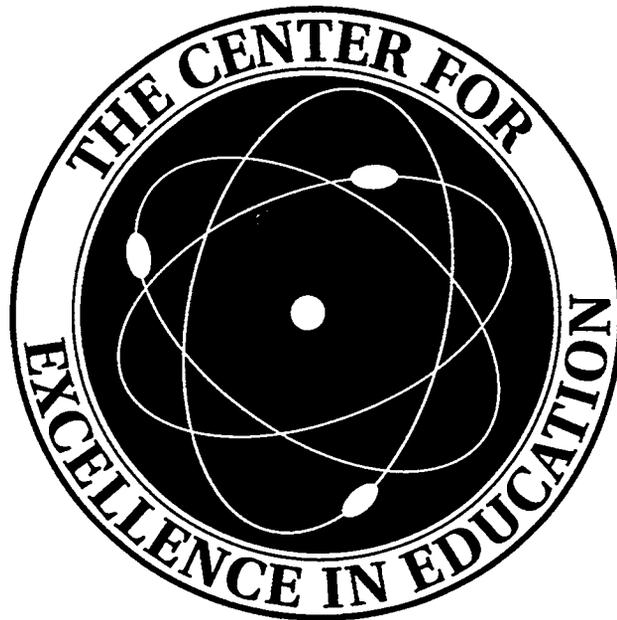


DOE/ER/75715-T2

# REPORT ON ENHANCING YOUNG SCHOLARS

## IN SCIENCE AND TECHNOLOGY

### THE CENTER FOR EXCELLENCE IN EDUCATION



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## **I. INTRODUCTION and SUMMARY OF STUDY**

## **NEED AND IMPORTANCE OF THE STUDY OF RSI ALUMNI CAREERS**

The present stock and flow of highly talented young persons engaged in the global discovery and application of science and technology are critical to the future pace of innovation. Historically, the world's largest reservoirs of scientists and engineers have been in the Western economies. Overtime, however, Asia has begun to build equivalent pools of scientists and engineers among their university graduates. According to 1993 data from the National Science Foundation and the UNESCO World Science Report, Germany leads all economies with a 67% ratio of science and engineering degrees to total first university degrees compared to the United States with a distant fifth place at 32% behind Italy, Mexico and Poland. If the nation is to keep its scientific and technological prowess, it must capture its very best talent in the science and technology fields.

The question is then raised as to the source within the United States of the science and technology talent pool. While between 1978 and 1991 there was an overall decline in male participation in undergraduate (-9%) and graduate degrees (-12%), the number of women receiving undergraduate (+8%) and graduate degrees (+34%) rose dramatically.. These numbers are encouraging for women's participation overall, however, women earn only a small percentage of physical science and engineering degrees. Why are there so few women in mathematics, engineering, and the physical sciences? The answers are complex and begin early in a woman's exposure to science and mathematics. In a NRC study on student attitudes in science and mathematics, it was found that by grade 12 the gap between male and female positive attitudes in science was 17%. Approximately 60,000 more women than men who initially liked science and mathematics in grade 4 had already abandoned it as a career by grade 12.

But what of the young men and women of the Research Science Institute who have already demonstrated their talent and interest in science and/or mathematics by grade 12. These young people need little encouragement to embark on studies and career goals in science and technology. However, the question of "staying power" of RSI alumni in pursuit of science and mathematics careers has been a question of the Center for Excellence in Education since the late 1980's. During this time, anecdotal stories of the greater attrition of RSI females than RSI males from science and mathematics were being reported to the Center. This was particularly disturbing considering the equivalence in ability of the two groups in native ability, academic performance, summer research experience, and scientific interests. The mean PSAT scores for females was 1444, that of the males 1450. As the number of reports of young women leaving science and math filtered back to the Center the initial response that "these girls are bright, they will figure it out" became suspect. An urgent need to determine unequivocally the patterns of loss of RSI women and men from science and math studies and careers, and most importantly define the reasons for this attrition.

## **PHASE I : DISCOVERY AND CRISIS**

In fall of 1991 the Center for Excellence in Education submitted a grant proposal to the Department of Energy requesting funds to study the career paths of RSI alumni in science and technology careers. In the spring of 1992, the U.S. Department of Energy awarded a grant to the Center to support two projects designed to retain high ability RSI students in science and math careers paths. The first project was a three-year study to identify the factors that enter into a student's decision regarding his or her continuation in a science/math career path. A special focus of the study was to determine reasons for the postulated high attrition rate of female students from such careers. Ultimately, a goal of this study was to identify and prioritize the most effective interventions in preventing this talent loss. A second project was to provide summer employment to the RSI alumni.

In October of 1992, the Center sent the first factually-based questionnaire to all 1984-1992 RSI alumni. This was an exceptional cohort group to study because of their talent and exceptional abilities, their early interest in science, early achievement in science and math, and a common summer research experience at the Research Science Institute. By spring of 1993 the first disturbing discoveries were made:

-More than one RSI alumni in ten chose a non-science/math major. Out of this group, women were responsible for almost all of the movement away from science. While 20% of RSI women had left a science related career, only 7.6% of males had made similar career changes. Thus despite equivalent abilities, RSI women were leaving science and mathematics at a rate three times that of men.

-Male interests in science and mathematics were more evenly distributed among the scientific fields, but females choose biology twice as often as males. However, from an original interest in biology only 1 in 3 women finished an undergraduate degree in biological sciences.

-At the undergraduate level, the first choice of a major for RSI women was a nonscience field, for RSI men a nonscience major ranked seventh.

-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 both the undergraduate and graduate years.

Since there was no difference between RSI males and females in native ability, original science and mathematics career interests between males and females, and since both had a common supportive RSI experience with continued networking, one has to examine other factors as possible explanations for the greater attrition of females than males from science and technology fields. One major factor may be the woman's experiences in and responses to in the environment and social milieu of science and mathematics. Another factor may be the different personal value systems and psychology of the two groups.

It was at this time that the concept of a "Career Decision Tree" was born. The movement of women away from science and math was postulated to be due not to one, but a series of decision points. The questions to ask then became 1) when did this decision process begin, 2) what were the causative factors for a decision to turn away from science and math at a particular point, and most importantly, 3) what would have altered this decision. In short, what factors are needed for continual commitment to a science/math career. Once the attrition of RSI females from science and math exceeded those of RSI males had been statistically substantiated, the study moved to Phase II, the growth and transition phase, to try to define the major factors involved in this attrition.

## **PHASE II: GROWTH IN UNDERSTANDING OF THE PROBLEM THE TRANSITION PHASE**

Four methods were used to unravel the reasons why RSI women have a higher attrition rate than RSI men from science and math 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 of questionnaire II that probed the environmental and personal factors identified by the first three methods as significant factors in continuing or leaving a science/math career.

### 1. Relevant Findings from Educational Researchers on Science Careers and Women

A major category of explanations of women's attrition centered on social environmental factors within science and mathematics is contained by phrases such as "the chilly climate" and "microinequalities". These include lack of female role models in science, lack of mentoring, feelings of a minority status, the extreme competitiveness of science in the classroom, the lack of encouragement by instructors, and cultural differences in mentor and student relationships. The second category of social factors centered on societal expectations. Society and the media give mixed messages of the relative importance of the multiple roles women must play. Often families unconsciously have differing expectations for male and female children especially in regard to career focus. Finally early schooling gives mixed messages. The final effect is a confusing set of signals about family and career, strength and feminine attractiveness, assertiveness and initiative versus being chosen by the male, and expectations of level of attainment in a career. Mixed messages result in the feeling of being a second-rate citizen and lack of self-confidence.

For a student considering a particular career goal the image or perception of the teacher or professor in a given chosen field portrays to the student the supposed quality and practice of life in this field of science or math. For many students the scientist and mathematician have highly negative, self-centered, workaholic images which are less likely to be emulated by aspiring young mathematicians or scientists. Students often make a short term decision to change majors based on projection of avoiding a future life style. The negative image of scientists and mathematicians as asocial also keeps students from approaching them for advice or mentoring. Often factors pertain to the content of science courses and the teaching methods. For many students the content is dull and taught in a mechanistic manner.

Women's personal choices also greatly affect their careers. Early decisions to enroll or not enroll in math and sciences has ramifications later in terms of longitudinal training characteristic of mathematics and science degrees. Motherhood, marriage, and career conflicts cause considerable anguish for women trying to do it all well. Affordability of quality day care still plagues our society.

Harriet Zuckerman and Jonathan Cole both speak to the concept of "accumulated disadvantage". In the paradigm of a decision tree this would mean many smaller factors or events deter or push a student away from a science/math career at critical points over a long

period of time. Ultimately, influences accumulate for the "other" path and continuing in math/science seems futile and success impossible. It is at this time that the decision to change majors or careers takes place. The key issue is, thus, how to aid or support the student at the time of a critical decision to leave science and math and proactively to reduce the "accumulated disadvantage" over the career path of the student.

## 2. Testimonial Letters from RSI Alumni.

In the fall of 1993, RSI alumni were asked to respond in writing 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. There was a considerable outpouring from both men and women with several unifying themes.

### *Absence of Women*

"professors a bunch of old men"

"tutorial teacher is the only woman and see her seldom"

"culture is masculine"

"isolation"

"out of chemistry because 'taught by all men'"

"out of mechanical engineering because only a "bunch of old men"

"switching from electrical engineering because no women"

"dropping physics because "all men and very intimidating"

### *Atmosphere of Learning*

"unfriendly"

"highly competitive"

"very competitive"

"out of math because an 'unfriendly atmosphere' "

### *Quality of Science Courses*

"professors are boring"

"physics -- too many problem sets and calculations, like concepts better"

"turned off by rigor and lack of imagination of physics courses"

### *Other Fields Easier and More People Oriented*

"politics more natural and easier"

"leaving computer science to help people"

"people more important than problem sets"

"leaving physics because so tired - love science, but cannot do family too"

### 3. Cognitive Interviews of RSI Alumni

In January of 1995, 29 RSI alumni, undergraduate and graduate men and women, including those with and without science or mathematics majors, were interviewed for 30 minutes each on their views and reasons for continuing or leaving a math/science career path. The interviews were based on cognitive interview methods. Students were asked initially to relate a life experience that solidified their interest in a math/science career. Starting at this point questions led from why persons in general chose or leave math/science studies through individuals to, finally, why women do so. Comparisons were made between male and female responses. A condensed preliminary sample of the findings of the interviews follows.

	<u>Male response</u>	<u>Female response</u>
Why did you chose science?	My ability My interest Encouragement Early successes Good social scene ---	My ability My interests Encouragement Early successes --- Respect of peers
Why do PERSONS leave science?	Negative perception of scientists Little independence Not at top --- --- ---	Negative perception of scientists --- --- "Struggle" Aggression Social isolation
Why do WOMEN leave science?	Women are social Science is asocial Men 'need' a career --- ---	Women are social Science is asocial --- "Beat by the System" "Insecure in Ability"
Why would YOU leave science?	No money to study No available job --- --- ---	No money to study --- Other interests Family needs Loneliness

What is needed to succeed?

"Tough"

"Tough"

"Assertiveness"

"Assertiveness"

"Competitiveness"

"Competitiveness"

---

Ability to 'present'

---

Not to stand 'down'

How do you handle very difficult courses?

"Wash over me"

"Overwhelmed"

"Understand later"

"Impossible"

Read widely

Reread same material

Blame others

My own problem

Findings of other studies were compared and compiled with the information provided by the RSI alumni from the cognitive interviews and testimonial letters. This resulted in the construction of Questionnaire II under the guidance of the Mathematica Policy Research Institute of Princeton, New Jersey to assure a no gender bias in its construction. The Mathematica Policy Research Institute conducts studies and surveys for the National Academy of Sciences. The instrument designed by the Institute asked RSI alumni to respond to the listed issues in a multiple choice, graded response, or scenario format. The investigated issues included:

- a. Choice of science/math discipline at end of high school and why chosen.
- b. Choice of first major in college and why chosen.
- c. Reasons for switching majors and when switched.

Areas investigated include influence of persons, perceptions of scientists, careers, own abilities, family, courses taken, atmosphere of science value to humanity.

- d. Factors associated with courses that were negative, such as, content or teacher.
- e. Changes in perception of science and math and scientists over years of schooling.
- f. Changes in perception of the place of women in science and their successes.
- g. Reasons for personal future career choices.
- h. Responses to scenarios that may underscore differences in male and female responses to a given problems. These include handling a difficult course, value of a math/science course, conflicts in family needs, impact of grades, and importance of being at the top of the class.

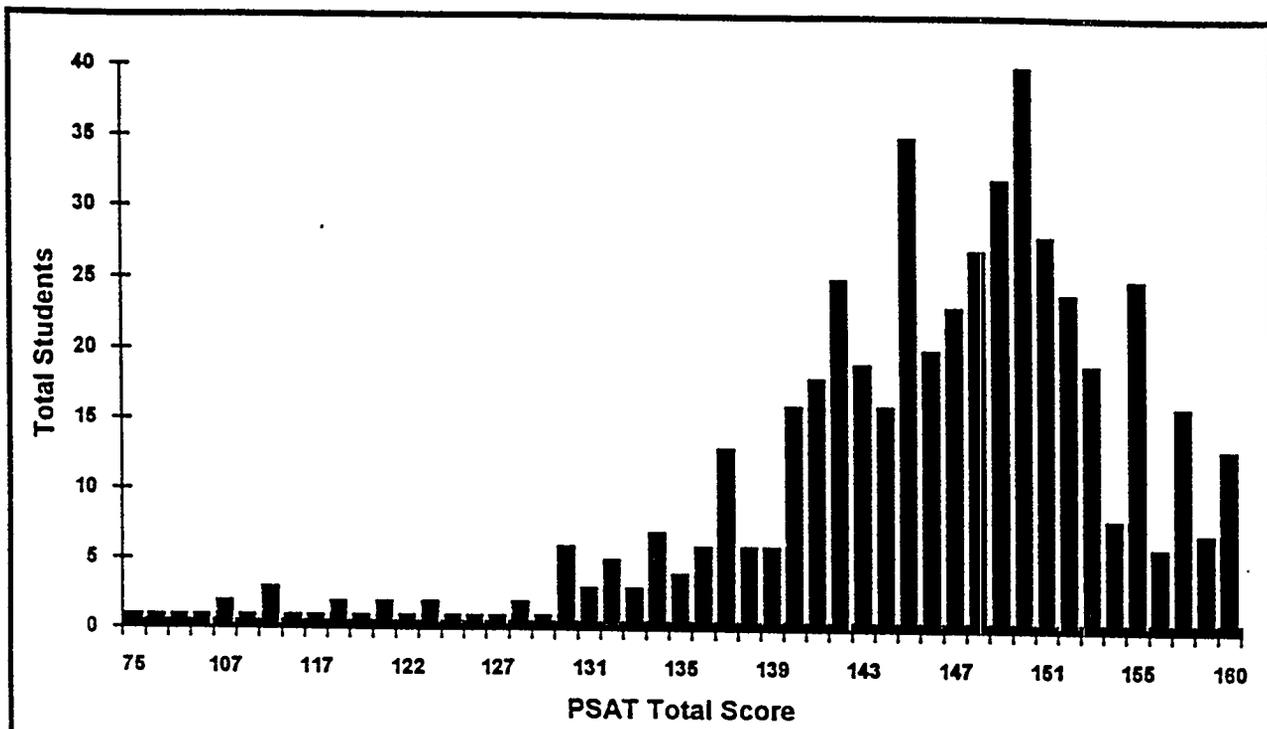
Questionnaire II was distributed to RSI alumni in December, 1995. Initial analysis was reported to the Department of Energy on July 2, 1996. Section V of this report contains the data collected from Questionnaire II with critique notes of analysis of results. Section VI suggests interventions to mitigate the loss of talented men and women from science/math career paths based on factors identified from Questionnaire II analysis needed for choice and continuation in such careers.

**II. FACTUAL INFORMATION ON RESEARCH SCIENCE  
INSTITUTE COHORT**

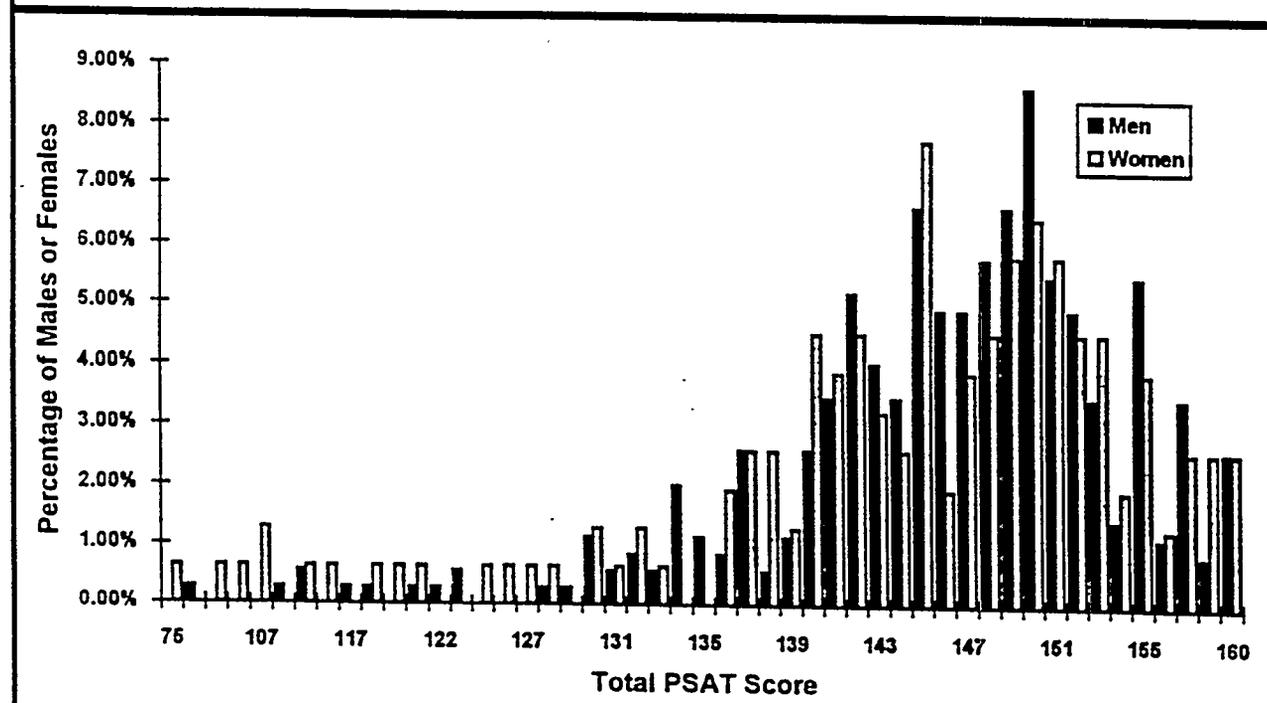
SINGULAR POSITION OF CEE TO STUDY THE ATTRITION/RETENTION OF  
YOUNG WOMEN IN SCIENCE FIELD

1. Extraordinary
  - a) cohort group of matched boys and girls
  - b) ten-year longitudinal database
2. Vast network of support services for students over past and future years.
3. Lateral study over many fields of math and science.
4. Singular database allowing high-school, undergraduate, and graduate longitudinal studies.
5. Because of ten year history, remarkable network of interest in cohort group by Women in Science.

