FACTORS THAT AFFECT A COLLEGE STUDENT'S ACADEMIC AND CAREER PATH IN SCIENCE/ENGINEERING-RELATED FIELDS

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INTRODUCTION

The alumni of the Research Science Institute are composed of over 600 highly gifted young men and women who each have been chosen to attend a special summer program of independent research and teaching. Each year since 1983 approximately fifty rising high school seniors from the United States who have already distinguished themselves as potentially outstanding future scientists and mathematicians are chosen in a highly competitive application process to work with outstanding scientists at a leading university. This program is presently based at the Massachusetts Institute of Technology and students are placed for research at universities throughout the Boston area. The RSI alumni represent intellectually equal groups of men and women who at an early age indicated a keen interest in pursuing a career in science and mathematics. Because of their importance to future national prominence in science and mathematics, the Department of Energy funded in 1992 a three-year study of the RSI alumni and their continuation and success in mathematical and scientific careers

A STUDY OF RSI ALUMNI

In October of 1992, the Center sent the first factually-based questionnaire to all RSI alumni. This was an exceptional cohort group of males and females because of their evenly matched exceptional talent and abilities, their early interest in science, early achievement in math and science, and a common summer research experience at the Research Science Institute. By spring of 1993, the first data assessing the achievements of the members of this special group and their continuation in science was completed.

1. The most striking discovery was that more than one RSI alumni in ten chose a nonscience major. Out of this group, women were responsible for almost all of the movement away from science. Thus, despite equivalent abilities, RSI women were leaving science and math at a rate many times that of their male counterparts.

2. Within those remaining in science fields women choose biology as a major
twice as often as men while male interests were evenly distributed among all scientific fields. However, from an original interest in biology on entering college, only one in three women finished an undergraduate degree in the biological sciences.

3. The critical years in deciding to leave science for RSI females began after the sophomore year of undergraduate studies and continued unmitigated through the years of graduate study. In contrast, the decision of RSI males to switch from science was at a low rate throughout the undergraduate and graduate years.

Since there was no measurable difference in native ability, experience, or scientific interest between RSI men and women, reasons for this unequal attrition of women from science/math studies and careers would have to be examined in factors of differences in environment and social milieu of men and women and/or their personal factors of value systems, perceptions, and life goals. Secondly, since the movement away from science by women once begun after the sophomore year continued, it appeared that the final decision to leave a scientific path was not a single precipitous event but rather an evolution of a series of earlier, less final critical points at which continuation on such a path was questioned. The questions to be asked then became: 1) when did this decision process begin? 2) what were the causative factors for a decision to turn from science and math at any particular point? and most importantly, 3) what would have altered this decision process? Stated simply, what factors are needed for continual commitment to a science/math career. The study of the RSI alumni then moved into Phase II, definition of the factors involved in the attrition of RSI women from science and math careers and formulation of recommendations to prevent this attrition.

RESEARCH ON RSI ALUMNI ATTRITION AND RETENTION IN SCIENCE

Four methods research were used to unravel the reasons why RSI women have a higher attrition rate than RSI men from science careers and the key factors needed to retain more women and men in these careers: 1) relevant findings from other studies; 2) testimonial letters from RSI alumni; 3) cognitive interviews of RSI alumni; and 4) construction and analysis of Questionnaire II that probed the environmental and personal factors identified by the first three methods as significant factors in continuation of a science career.

Letters of Testimony

Findings from other researchers on reasons for the higher attrition rate of females than males from science careers were reflected in testimonial letters from RSI alumni. In the fall of 1993, RSI alumni were asked to respond in writing about their view of science and math studies and careers and factors necessary for a successful career.
They were also asked if they were to leave science, what would be the deciding factors. Responses from both men and women had several unifying themes:

1. The minor number of women in science/math mentor and academic faculty roles was most often cited. Phrases such as “the professors are a bunch of old men”, and “the tutorial teacher is the only women I see and I seldom see her”. Isolation and observing only men faculty or in authority was cited as the reason for women leaving majors in mechanical engineering, electrical engineering, physics and chemistry.

2. The atmosphere of science was the second most cited reason for leaving describing it as “unfriendly”, and “highly competitive”.

3. The quality of science courses and teaching was also a factor in losing interest in a science career. Described as “boring”, and with “too much rigor with too little imagination” students lost interest in the subject matter.

4. Reasons for a choice of a nonscience field of study were often related to the new majors “emphasis on importance of people”, its “more natural and easier” subject matter, and conflicts of family and career.

Cognitive Interviews

To further develop an understanding of the reasons for attrition from science/math careers of RSI alumni and methods to possibly prevent this attrition individual and small group (3-6) cognitive interviews were done with a representative sampling of RSI alumni at the undergraduate and graduate level both within and out of science-related studies and careers. Each interview probed reasons for the individuals initial choice of a science career and then moved to a general question of “why persons leave science?” to “why women leave science?” and finally to “why would or did you leave science?”. Comparisons were made between male and females responses. Several striking factors were evident.

