classes decide their major before coming to NAU, many are uncertain about their choice and will opt to change it before they graduate. Seniors surveyed in the introductory geoscience classes indicated that more than a third considered classes at NAU to have been influential in their choice of major. By cross-tabulating the results of several survey questions (see Appendix C), a group of potential candidates for recruitment was identified that we termed the target group. It was determined that 6.9% of students in the introductory geoscience classes are members of the target group. Although a small percentage, it represents a large number of individuals (54 in academic year 08-09); in fact more than could be accommodated were they all to decide to major in geology. All of these factors suggest considerable potential for recruiting students into the geology degree program from introductory geology classes.

Several negative factors were identified that could

potentially discourage students from majoring in geology. Students view geology occupations as low-paying and low in prestige relative to the other sciences. They also view geology as the least difficult of the sciences. These perceptions could be countered by providing data to introductory students showing the salaries of geologists in comparison to other science occupations (e.g., Gonzales, 2009), and by communicating the rigorous nature of the more advanced classes in the geology degree program. Two positive factors that were identified are that students view a career as a geologist as potentially the most fulfilling of the sciences, and view geology occupations as being among the more environmentally sensitive of the science occupations.

Two other factors were identified as influential in a student's choice of major: new and modern classrooms, and the use of modern technology in courses in their major. Although we did not ask students to rate NAU geology classrooms in regards to their newness or whether they were satisfied with the use of technology in the introductory geology classes, it is nevertheless useful to know that these factors are important.

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Appendix A (electronic): Survey instrument used in fall 2008 introductory geology classes.

Appendix B (electronic): Survey instrument used in spring 2009 introductory geology classes.

Appendix C: Criteria for defining the target group. A student was classified as belonging to the target group if in response to "I will not change my major before I graduate," they gave any answer other than "strongly agree," and in response to "A requirement of two semesters of calculus makes me less likely to choose a major," they gave any answer other than "strongly agree" or "somewhat agree," and in response to "A requirement of two semesters of physics makes me less likely to choose a major," they gave any answer other than "strongly agree" or "somewhat agree," and in response to "A requirement of two semesters of chemistry makes me less likely to choose a major," they gave any answer other than "strongly agree" or "somewhat agree," and in response to "I would consider being a science major," they answered "strongly agree," "somewhat agree," or "neutral."

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