\* \* \* \*



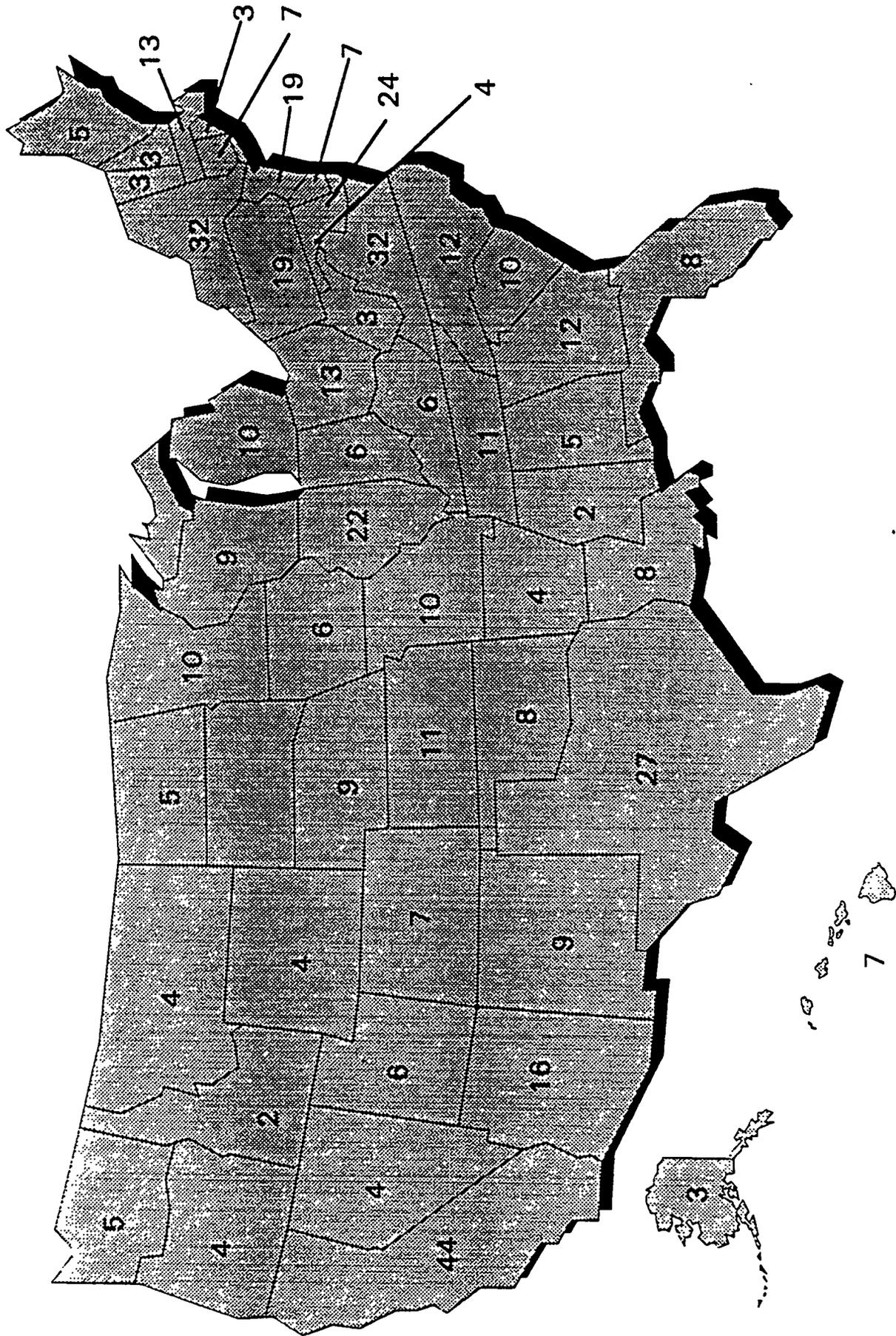
Total PSAT scores for all students



PSAT Score Comparison By Percentage of each Sex

The top graph shows the PSAT score distribution for all students who have attended RSI since 1984.  
 The bottom graph shows a comparison of PSAT scores of the number of each sex as a percentage of that sex.

# Each State's RSI Representation



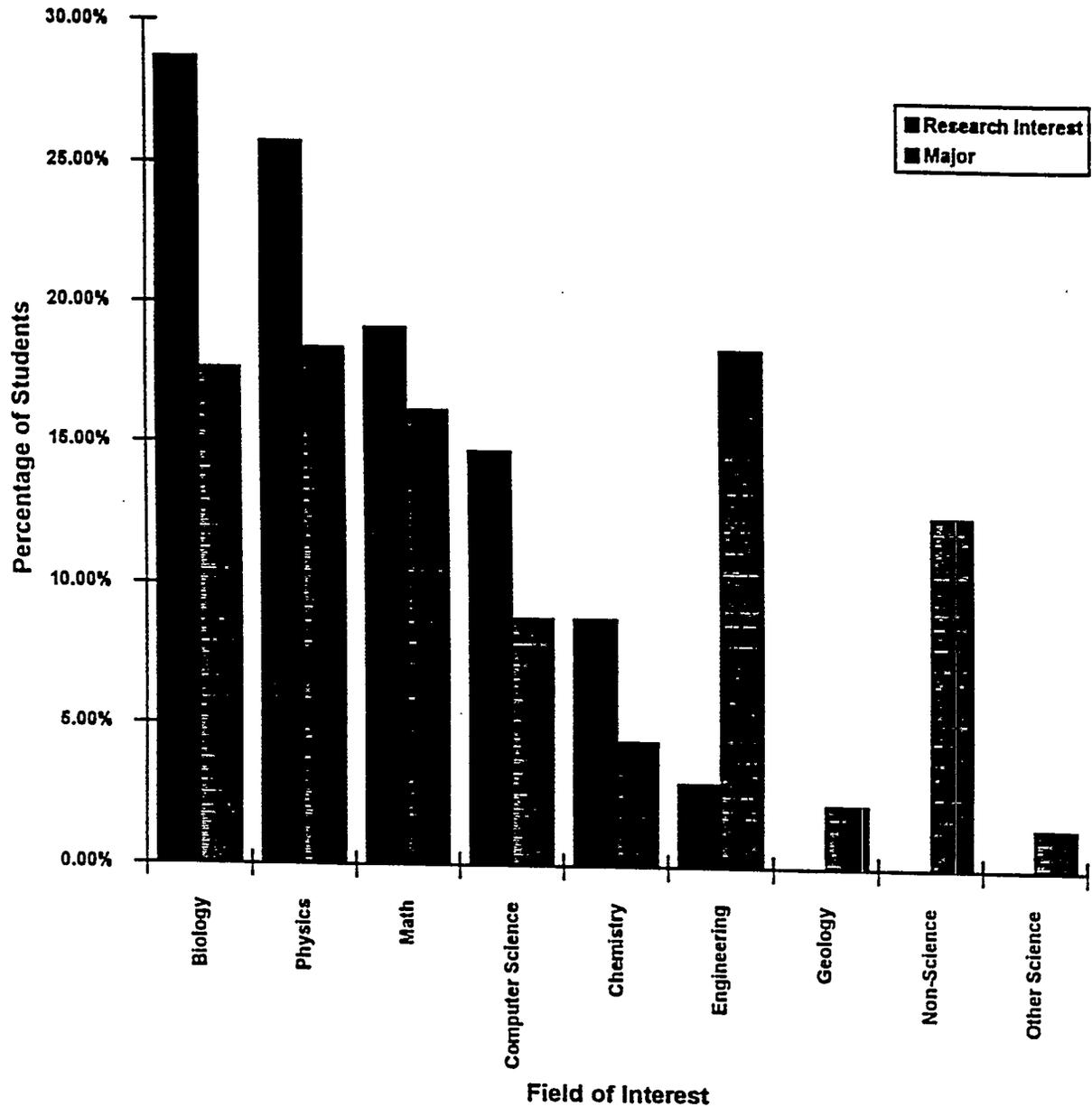
### **III. MAJOR FINDINGS OF PHASE I OF STUDY**

## **Preliminary Conclusions from the Available Data Received to Date DOE Funded Research 1992-93**

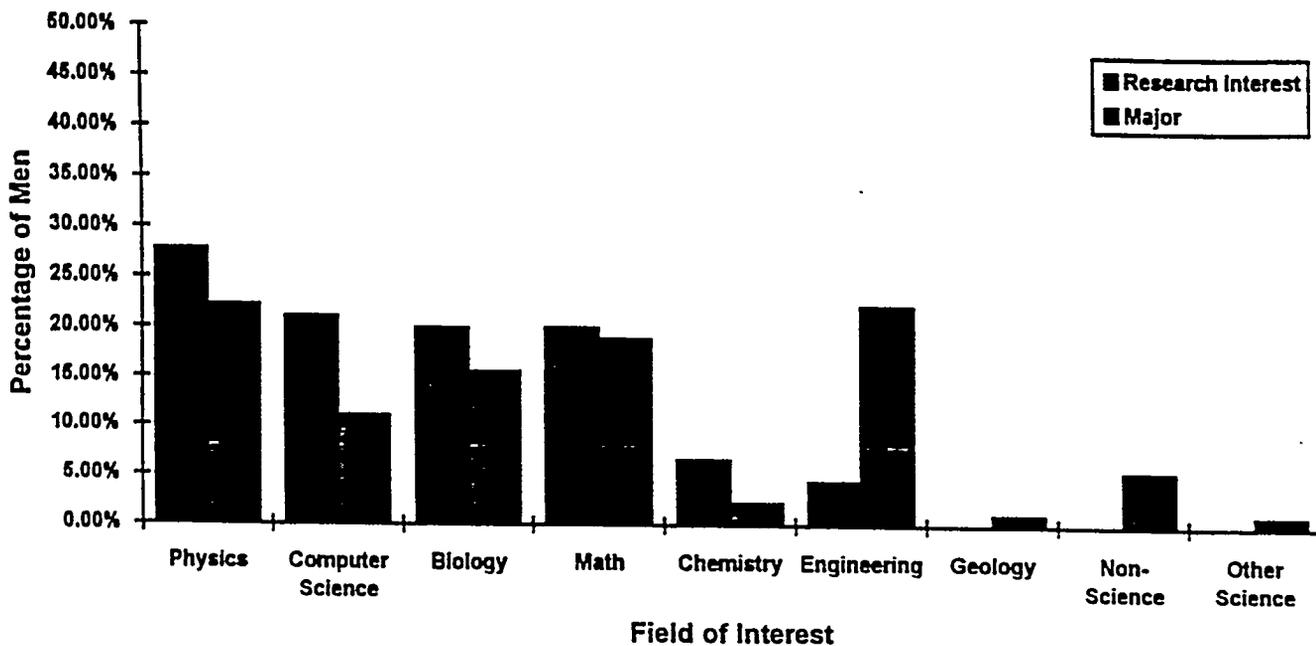
In October of 1992, the Center for Excellence in Education began a survey to determine how alumni of its Research Science Institute (RSI) program made their career decisions. The study's aim is to identify the crucial points in each student's life at which he or she makes decisions about which field or career to pursue. The study was prompted by a recognition that a disproportionate number of females opt not to follow paths to scientific careers. The rationale behind using the RSI alumni as the study's sample is that they constitute a geographically diverse and uniformly very high ability group. In addition, they are in every year between senior year of high school and fourth year of graduate school, which provides an opportunity to observe each stage in the process of choosing a field and subsequently choosing a career. So far 310 out of 524 questionnaires have been received; 93 of the respondents are female out of a possible 163, and, of these respondents, 188 were of sufficient age and had provided sufficient data to be included in the sample used to compare RSI research interest with college major. The following are preliminary conclusions drawn from the available data received to date, which is depicted in the graphs:

- When both sexes are considered, the only categories making true gains are engineering and non-science. The other two increases, geology and other science, could be traced to the students' exposure while in college to a greater breadth of options.
- One of every seven students who not only are very interested in science, but also are very good at it will not pursue even a college major in it.
- Male interests are fairly evenly distributed among the scientific fields in both high school and college, but females have a marked preference for biology. A woman is twice as likely to be in biology as she is in any other single field.
- Women are clearly responsible for almost all of the movement away from science. Fewer than one man in ten has given up science as his chosen field, but almost one in three women has done so. Women appear nearly four times as likely to move out of science as men.
- Academic and professional fields are the most likely areas for parents of alumni. These parents are more likely to be working in medicine or as industry scientists or engineers than they are in academia, but academia remains, by far, the largest single category.
- A vast majority of parents of alumni are in occupations which have required or still require a long association with education. Given these facts, it seems that almost all of those attending RSI have been raised in an environment that encourages scholastic achievement.
- The PSAT graphs include the mean score for the males is 146 and for females 143, which are in the top one percent of all PSAT scores.
- The means are within two percent of each other, and therefore seem to present two very similar populations. Having the groups so similar should preclude having attrition due to inability.
- The map indicates that the population is geographically diverse.

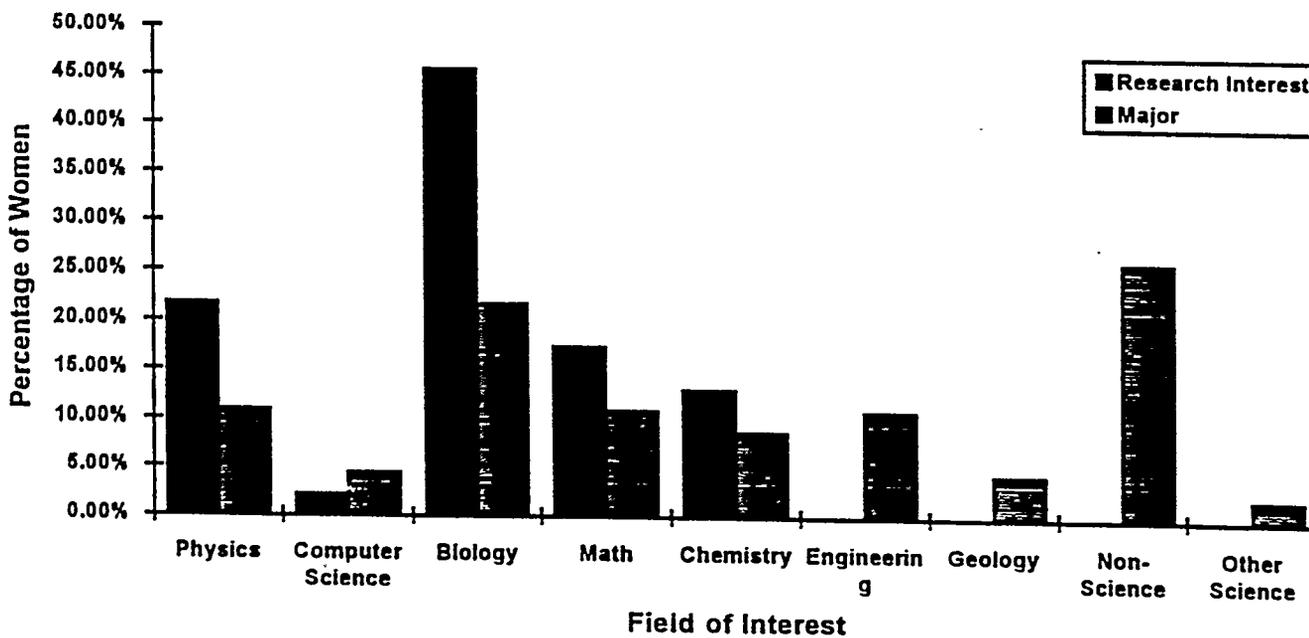
## All Students' RSI Interest and Undergraduate Major



This chart uses 188 of the 310 respondents to the preliminary questionnaire as a sample to illustrate changes in field of interest. This sample consists of all respondents who have either graduated from college or chosen a major. The data on this chart and the next two comes from this sample. The comparison is between the student's declared field of interest on his/her RSI application and his/her undergraduate major.