1. Although men and women cited the negative perception of scientists as a reasons for leaving science only men mentioned not being at the top or little independence as causative factors. Only women mentioned the “struggle” and “social isolation”.

2. When asked “why women leave science” both men and women answered “women are social, science is asocial”. Only women again cited being “beat by the system” and being “insecure in their ability”.

3. Finally, when asked “why would you leave science” only men spoke of “no available job” while only women mentioned “other interests”, “family needs” and again “loneliness”. When challenged with a difficult course(s) that may suggest leaving science as a career, only men responded with “letting the material wash over them” while only women responded with feelings of being “overwhelmed” and the material being “impossible”.

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Questionnaire II

Findings of other studies on the attrition of women and information from RSI alumni testimonial letters and cognitive interviews were assembled to construct Questionnaire II of the study under the guidance of Mathematica Policy Research Institute of Princeton, New Jersey. The objective of the instrument designed was to define the important factors in the attrition of RSI alumni from science and math careers especially for the women of RSI. Significant differences in responses between men and women could be used to design interventions for future RSI students and perhaps specifically for RSI females that would stop the higher rate of attrition of RSI females from science. The instrument designed asked the RSI alumni to respond to issues in a multiple choice, graded response, or scenario format. The general areas queried were a) reasons for the initial choice and final choice of majors, b) perceptions of science and math as career choices, c) reasons for future career choices, and d) responses to difficult academic situations presented in a case-study format.

Questionnaire II was sent to all RSI alumni from 1984 through 1995 in December, 1995. Presently, 60% of RSI alumni (294) have responded to Questionnaire II. 186 males and 106 females. Although, the sample of RSI alumni is not complete nor the analysis of the data, striking and interesting differences and trends in responses of men and women to questions based on key factors involved in continuation in science are already noted in the preliminary data.

Reasons for early choice of a science career
Although 90% of RSI alumni both male and female choose a science major upon entering their freshman year, the reasons for this choice differs according to gender. RSI women more often cite encouragement by family members and teachers and a greater opportunity to help others by science. RSI men in contrast more often cite their own native ability and interest as the primary reasons for choosing science. Correlated with this are gender differences in the initial choice of career setting and working environment. Women cite a setting in which there is an opportunity to help people while men choose a setting because it provides an opportunity for creative initiative.

Science versus a nonscience college major
Sixty percent of RSI women and sixty-four percent of RSI men have changed their freshman plan of study by the time they declare their first major. For men, although they may change their field of science approximately 90% still remain in science at the time they declare their final major while womens' numbers increase progressively toward nonscience choices as they change majors.

Perception of difficulty of science careers and lives of scientists
RSI students, male and female, are equally interested in science careers during high
school and early college as evidenced by their performance, hobbies, and self-selection for RSI. During the course of undergraduate and graduate studies, the perception of science and scientists may change from positive to negative for those choosing another career path. When the RSI alumni were queried as to their perception of the practice of science, women were notably more negative about the extreme competitiveness of science than men. Both men and women agreed on the perception that a scientific career is more difficult for a woman but only women strongly agreed that a scientific career creates family conflict, leaves women isolated, and is more discriminatory to women. Women strongly agreed that science is as difficult for men as it is for women.

Reasons for choosing graduate school and career settings
Ninety percent of both RSI men and women strongly agreed as to the importance of attending graduate school. After completing their graduate education, women in choosing an area in which to work and its setting choose their work and an opportunity to help people as important factors. For men the level of income was more important than for women in the choice of type of work and setting.

Ways to cope with difficult academic situations
RSI alumni were asked to choose the best response to six common though difficult situations that arise during the undergraduate and graduate years. The ability to successfully cope with such difficult situations without losing self-confidence may be key factors in the continuation in a science career path. Faced with a difficult course, women more than men choose to find a tutor rather than work in a group or speak to the instructor. For someone struggling with the relevance to humanity of mathematical or scientific studies during university, women more often than men suggested an immediate practical solution and decision based on present experiences such as a summer internship. Males focused on long range goals and suggested more than women that the person “not worry, relevance will come with time”. In a difficult graduate school situation when a relationship and dual positions in the same location cannot be found, males more strongly than women suggested that they should decide who will be the primary earner and then compromises should be made by the other party. For someone who considers themselves a minority and is having trouble with that status, women more often than men responded by suggesting the person find a role model and network with other minorities.

Although not complete, the RSI study is a singular and highly significant study. Its cohort of ability-matched males and females facilitates gender comparisons of personal attributes essential for career success and differences in gender responses to environmental and social challenges in a math/science career path. This study is equally applicable to the challenges, social and personal that high-ability women face in pursuit of an eminent career in business, politics, and industry as well as academics. Findings of this study will lead to recommendations for interventions for retention of
high ability women in the nation’s talent pool and insurance of achievement of their full potential. It is the hope of the interventions and training designed as a consequence of this study that women will be protected from imbibing self-defeating socialization patterns and that in time the increased numbers of highly-talented women as are in the RSI will achieve at high levels in math and science and change the environment in which they must operate.