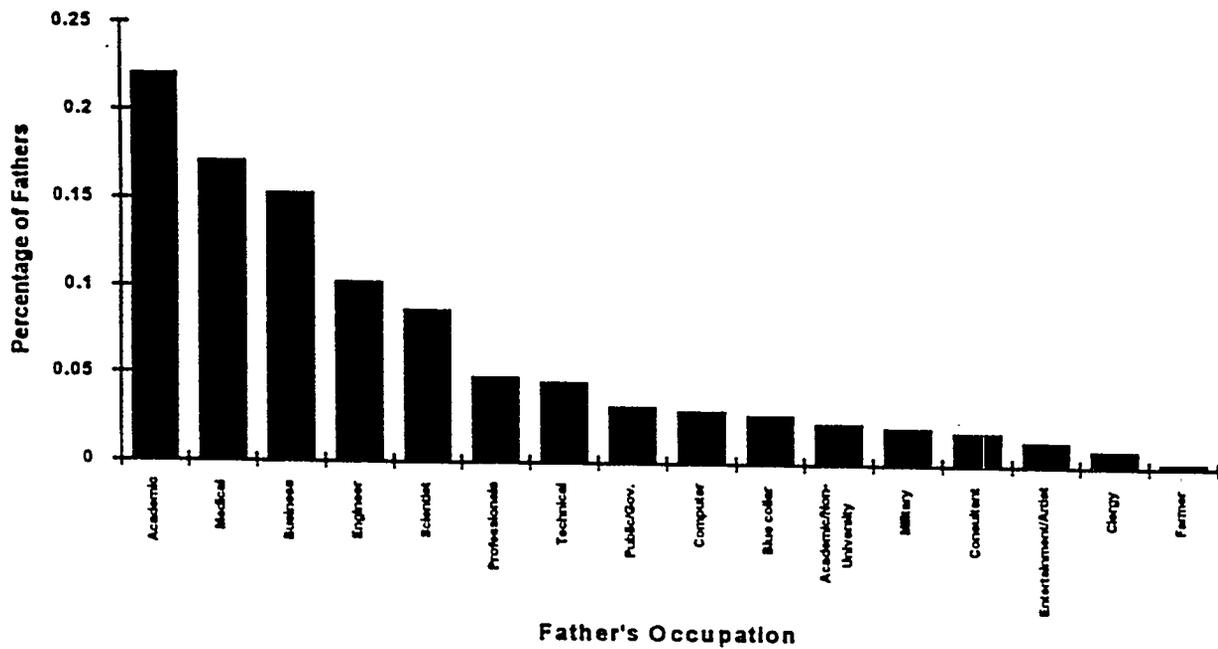


Men's RSI Interest and Undergraduate major

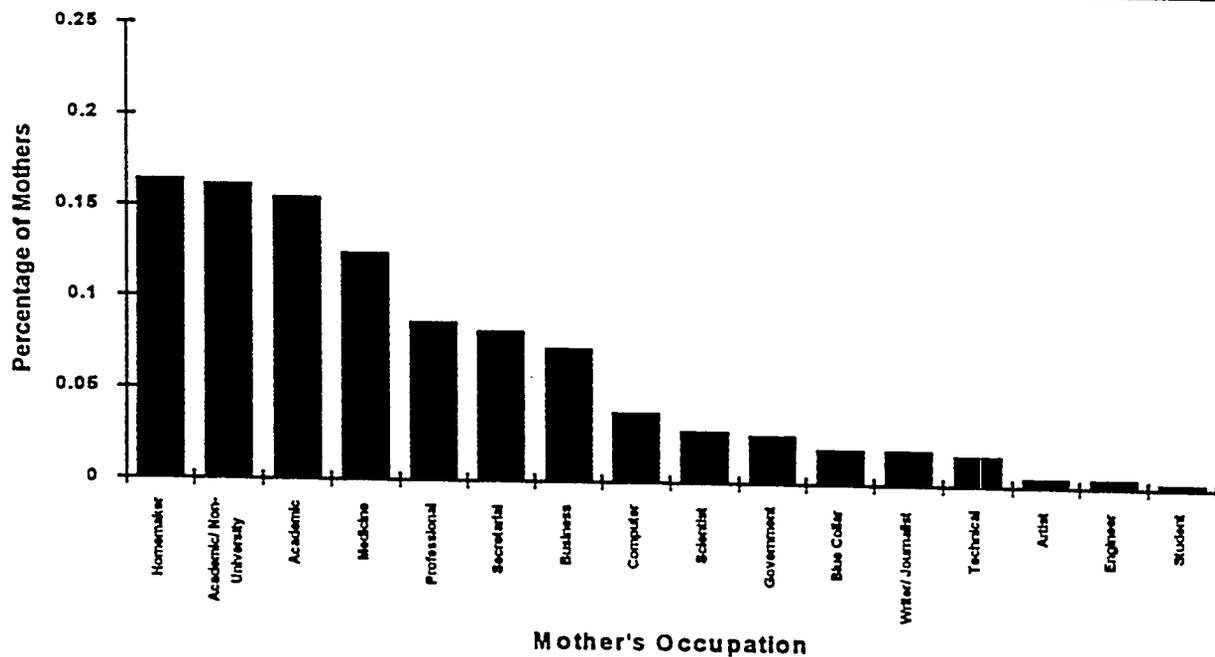


Women's RSI Interest and Undergraduate Major

These graphs show, for each sex, the student's declared field of interest upon application to RSI compared to the student's undergraduate major. These data are for the sample of 188 of the students responding to the preliminary questionnaire.



Percentage of Fathers in a Category of Occupations



Percentage of Mothers in a Category of Occupations

These charts depict, for all RSI alumni, the occupations of their fathers and mothers. The occupations have been grouped into categories, and the preponderance of academic parentage for the young men and women attending RSI becomes evident. The categories are not identical, but were made as similar as possible.

Over all Probability of Switching : .6241 for females: .6596 for males: .6071

Probability of switching at all, by field:

Field	Total		Males		Females	
	Number in Field	Percent Switching	Number in Field	Percent Switching	Number in Field	Percent Switching
Biology	93	0.5806	43	0.5813	50	0.58
Chemistry	32	0.8125	19	0.7368	13	0.9230
Computer Science	37	0.7027	36	0.6944	1	1
Engineering	8	0.75	6	0.6666	2	1
Mathematics	45	0.5555	35	0.5428	10	0.6
Physics	74	0.5945	57	0.5614	17	0.7058

Probability of switching into a particular field given one is switching:

Field	Total	Males	Females
	Number Switching = 181	Number Switching = 119	Number Switching = 62
Biology	0.0663	0.0588	0.0806
Chemistry	0.0718	0.0672	0.0806
Computer Science	0.0718	0.0840	0.0484
Engineering	0.2652	0.2857	0.2258
Geology	0.0221	0.0168	0.0323
Mathematics	0.1547	0.2101	0.0484
Non Science	0.1934	0.1261	0.3226
Other Science	0.0663	0.0588	0.0806
Physics	0.0884	0.0924	0.0806

Note:

let prob. of switching to field A =  $p(S^A)$

# switching to field A =  $S^A$

total switching = S

Total people = T

so  $p(S^A) = S^A/T$

and probability of switching to A given a choice to switch =  $S^A/S$

So multiply the figures in the above table (all =  $S^A/S$ ) by S/T (i.e. the probability of switching) to get the probability of switching overall.

for instance : the prob of switching females to move out of science is .3226

the probability of any female to switch to non-science is  $.3226 * .6596 = .2127$

this method was used to calculate the table below:

Probability of Switching into a particular field before the decision to switch is made:

Field	Total	Males	Females
Biology	0.0414	0.0357	0.0532
Chemistry	0.0448	0.0408	0.0532
Computer Science	0.0448	0.0510	0.0319
Engineering	0.1655	0.1735	0.1489
Geology	0.0138	0.0102	0.0213
Mathematics	0.0965	0.1275	0.0319
Non-Science	0.1207	0.0765	0.2128
Other Science	0.0414	0.0357	0.0532
Physics	0.0552	0.0561	0.0532

Overall changes in numbers as a percentage of each group, by field:

Field	Total	Males	Females
Biology	-0.1448	-0.0918	-0.2553
Chemistry	-0.0448	-0.0306	-0.0744
Computer Science	-0.0448	-0.0765	0.0212
Engineering	0.1448	0.1531	0.1276
Geology	0.0138	0.0102	0.0212
Mathematics	0.0103	0.0306	-0.0319
Non-Science	0.1207	0.0765	0.2127
Other Science	0.0414	0.0357	0.0532
Physics	-0.0966	-0.1071	-0.0745

**IV. PHASE II OF STUDY: GROWTH IN  
UNDERSTANDING OF FACTORS ASSOCIATED  
WITH ATTRITION FROM A SCIENCE/MATH  
CAREER PATH**

**A. Cognitive Interviews of RSI Alumni**

**B. Letters of Testimony**

### **RSI ALUMNI INTERVIEWS, FEBRUARY 10, 1995**

On February 10, 1995 a selected group of Research Science Institute Alumni at either Harvard or Massachusetts Institute of Technology were interviewed by Dr. Mary J.DeLong and Dr. Margaret Boone to define their reasons for pursuing or leaving math/science studies. Students chosen represented undergraduate and graduate years. The cognitive interviewing technique used for the interviews is used by the National Academy of Sciences in interviewing postdoctoral graduates. This method gains insight into decision points of students choices in careers by asking for information on critical events in their lives that enhanced or changed their choice of a mathematics or science career. A copy of the opening statements by the interviewers to the student(s) is included at the end.

## SUMMARY OF RESPONSES OF STUDENTS

Women of RSI leave science/math studies at the rate of three times that of RSI males. To define possible gender differences for choosing or leaving a science/math career the information presented is organized according to male and female responses.

### Reasons for Choosing Science and/or Mathematics Studies Until Now.

#### Men

1. Parents' encouragement/support
2. Teacher encouragement/support
3. Aids understanding of world
4. Early belief in intellectual ability
5. Early success in elementary - H.S.
6. Science contributes to man
7. Free to advance quickly in school
8. Summer and additional programs  
Good for peer group
9. Positive social experience

#### Women

1. Parents encouragement/support
2. Teacher encouragement/support
3. Aids understanding of world
4. Early belief in intellectual ability
5. Early success in elementary - H.S.
6. Med school contributes to man
7. Free to advance quickly in school
8. Summer and additional programs  
Good for peer group
10. Science gains respect of peers  
so choose it because of status not  
interest

#### Overall Summary:

All students had an early parental interest and mentoring in mathematics and/or science. This type of parental training often started as early as age five and was in all but one case the father of the family was the mentor. For girls this type of mentoring appeared very important in both expectations to succeed in a difficult discipline and training to compete in a challenging academic environment. For the early years, social differences of gender were not apparent. By middle school many had achieved a some recognition for their intellectual abilities or interest in science and for some this substituted for social recognition. Summer experiences during high school were very important for providing an intellectual peer group and a sense of one's personal level of intelligence or giftedness in relation to other similarly talented students.

Overall students felt that study of science or mathematics was "expected" of them early in their lives and because of their abilities they grew into these parental and teacher expectations.

The questioning of alternatives to science or mathematics did not occur until the undergraduate years.

The intense mentoring that occurs for many of the mathematically gifted students creates a selective advantage of accomplishment early in life. The question was raised several times whether students with equal natural ability could ever "catch up" to the wealth of early experience of some students.

### Reasons for Leaving Science and/or Mathematics Studies

#### Men

1. Perception of scientists as asocial
2. Time to independence in career too long
3. Does not have ability to be best in field so leave; need to be at top RSI experience first realization of this
4. Disillusioned in politics of science
5. Knowledge that liberal arts can be a contributing factor to society not realized until college
7. Science is basically an entrepreneur's endeavor and lonely

#### Women

1. Perception of scientists as asocial
3. Lack of ability creates too much struggle to continue
4. Disillusioned in attitude of premeds
6. Constant struggle to be respected and considered competent
8. If two B's or a C is earned in calculus or science classes this is an indication that the ability is absent and one should not pursue a science/math career

#### Overall Summary:

Two important factors for turning from a math/science career repeatedly appeared. The first factor is the negative perception of the life of a scientist or mathematician. It is perceived as being monolithic with little humanity or human interaction, an asocial life. These perceptions were formed during experience in research internships and through academic instructor exposure. This was a major contributing factor for change from a math/science career for both men and women. The second factor is the competitiveness and perceived aggression or hostility of science

and mathematics. This is true during the undergraduate years, especially during the first two years, when in a highly competitive institution students are competing for top grades. Men who stay in science/math interpret this behavior as "necessary for success" and a challenge to overcome. Women totally dislike this mode of interaction and often see it as "demeaning" and are "overwhelmed" by the experience. Only women who have had consistent strong male competitive mentoring or single mother households take this type of behavior in stride and see it as the men do as a challenge. This competitiveness disappears in graduate school where male-female interactions and relationships with mentors are more equitable.

Women are more easily discouraged by the struggle for good grades. In contrast to the men who interpret average grades a lack of effort in the struggle for high grades, women immediately interpret modest grades as proof of their lesser intelligence. For women high grades they earned in challenging courses are due to professors who are easy graders. The woman's more fragile belief in her personal abilities is quickly tested in the freshmen undergraduate year. Once an average grade is earned self-esteem and self-confidence begin to erode.

Another critical difference between men and women is that males have often moved from external expectations to mastery of a subject as the motivation for effort during their early undergraduate years. In contrast, women are still strongly motivated by external expectations and worry about "letting people down". Because mastery but not performance is the motivation for males they are able to let very difficult material "wash over them" and review it several times again. They are comfortable with not understanding everything at once and expect mastery and understanding to come in time. Comfortable with not knowing, they often read widely and try new things more readily. Women in a similar intellectually challenging situation become very anxious about understanding chapter one and then two, etc.. Their performance anxiety inhibits their seeking of meaningful help in difficulty and being comfortable without total understanding. With time the woman becomes very isolated from successful peers in the discipline. At this time if a success is realized in another course which can rebuild self esteem and confidence and identify other talents, a career change from math/science can be easily rationalized.

A symptom of the performance anxiety realized by many high ability women is also exhibited in their desire to start lower in class level despite placement testing when entering freshmen year. This may be advisable to shore up self confidence. Women also look more for advising on the proper level of courses to be taken than men. They desire more so than men more advising. This again reflects the higher comfort level of men with not knowing. Women seek to increase their comfort level that they will succeed by seeking mentor/advisor decisions for proper courses for them, even if at the time it does not seem appropriate. They may seek advice before choosing a course but seldom when in difficulty with the course.

In summary, the critical factors that need addressing are 1) the negative perception of the scientist/mathematician as asocial, 2) the inability of many women to deal with the aggressive and competitive nature of science and math primarily during their first two college years, 3) the need for women and some men too to move to a mastery concept for motivation for performance so to let the difficult materials of mathematics and science "wash over them" in the first two critical years of college without sacrificing self esteem and self confidence. The mastery concept will also create more self reliance in women.

## Reasons a Present Science/Math Student Would Change Career Goals.

### Men

1. No job available; have financial pressures to support self and family
2. No financial support for studies

### Women

2. No financial support for studies
3. Another interest
4. Family interests not respected by department
5. Social isolation

### Overall Summary:

Overall, men would be more influenced by monetary reasons in changing their present science/math careers than women. The men interviewed see the women as having the choice of choosing or not choosing a career. Men feel a great necessity to secure financial independence. Finances was not a factor for women except during training and may reflect differing societal expectations for men and women in general which have been adopted by the RSI women. Women presently studying science and math would be more influenced by family and social factors if they were to change careers. Again the factor of social isolation appears for women only.

## Necessary for Success in a Science/Math Career.

### Men

1. Have to be "tough", assertive/competitive

### Women

1. Have to be "tough", assertive/competitive

### Overall Summary:

There is no doubt about the atmosphere of science and mathematics at highly competitive institutions for both men and women. It is the way in which each gender deals with this atmosphere that changes the outcome in careers. Women repeatedly spoke of being "tired of struggling". They spoke of how "presentation" is often more important than the actual ideas.

Issues that need addressing here are again 1) dealing with a competitive, aggressive atmosphere, and 2) creating a place in the life where this is not the atmosphere. A FINALS CLUB for women of science at Harvard might be the first step.

## Views of Why Women Leave Science/Math Careers More Than Men.

### Men

1. Women naturally more social than men, science is asocial by its nature
2. Women want to feel as we all do - to "belong", with few women in science and math this is difficult to achieve
3. Women have to have "extraordinary" commitment to science/math to "put up with the shift"
4. Because of the nature of science as an "old boys network" the inclusion of women is difficult but women are not intentionally excluded by men
6. Women have more options and can leave a career to raise a family, not an option for men

### Women

1. Science is asocial and unfriendly, women want more in their life than just science
3. Women leave "beaten" by the system
5. Women feel less secure about their ability

### Overall Summary:

Social factors again are paramount in both mens' and womens' minds in choosing a math or science career and in the reasons for the attrition of women from science. Ability is addressed only as a "feeling" not reality.

## Differences in Responses to a Challenging Academic Situation by RSI Alumni

### Men

### Women

1. In a course in which material presented is only marginally understood by the students  
Let the material "wash over them" for reading or understanding later  
Feel anxiety about understanding the the material -- feel they do not have the ability to understand it.
2. In optional reading or exercises or books far in advance of present level of understanding  
Let the material "wash over them" for rereading many times later  
Do not read optional material that is beyond their level
3. When a B or poor grade on a test or course is earned  
Did not study enough  
Parent's say "work harder"  
Do not have the ability to understand  
Parent's say maybe not for you
4. To deal with asocial nature of science and math courses  
"That's what is needed for success"  
Want to form peer groups, Study Nights  
Seek comfort in group or become isolated
5. When material in course seems too fast or too advanced  
Respond by blaming poor advisement, atmosphere of university but do not seek professors help
6. When course instructors are demeaning and create a judgmental atmosphere when questioned in class  
Blame personality of professor or TA  
Accept instructors negative personal comments without question, internalize, loose self esteem
7. When ideas within a course or discussion becomes a true academic debate  
Directly debate issue so as not to "loose face" or until a "stand down" is necessary  
Feel "talked over" or "overwhelmed"

## OVERALL SUMMARY OF THE INTERVIEWS

1. The first questioning or final decision to leave a science/math career focus occurs within the freshmen year at university for RSI men and women. The freshman and sophomore years include adjustments in:

a. Academic performance based not on external expectations of others but on internal expectations i.e. from motivation for learning due to external expectations to learning motivation due to seeking internal mastery of a discipline. If this does not occur anxiety of performance persists and is self-defeating in difficult situations. This is especially true for women.

b. Rank in ability compared to peers i.e. acceptance of not being first  
Acceptance of level of ability in relation to others  
Rank is very important to men, less so for women. Women struggle more with believe in ability to achieve the goal even at a lesser level.  
Women tire of the struggle to achieve at a high level.

c. Assertiveness and competitiveness needed in the new environment  
Survival skills needed to "belong" in math and science studies are unacceptable to the women but tolerated and understood by the men.

d. Basis and solidification of self-esteem  
Women especially have a fragile self-esteem often based on very high expectations of personal performance. Small failures loom large and the overall perspective is lost of both their innate ability and the long term goal.

e. Students identify with peers in math or science or abandon this peer group leading to social alienation within the discipline.

The decision points of staying in or leaving science are often based on one of these five issues dealt with immediately in the freshman year. Dealing with these issues prior to the freshman year, during, and immediately after it appears a critical time in career choice and continuation in a science/math career for both men and women who are RSI alumni.

2. The ability to deal successfully with aggression and competitiveness characteristically male attributes is a major need of RSI women alumni especially in the freshmen and sophomore years. In graduate school students have proven themselves and male and female dynamics are more equal in assertiveness and competition.

3. Women who have successfully learned the "tactics" of science and math are often from childhoods where the father is a mentoring, challenging figure or a single mother with a strong sense of self-esteem transferred to the daughter. At university she continues her expected type of competition learned as a youth.

## FORM FOR FORECASTING CRITICAL INCIDENTS

Student Initials \_\_\_\_\_

Year of Incident \_\_\_\_\_

Age \_\_\_\_\_

Thinking ahead about the most important incidents that might affect your decisions about school and career. If you picture your future life as a straight line beginning from now, what events, changes or happenings with important people in your life would happen? They would be major factors in their effect on your career decisions. These factors could be either positive--events that would encourage your career in science and mathematics. Or, they can be negative--events that would discourage your career in science and mathematics. There may be one or several such incidents you can imagine in the future.

Incident Title \_\_\_\_\_

Negative \_\_\_\_\_ Positive \_\_\_\_\_ Both \_\_\_\_\_

Brief description of the incident:

## **Preliminary Results Gathered from Personal Testimonial of RSI Women**

### **Absence of Women**

- "professors a bunch of old men"
- "tutorial teacher is the only woman and see her seldomly"
- "culture is masculine"
- "isolation"
- "women missing"
- "study group all men/very intimidating"
- "absence of women doing math"

### **Atmosphere of Learning**

- "unfriendly"
- "highly competitive"
- "very competitive"
- "science students in college are cold"
- "teachers not friendly"

### **Science Courses**

- "professors are boring"
- "turned off by rigor and lack of imagination"
- "physics--loads and loads of calculators--better at concepts"
- "rigor only, not fun"

### **Other Fields Easier**

- "politics more natural and easier"
- "social science easier"
- "so tired, cannot do family, too"

### **Other**

- "helping people"
- "people are more important than problem sets"

## **Letter from 5th-year graduate student in physics**

I am a fifth-year graduate student in physics, pursuing my Ph.D. My early interest in science germinated as a result of several factors. In order of importance, they are:

- 1) Parental encouragement. My parents loved science, and they never gave me the idea that it was a field for boys. They actively fought that idea, in fact.
- 2) Stimulating classes/energetic teachers. In high school and college, some of my chemistry and physics teachers were masterful instructors who worked to make the material interesting and accessible, as well as amusing characters. The great majority of my teachers strongly encouraged my study of science.
- 3) Summer activities. From age 10 to age 15, I spent part of each summer at an academic program geared toward science or math. Often it was invigorating to feel accepted and encouraged by a group of agemates at such a program.

Like most graduate students, and probably almost all woman graduate students, I have considered leaving the field. Now I am sure that I want to finish my Ph.D., and I really love my work; but even a few months ago I was less sure. The culture of science is rather masculine in structure, and the socialization that girls often undergo, which tells them to be docile, accomodating, and unsure of themselves, does not prepare them well to survive in science.

More specifically, scientists deal with eachother often rather antagonistically, verbally ripping apart their colleagues and casting doubt on eachother's work. For girls and women, who have been raised to be sensitive to others' disapproval, this style can be especially devastating to self-esteem. An unwritten scientific ethic also mandates that people avoid as much as possible asking others for help, because asking is seen as a sign of weakness. This sort of isolation is detrimental to both sexes, especially to very social people. One further difficulty with the culture of science is the unwritten requirement that practicing scientists must sacrifice their outside lives to put in long hours in order to be "productive." This puts strain and/or guilt on anyone with outside interests, particularly those who want to have children; and as much as we'd like to say that society has changed, women still do most of child-rearing.

That's where science can be hard. It's not all bad--hardly! It is also very stimulating and exciting to learn how the universe works. Many student in my program have wildly-varying outside interests and see the problems that exist in science. There is hope that the younger generation can, slowly, change the character of science, by raising the sensitivity of classroom teachers, helping girls to feel more positively about themselves, and molding academia to comform to social realities.

## Letter from college junior in mathematics

Of all the things that influenced my interest in math (and science), my parents were probably the greatest influence. They are both mathematicians, and for as long as I can remember, we have talked about math on car trips, or wherever, and they've always let me hear about their problems, even if I didn't always understand everything. One big factor which I've just realized recently is that they convinced me that *\*knowledge\** is mostly irrelevant when it comes to problem solving. They let me work on the interesting problems that they gave to their college classes, even though I didn't really know anything, because they could explain the notation and restate the problems in terms I could understand. So I got to see the beauty of problem solving and of math ideas before I had to *\*learn\** math, as a structure, and with rigor.

Teachers and math team were the next most important factor. Again, my most influential teachers were those who encouraged **PROBLEM** solving, rather than learning the theorems and principles. Also, I had several teachers who taught me discipline and diligence (not always science teachers), which has really helped me **NOT** become overly frustrated with math.

Math teams had a big effect on my interest in math, because I realized that I was good at it. Of course, I can't say what would have happened had I not excelled at math contests.

My last two years of high school were at the North Carolina School of Math and Science, and that is where my interest in math was solidified. Until then, I knew I liked math, and I knew it was fun, but I didn't know if I wanted to do it. Actually, I think I just didn't want to say that I wanted to do the thing that both my parents do. A critical factor was the presence of other females who were also **VERY** talented in math and science. E.g. my best friend was on the physics olympiad team the same year that I was on the chemistry olympiad team, and nearly all of my close friends are now engineering, math and physics majors. And so I was in a totally skewed culture in which doing math **WAS** perfectly normal, and there was more positive than negative peer pressure.

Summer activities really weren't so much of an issue for me. I went to both CTY and TIP, but I didn't get much out of either, in part because I was really homesick. By the time I went to RSI and the Chemistry Olympiad training program, I was pretty solidly determined to go math or science.

Then, I went to Rice, and for the first time, I considered that I might not want to do math. That came as a surprise to most people

(including me) because I seemed to have such a strong background, and all the encouragement that anybody could need, but it still wasn't enough to keep me from doubting. In hindsight, I contribute that doubt to several factors

1- the total absence of other women doing math. There was one female faculty member, there for her first year. I didn't meet her until more than half way through the year. I didn't meet another female math major until my sophomore year. There were no female graduate students. All of my female friends were humanities type people

2- the focus in my first year course was on theorem learnign, and rigor, rather than problem solving, and so it wasn't fun anymore

3- my teachers were more distant, and not nearly so encouraging, and I thought that must be a reflection of my lack of ability

4- I was in a new situation in that other students didn't know me and so didn't assume that I would excel. In NC, even when I first went to NCSSM, everybody knew me, and assumed that I would be the best, and so I couldn't doubt myself.

5- I somehow was thinking of my future in terms of a part-time or temporary job, rather than a career, and so I was more likely to consider teaching high school, rather than a research career, which is less mobile and less flexible, in terms of taking a few years off.

6- My RSI paper had been accepted for publication, but I was still working on the rewriting, and all the little details that are no fun at all after the paper is done in your own mind, and so I wondered if maybe I just didn't like it any more.

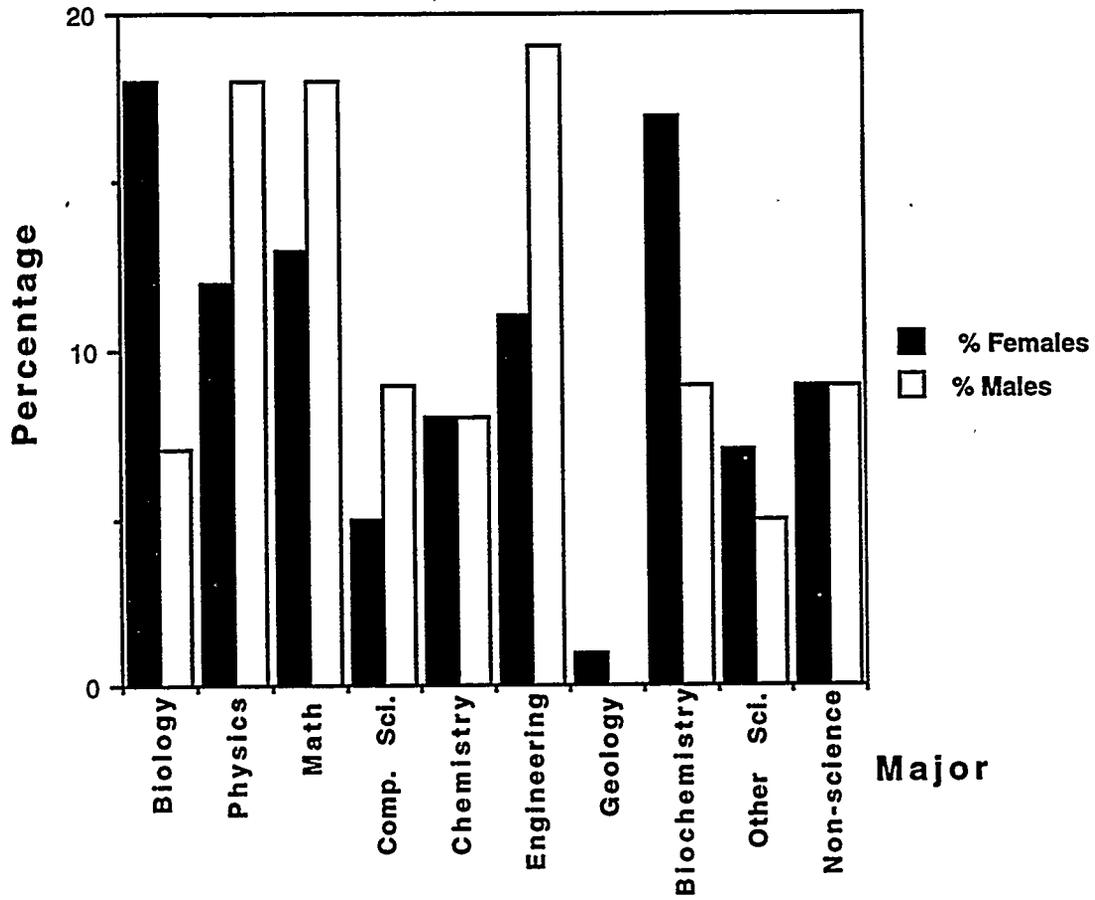
**V. PHASE III OF STUDY: QUESTIONNAIRE RESULTS  
ON FACTORS IMPORTANT IN CHOICE AND  
CONTINUATION OF A SCIENCE/MATH CAREER  
PATH**

**A CHOICES AT THE END OF THE  
SENIOR YEAR IN HIGH SCHOOL**

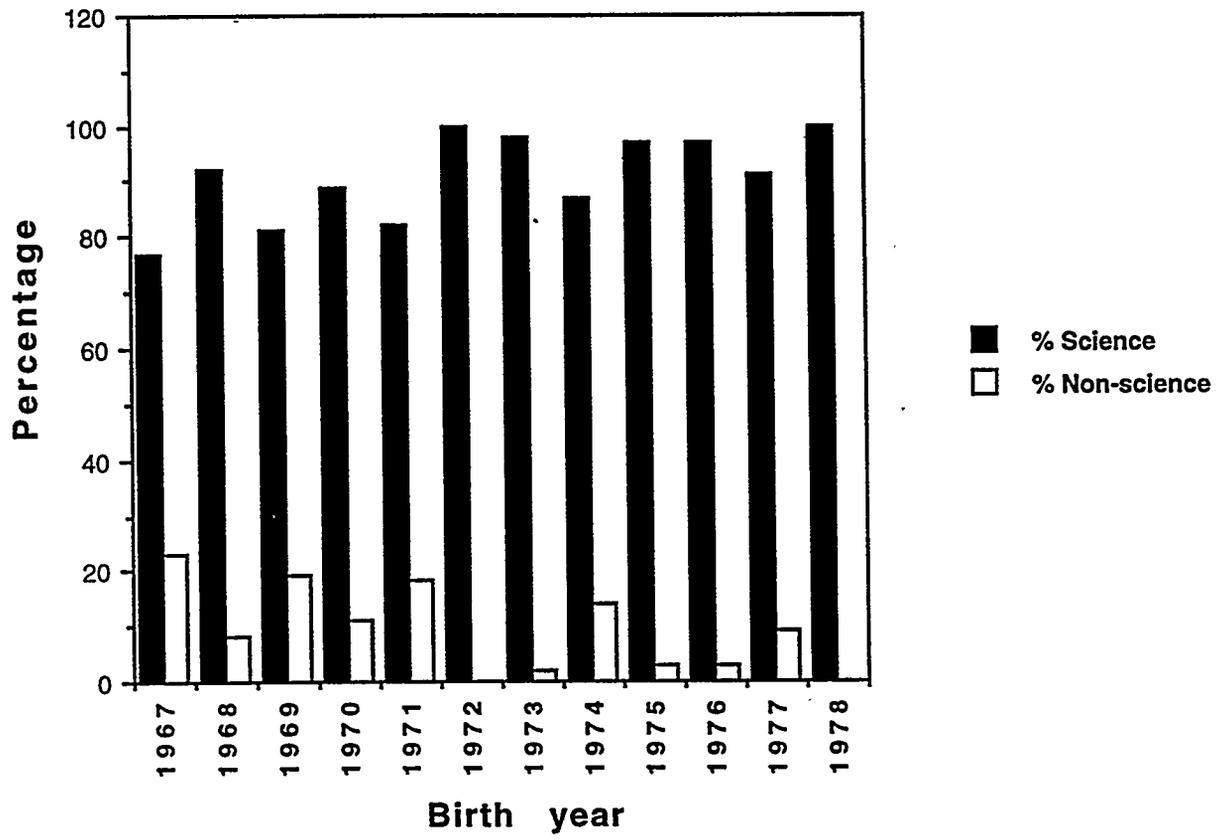
**A1. At the end of your senior year in high school, in what field of study had you decided to major when you entered college?**

First Intended Major: \_\_\_\_\_

## First Intended Major



### First Intended Major



**A2. How much did each of the following influence your decision to select that field for your first intended major?**

*Mark (X) one for each*

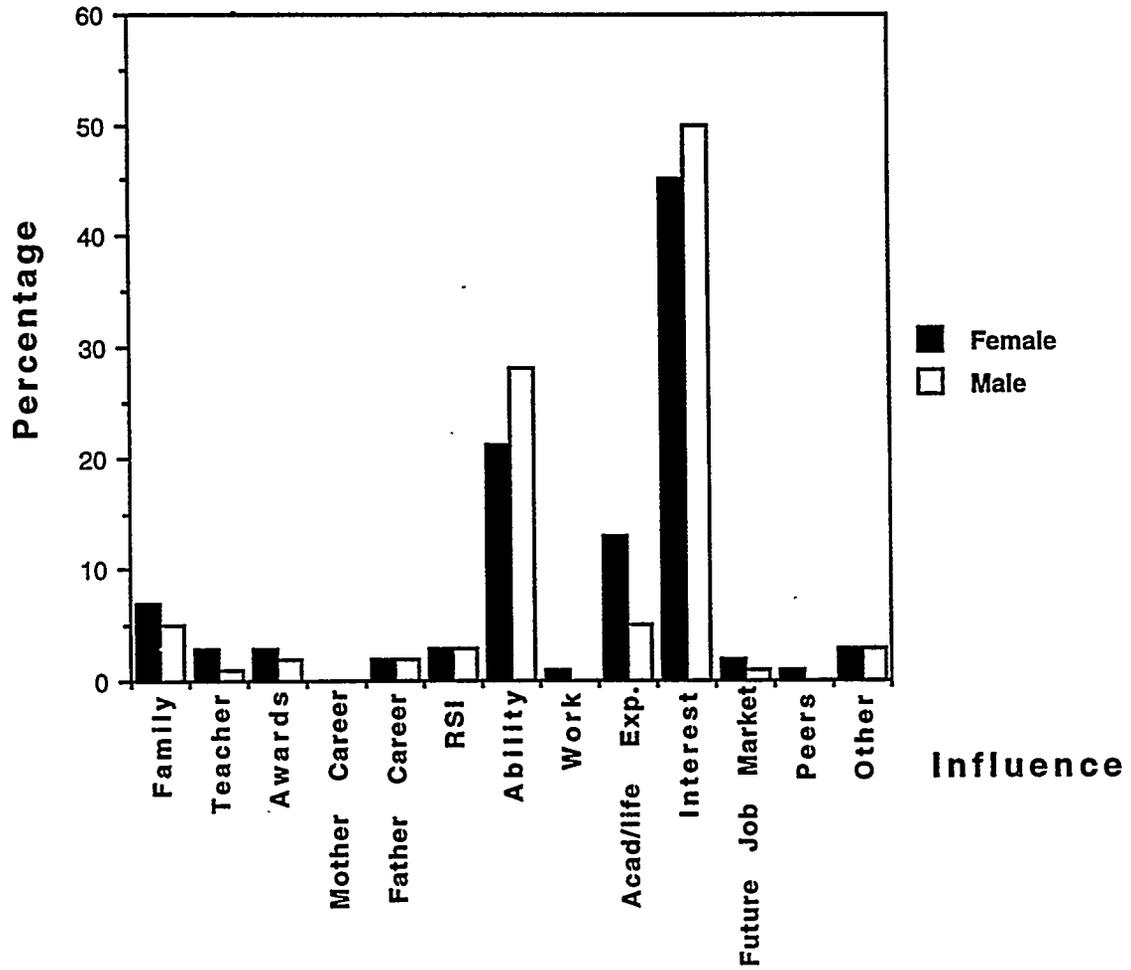
POSSIBLE CATEGORIES	<i>Mark (X) one for each</i>		
	Very Influential	Somewhat Influential	Not Influential At All
1. Encouragement of family member(s).....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Encouragement of teacher(s).....	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>
3. Winning awards and scholarship.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Influence of mother's career.....	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>
5. Influence of father's career.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Research experience at RSI.....	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>
7. Your ability or talent in the field.....	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>
8. Work experience.....	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>
9. Your strong academic or life experience in this area.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. It was interesting to you.....	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>
11. Perception of future job market.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. Influence of peers.....	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>
13. Other factor (Specify: _____)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**A2a. Which TWO factors in A2, exerted the MOST influence upon your decision to pick that first intended major? ENTER THE APPROPRIATE CATEGORY NUMBER FROM A2 IN THE BOXES BELOW.**

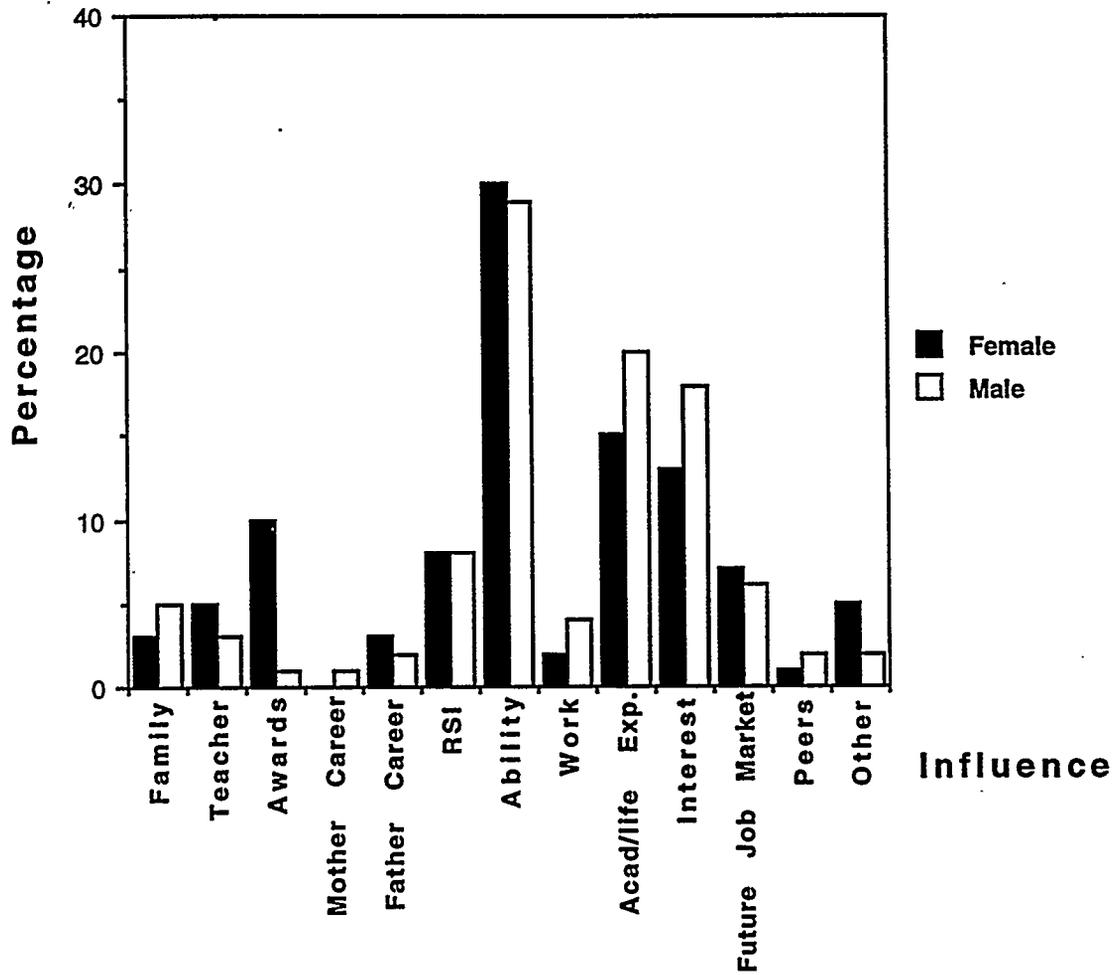
First reason:

Second reason:

## Most Influential Factor On Major



## Second Most Influential Factor On Major



**A4. As you entered college, what type of work did you think you most wanted to do after you would complete your degree or degrees?**

**Mark (X) one box**

1  Teaching

2  Research

3  Management/administration

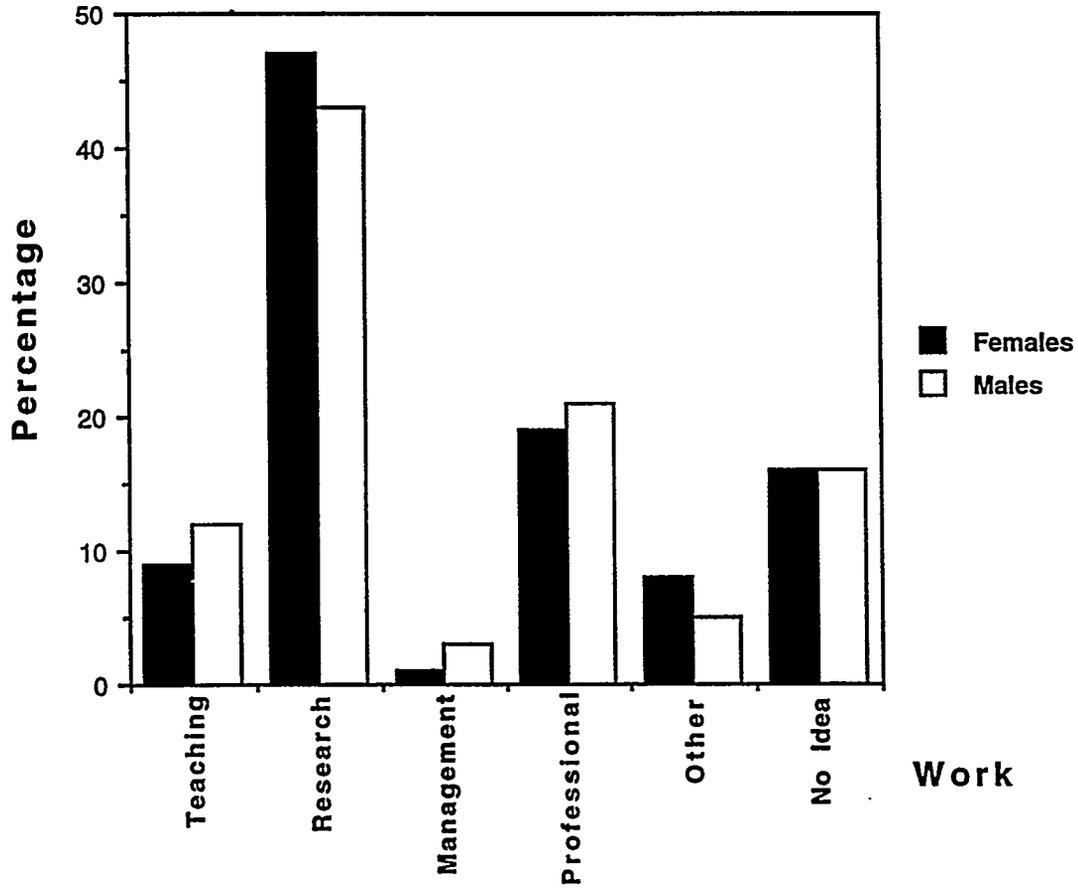
4  Professional practice

5  Other (*Specify:*

\_\_\_\_\_)

6  Had no idea

## Work Expected After College



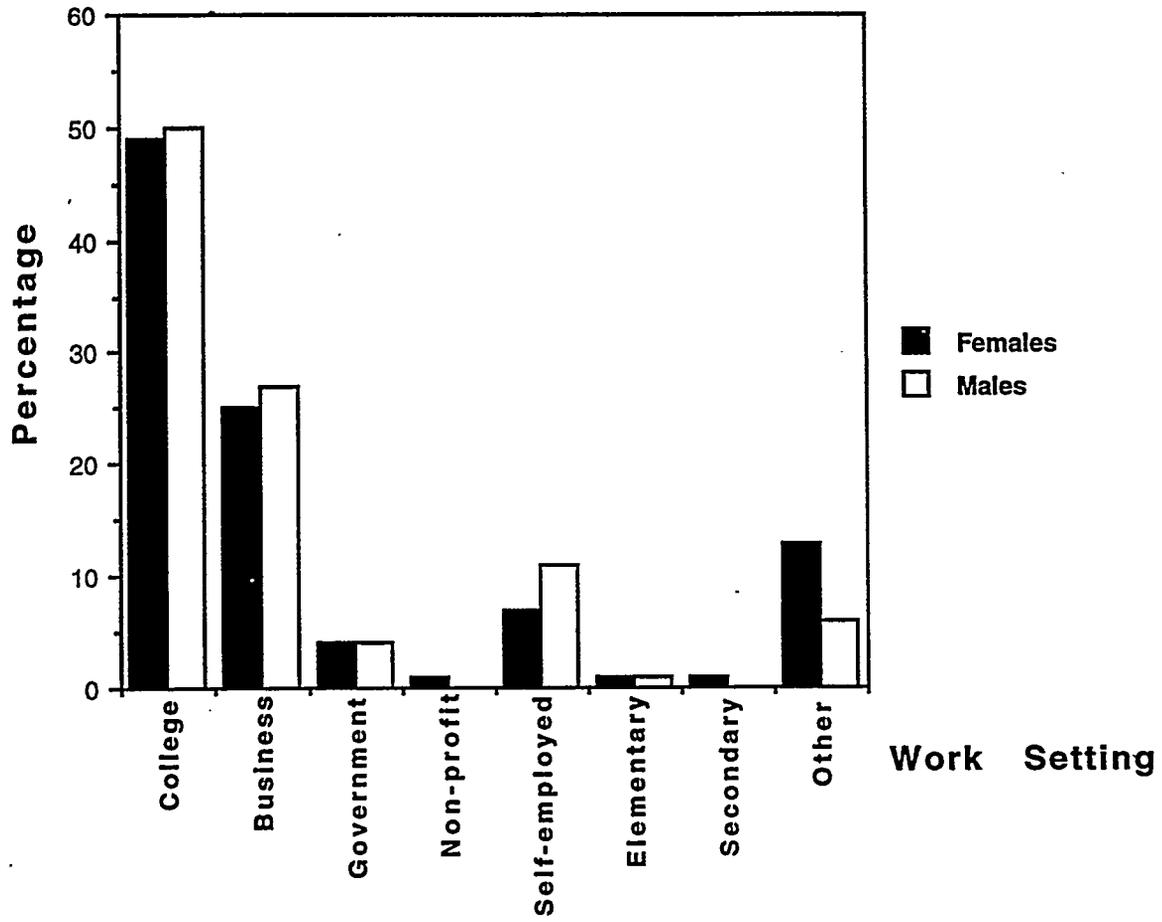
**A5. As you entered college, in which type of setting did you think you most wanted to work after completing your degree or degrees?**

**Mark (X) one box**

- 1  College or university
- 2  Business or industry
- 3  Government
- 4  Nonprofit organization
- 5  Self-employed
- 6  Elementary school
- 7  Secondary or high school
- 8  Other (*Specify:*

\_\_\_\_\_ )

## Desired Work Setting After College



**B2. Was your first formally declared major the same as your intended major when you entered college as listed in A1?**

**IF YOU HAVE NOT YET FORMALLY**

**DECLARED A MAJOR, CHECK THIS BOX →  SKIP to C1  
(page 6)**

**1  Yes, the same →SKIP to B4**

**2  No, not the same**

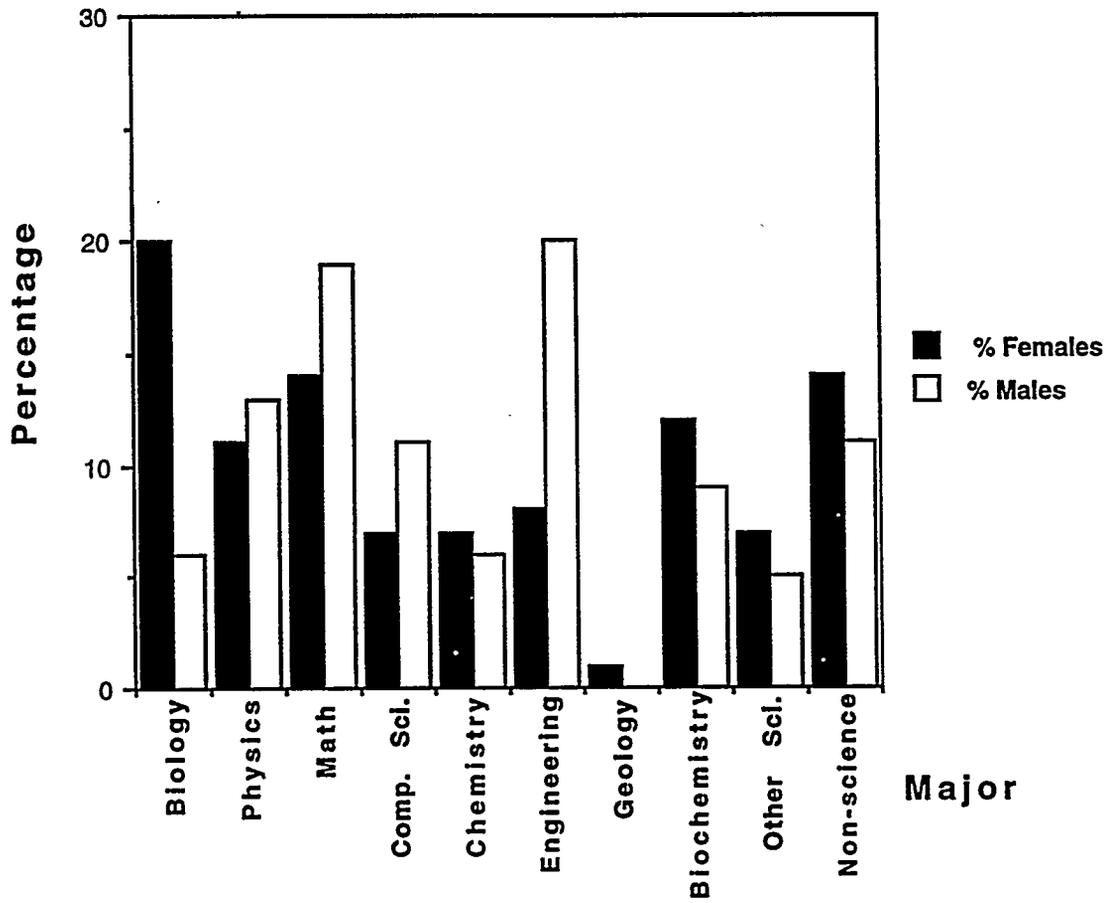


**B3. What was your first formally declared major field of study?**

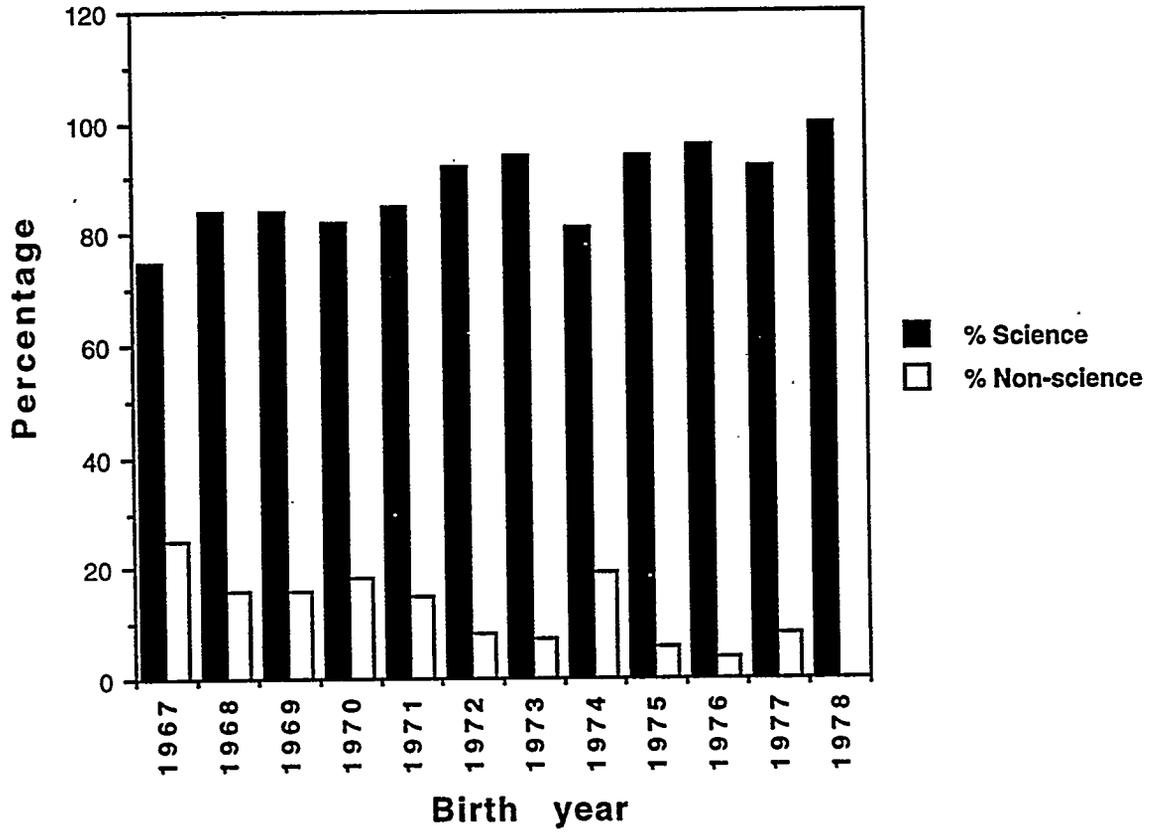
First Formally  
Declared Major: \_\_\_\_\_

\_\_\_\_\_

## First Declared Major



## First Declared Major



**B5. Have you completed your undergraduate degree?**

1  Yes → *SKIP to B7*

2  No



**B6. Is your current major the same as your first formally declared major?**

1  Yes. → *SKIP to B6c*

2  No



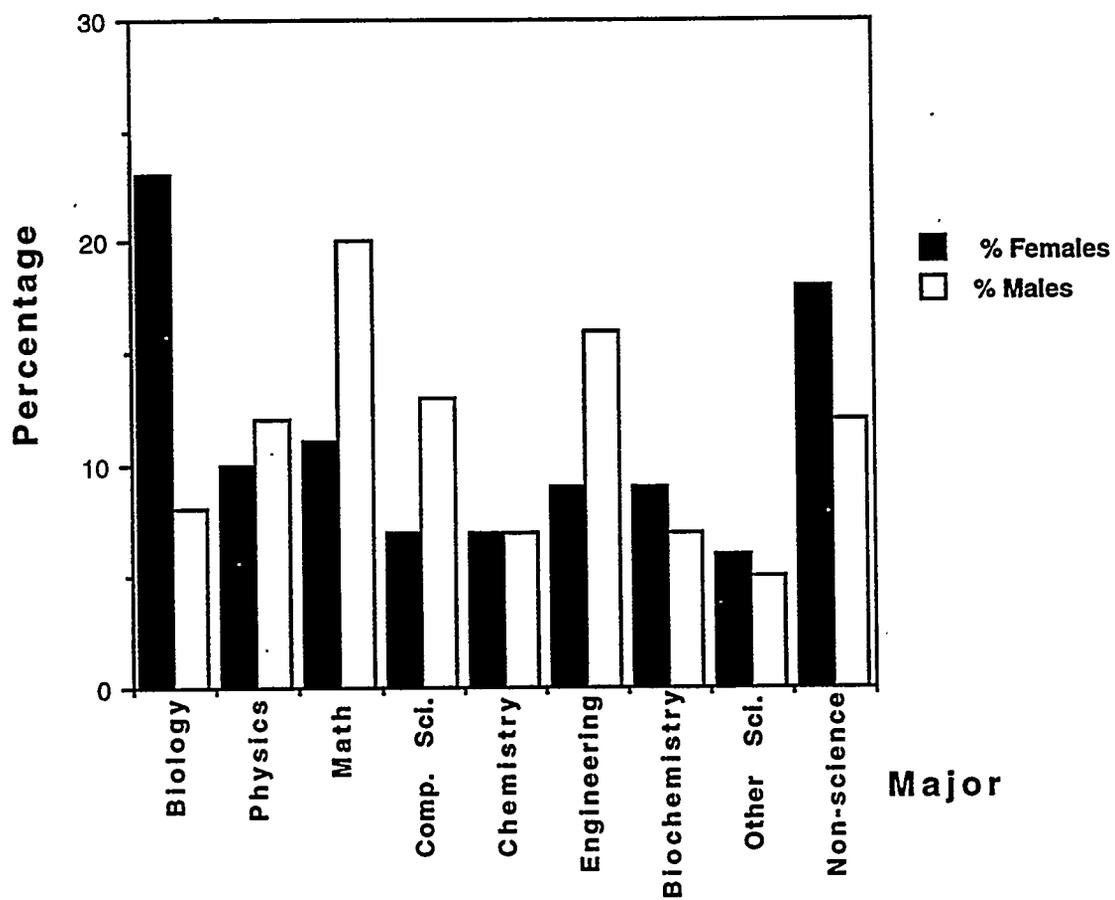
**B6a. What is your current major field of study?**

Current Major: \_\_\_\_\_

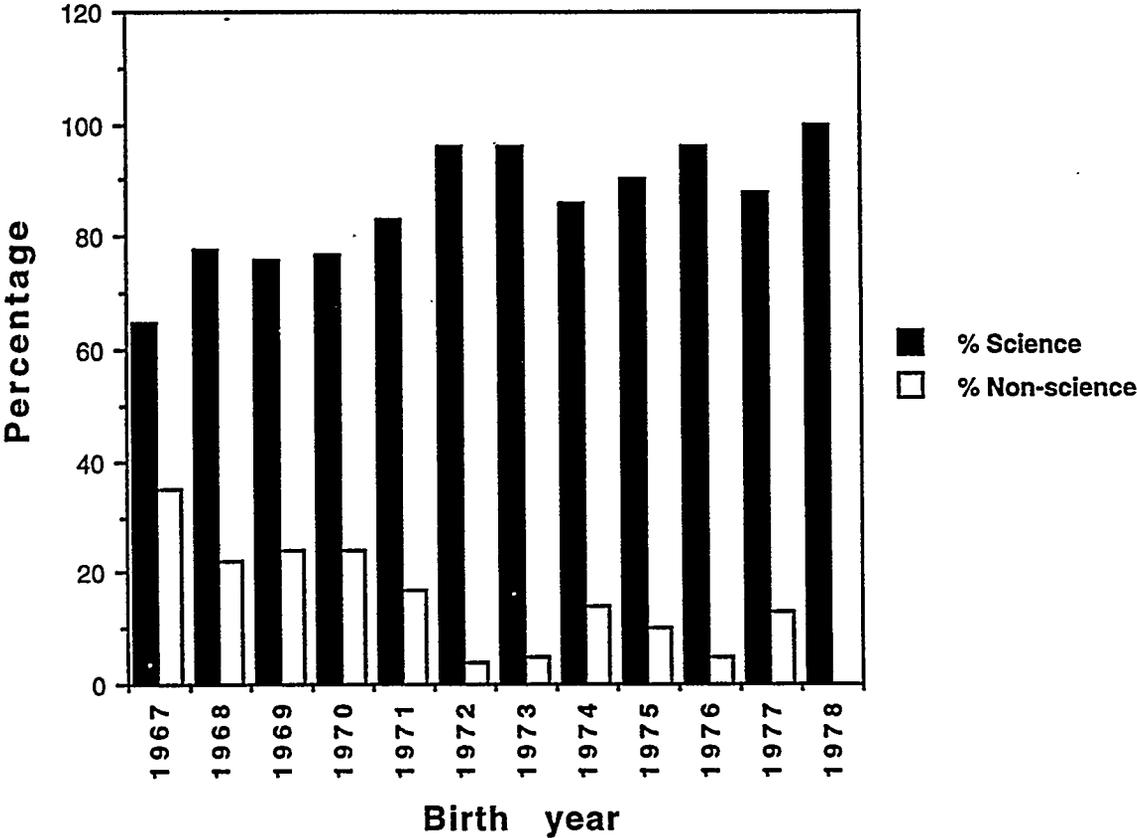
**B7a. In what field of study did you complete your undergraduate degree?**

Undergraduate Major: \_\_\_\_\_

## Current or Completed Major



# Current or Completed Major

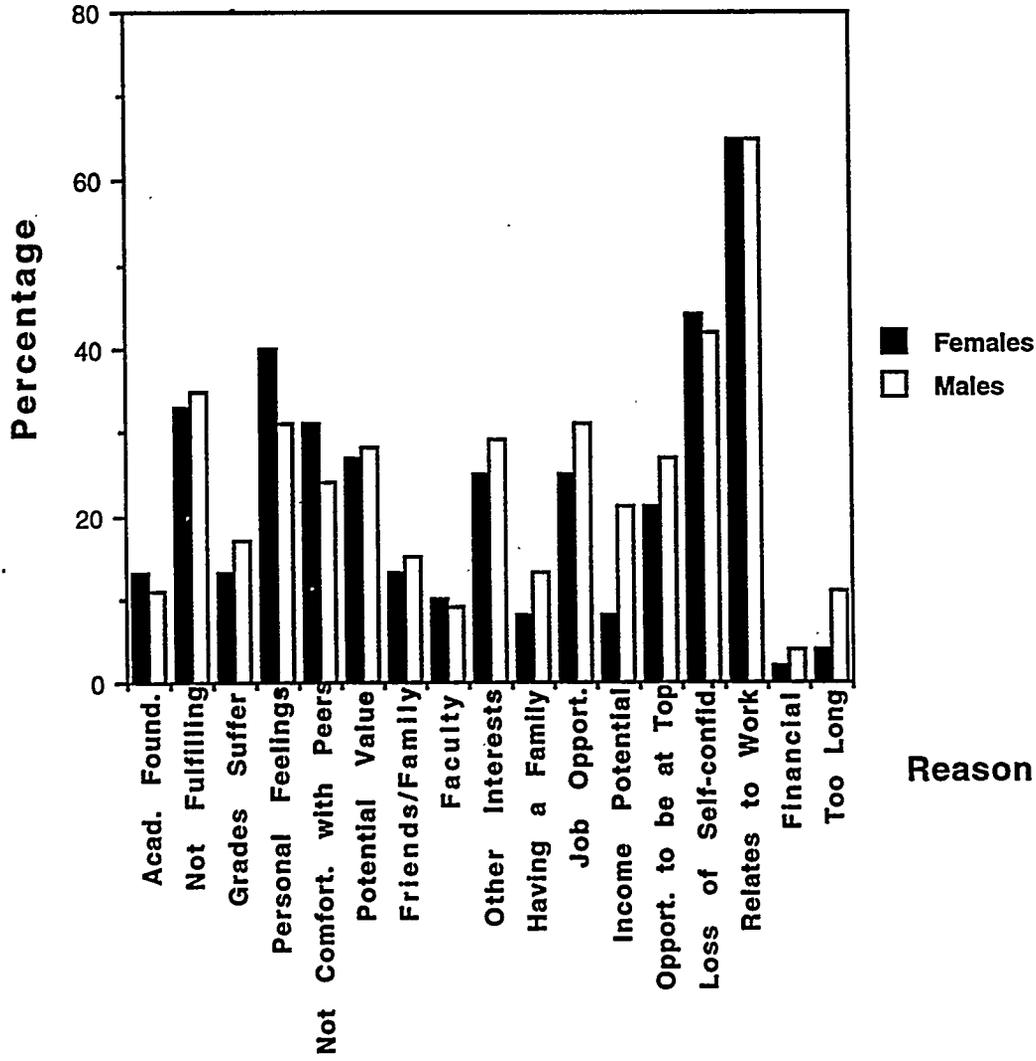


**B9. Why did you switch from your first intended major (A1) to another field of study?**

**Mark (X) "Yes" or "No" for each**

- |  | <u>YES</u>                   | <u>NO</u>                  |
|--|------------------------------|----------------------------|
| 1. Insufficient academic foundation in your first intended major ..... 1                       | 1 <input type="checkbox"/>   | 2 <input type="checkbox"/> |
| 2. No longer perceived a science/math career to be as fulfilling as you once did .....         | 1 <input type="checkbox"/>   | 2 <input type="checkbox"/> |
| 3. Concerned your grades would suffer .....  | 1 <input type="checkbox"/>   | 2 <input type="checkbox"/> |
| 4. Personal feelings of success or-failure .....   | 1 <input type="checkbox"/>   | 2 <input type="checkbox"/> |
| 5. Did not feel particularly comfortable with your peers in that field .....                   | 1 <input type="checkbox"/>   | 2 <input type="checkbox"/> |
| 6. Your new major is of greater potential value to society .....                               | 1 <input type="checkbox"/>   | 2 <input type="checkbox"/> |
| 7. You were encouraged by friends/family to switch majors .....                                | 1 <input type="checkbox"/>   | 2 <input type="checkbox"/> |
| 8. You were encouraged by faculty to switch majors .....                                       | 1 <input type="checkbox"/>   | 2 <input type="checkbox"/> |
| 9. Your first intended major left too little time for other interests, personal pursuits ..... | 1 <input type="checkbox"/>   | 2 <input type="checkbox"/> |
| 10. A career in the new field will be more compatible with someday having a family .....       | 1 <input type="checkbox"/>   | 2 <input type="checkbox"/> |
| 11. More job opportunities in your new field .....   | 1 <input type="checkbox"/>   | 2 <input type="checkbox"/> |
| 12. Better income potential in the new field .....   | 1 <input type="checkbox"/>   | 2 <input type="checkbox"/> |
| 13. More opportunities to be at the top of your field in this new area .....                   | 1 <input type="checkbox"/>   | 2 <input type="checkbox"/> |
| 14. Feeling less self-confident about your abilities in first intended major .....             | 1 <input type="checkbox"/>   | 2 <input type="checkbox"/> |
| 15. My current major relates more directly to the work I would like to do.....                 | 1 <input type="checkbox"/>   | 2 <input type="checkbox"/> |
| 16. Financial impact of education cost to obtain the career goal.....                          | 1 <input type="checkbox"/>   | 2 <input type="checkbox"/> |
| 17. Too long of a period of preparation for a career.....                                      | 1 <input type="checkbox"/>   | 2 <input type="checkbox"/> |
| 18. Other ( <i>Specify:</i><br>_____)  | . 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 19. Other ( <i>Specify:</i><br>_____)  | . 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |

## Reason Switched Intended Major



**B10. Did any of the courses you took in your first intended major contribute to your decision to switch from that field to another?**

1  Yes

2  No → *SKIP to C1 (page 6)*

**B10a. Which courses that you took in your first intended major contributed to your decision to switch from that major?**

**IF MORE THAN TWO: RECORD THE TWO THAT CONTRIBUTED THE MOST**

Course: \_\_\_\_\_

Course: \_\_\_\_\_

**B10b. In what ways did taking these courses contribute to your decision to switch majors?**

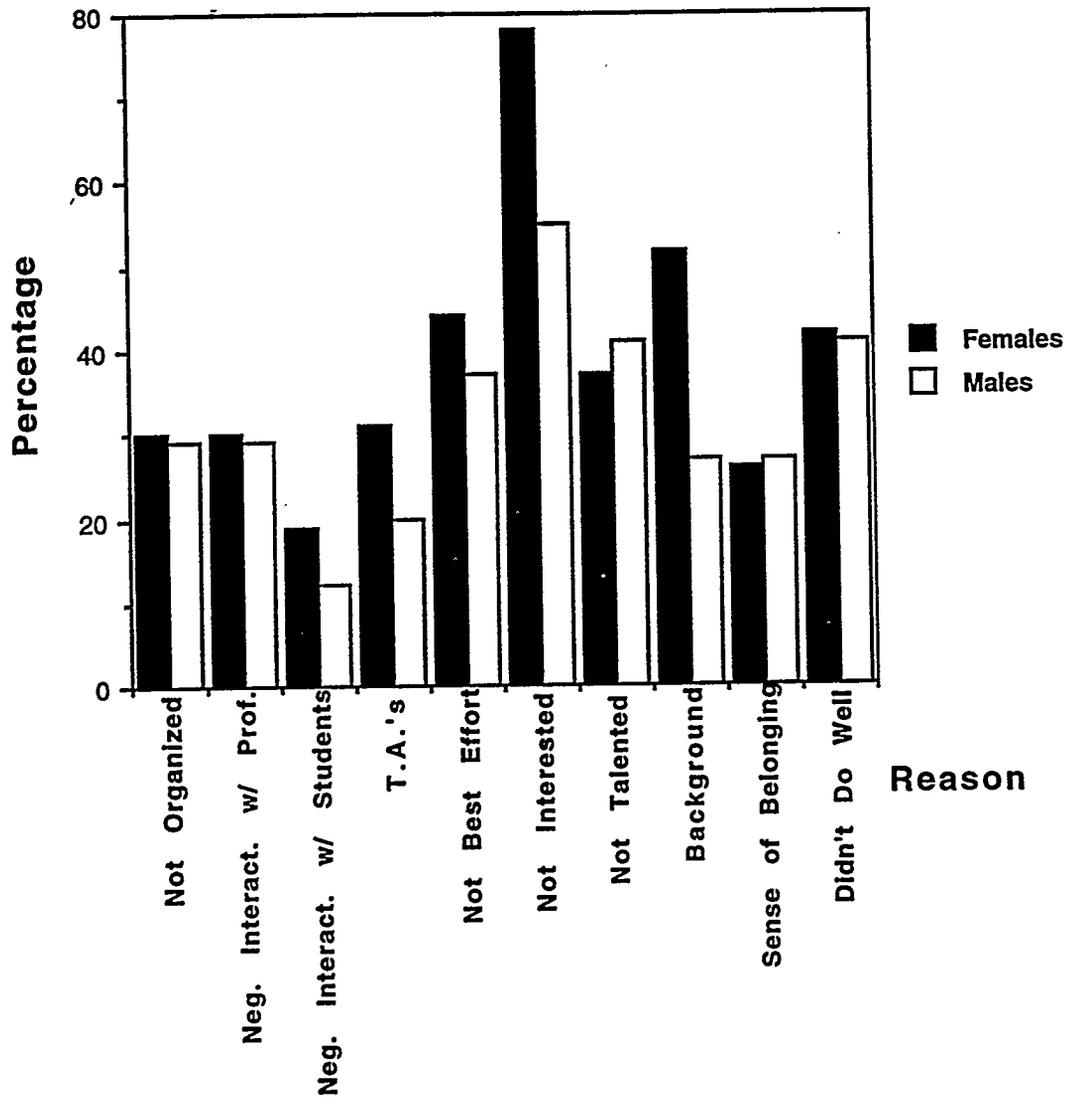
*Mark (X) "Yes" or "No" for each*

- |  | <u>YES</u>                 | <u>NO</u>                  |
|--|----------------------------|----------------------------|
| 1. Course was not well organized and/or informative.....                 | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 2. Negative (direct or indirect) interactions with the professor.....    | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 3. Negative interactions with the teaching assistants.....               | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 4. Teaching assistants not organized/helpful.....                        | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 5. Did not give my best effort.....                                      | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 6. Not particularly interested in the topic.....                         | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 7. Not as talented in this area as I thought.....                        | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 8. My background in this topic was insufficient.....                     | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 9. Lack of a sense of belonging/ not comfortable with my classmates..... | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 10. Didn't do as well as I expected...                                   | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 11. Other ( <i>Specify:</i>  |                            |                            |

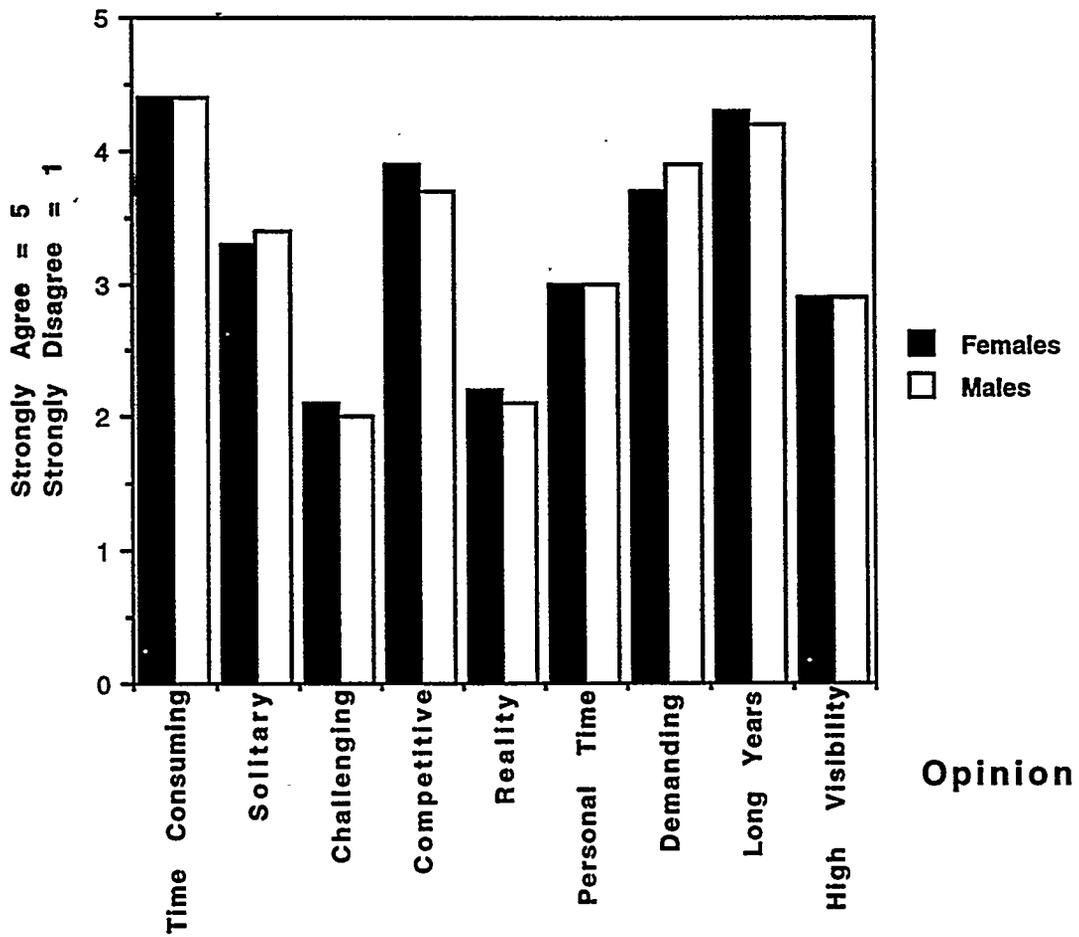
\_\_\_\_\_ )... 1  2

12. Other (*Specify:*  
\_\_\_\_\_ )... 1  2

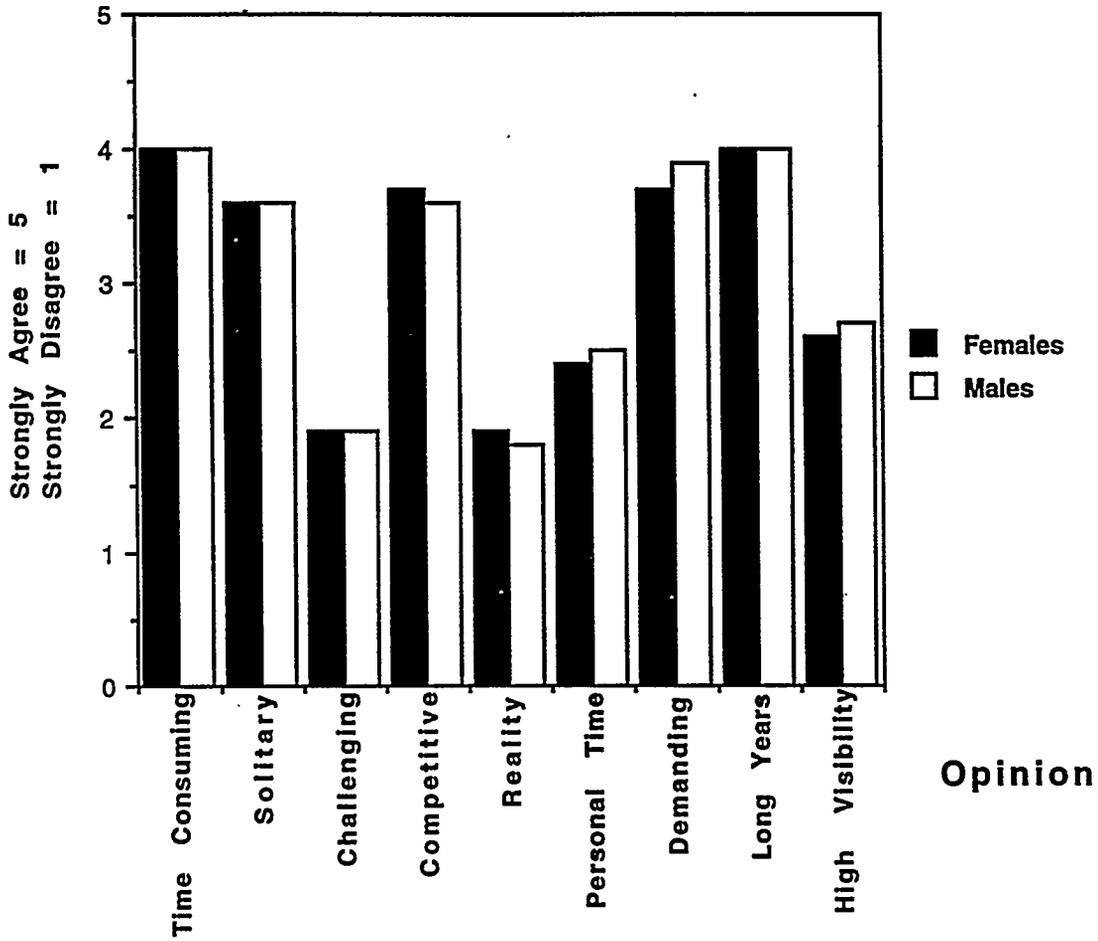
## Course Contribution To Major Switch



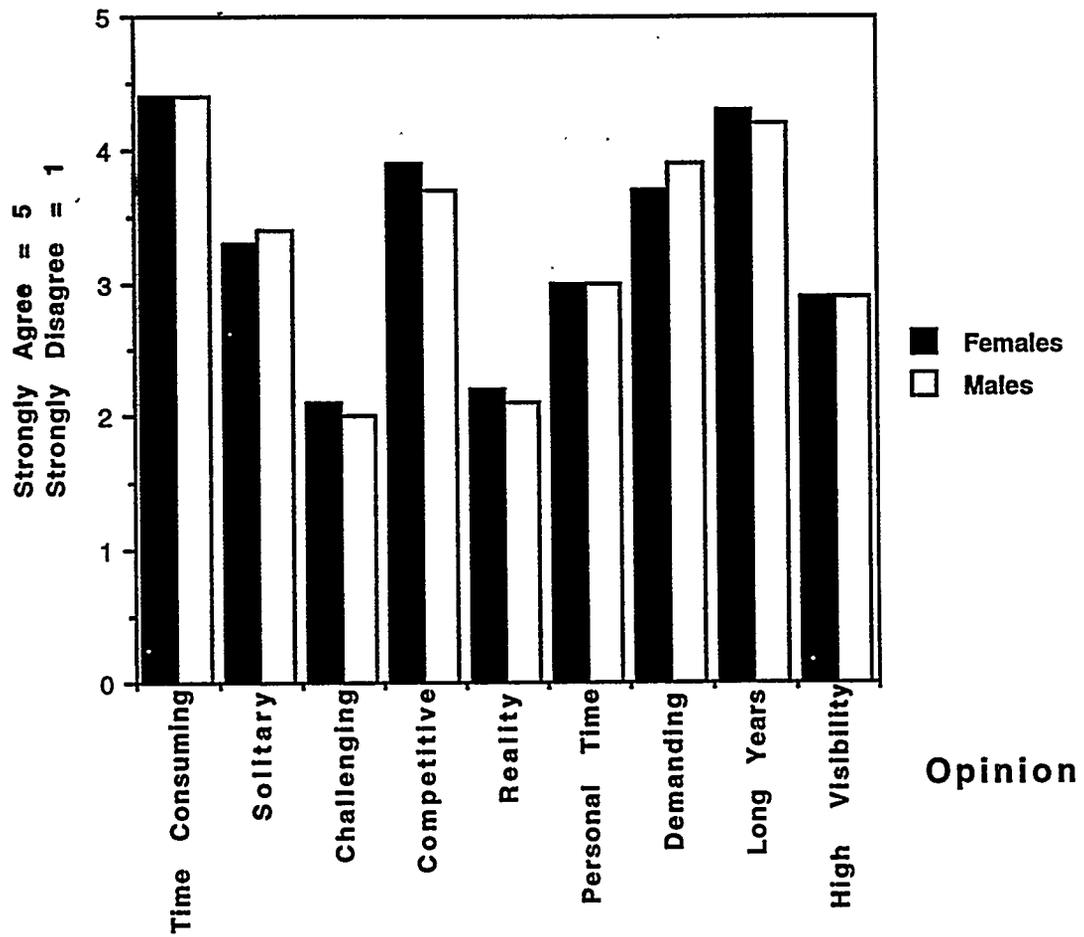
### Science And Math As A Career Choice At Current Time



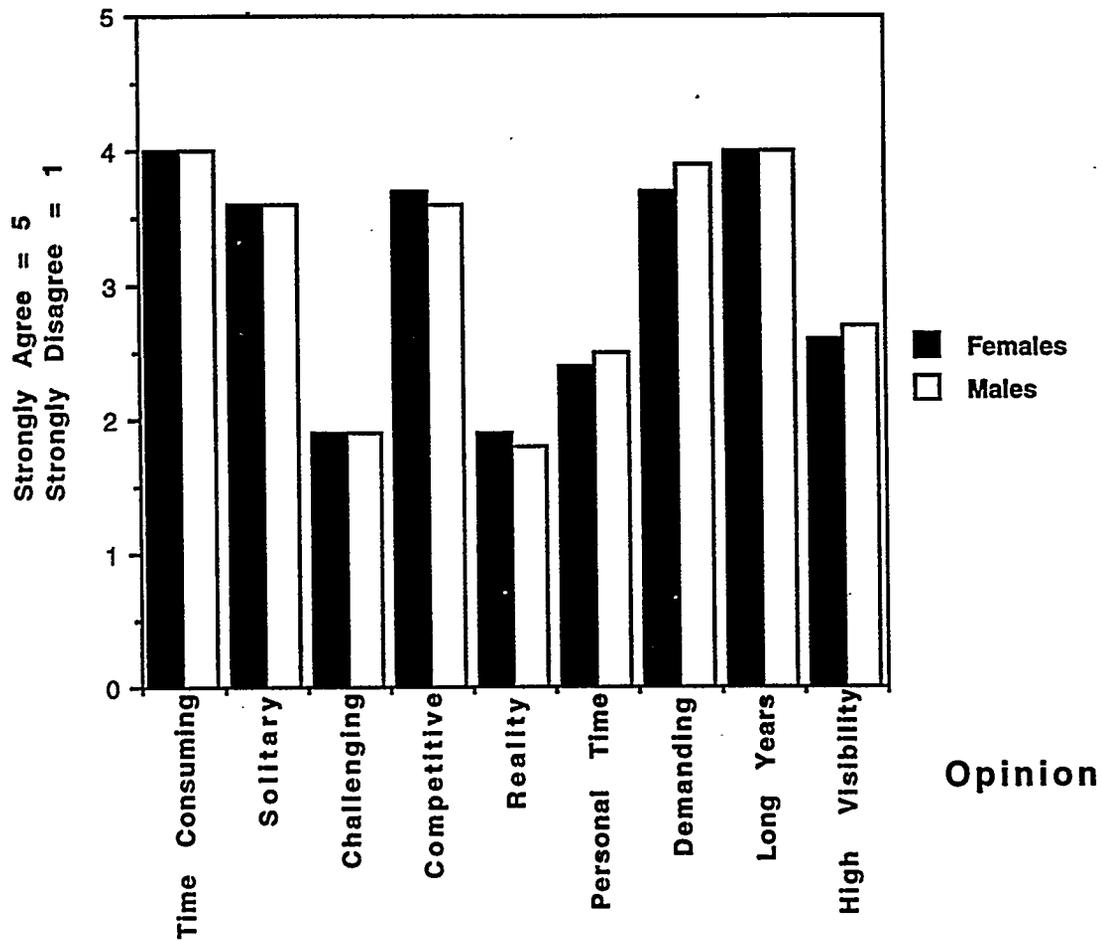
## Science And Math As A Career Choice When Entering College



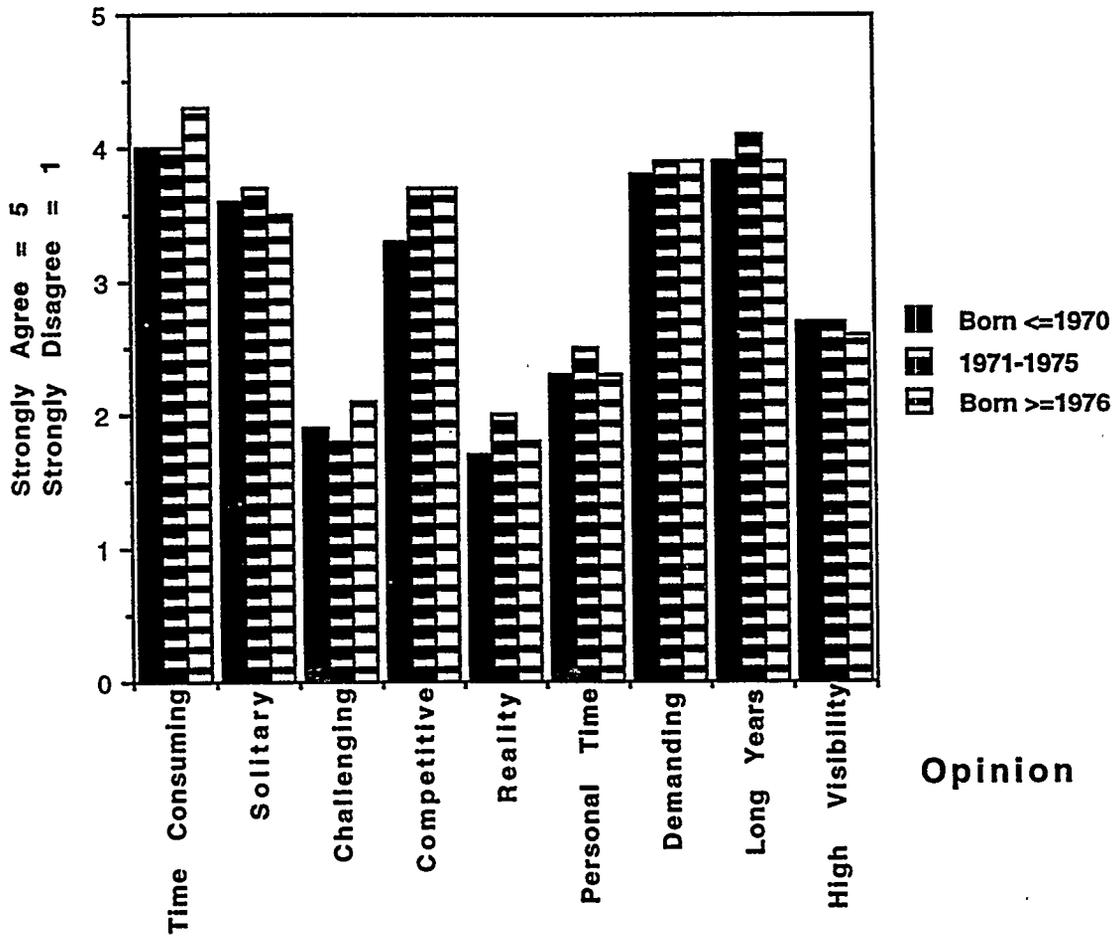
## Science And Math As A Career Choice At Current Time



## Science And Math As A Career Choice When Entering College



## Science And Math As A Career Choice When Entering College



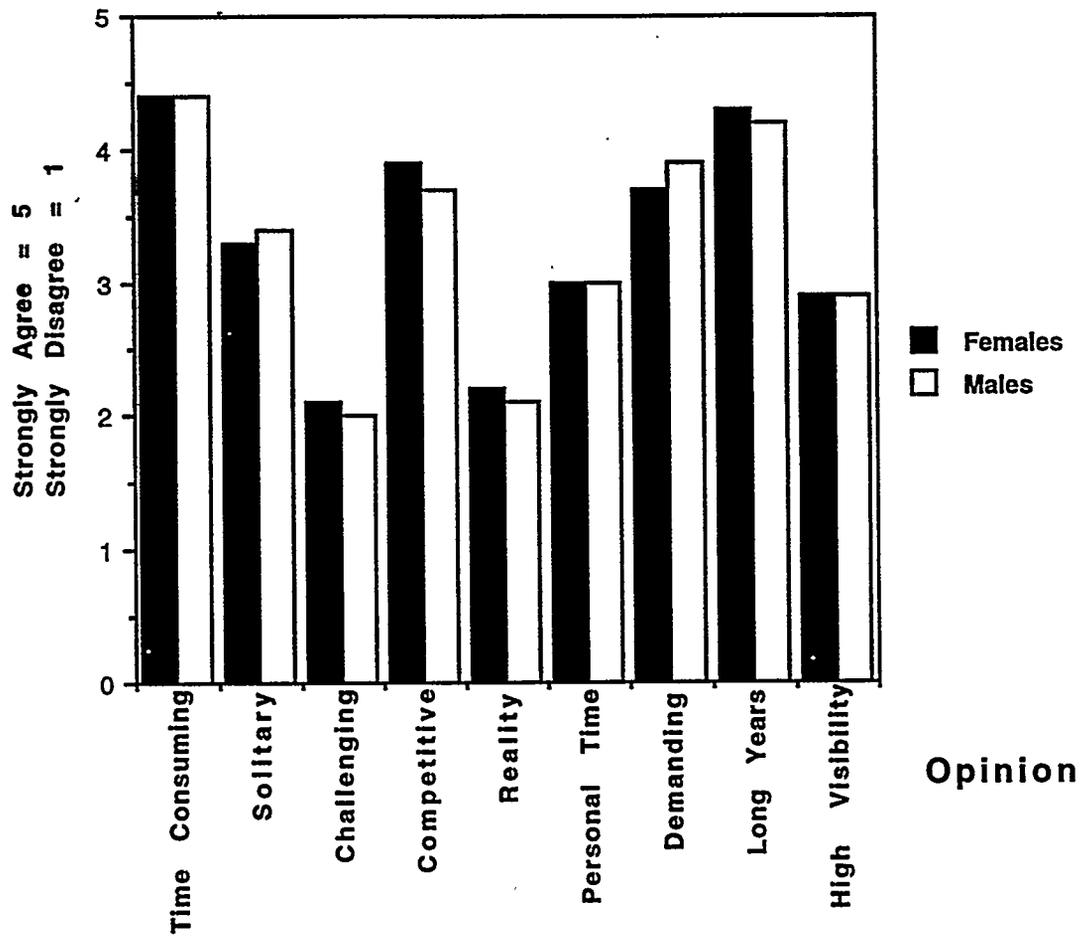
**C2. To what extent would you agree or disagree with those same statements today?**

*Mark (X) one for each*

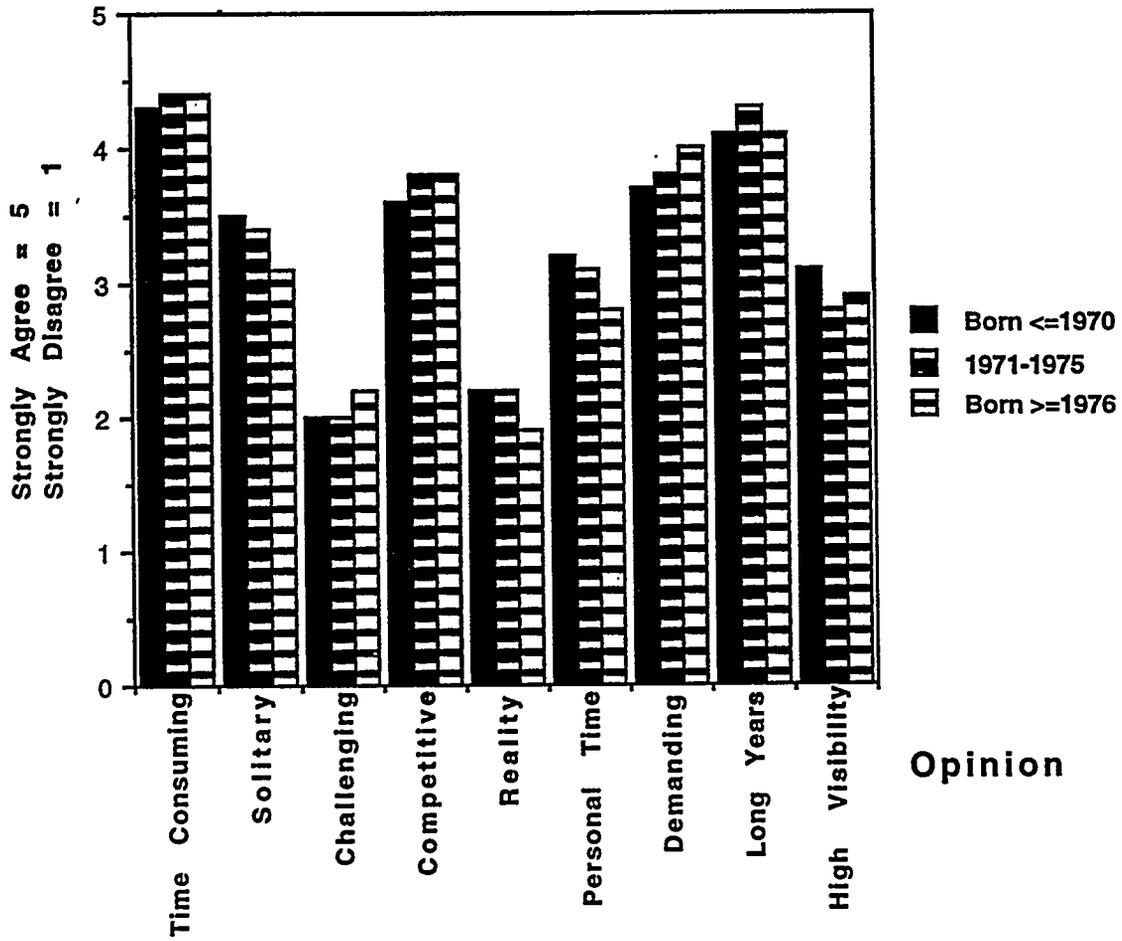
Agree Strongly	Agree Somewhat	Neither Agree Nor Disagree	Disagree Somewhat	Disagree Strongly
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1. Science and math studies/careers are time consuming.....	<input type="checkbox"/>				
2. Science and math careers are generally more solitary in nature than are other careers.....	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>
3. Science and math careers tend to be too intellectually challenging.....	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>
4. Science and math colleagues/students are very competitive.....	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>
5. Science and math studies are not well grounded in reality.....	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>
6. Science and math studies do not leave enough time for other electives and personal pursuits.....	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>
7. Science and math studies tend to be more intellectually demanding than other disciplines.....	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>
8. Science careers require long years of formal preparation.....	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>
9. It is almost impossible to become highly visible in science and math.....	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>

## Science And Math As A Career Choice At Current Time



## Science And Math As A Career Choice At Current Time

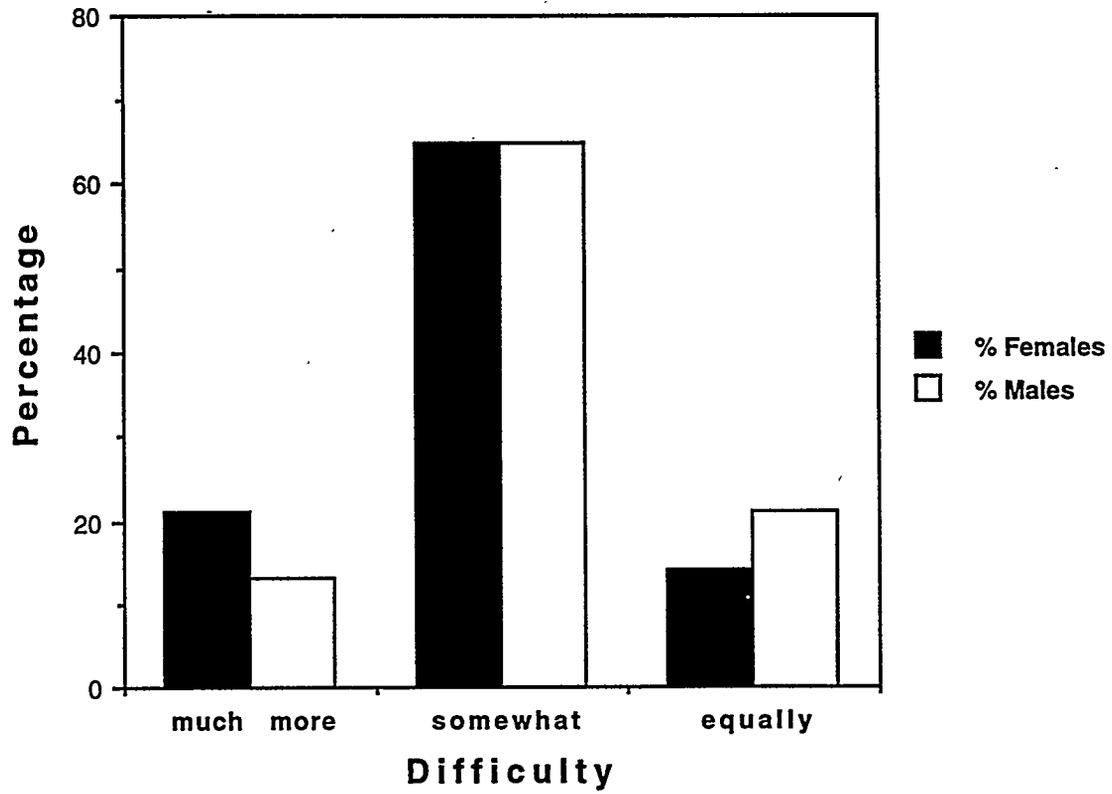


**C3. Which statement BEST describes your current thoughts on careers in science and math for men and women.**

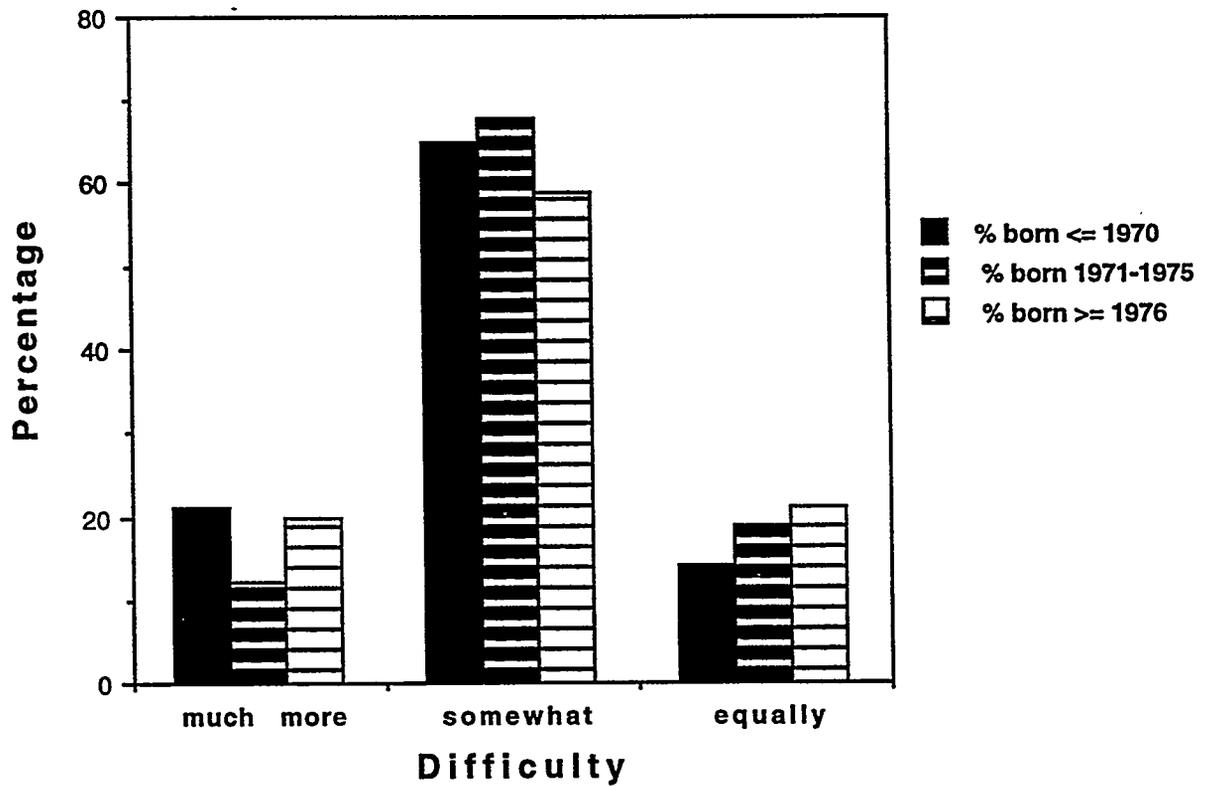
*Mark (X) one box*

- 1** For a variety of reasons it is much more difficult for women to have successful careers in science or math
- 2** For a variety of reasons it is somewhat more difficult for women to have successful careers in science or math
- 3** For a variety of reasons it is equally difficult for women and men to have successful careers in science or math

## Difficulty of Science/Math Career



## Difficulty of Science/Math Career



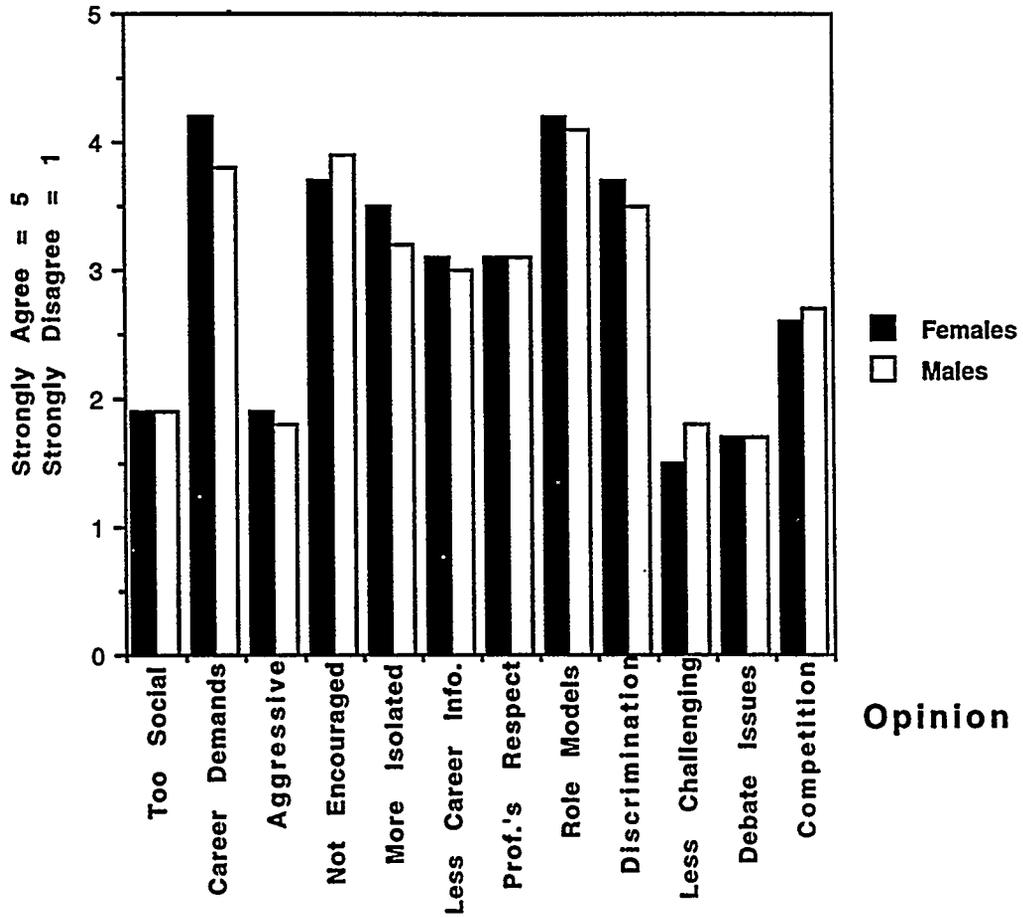
**C4. To what extent do you agree or disagree with each of the following statements.**

*Mark (X) one for each*

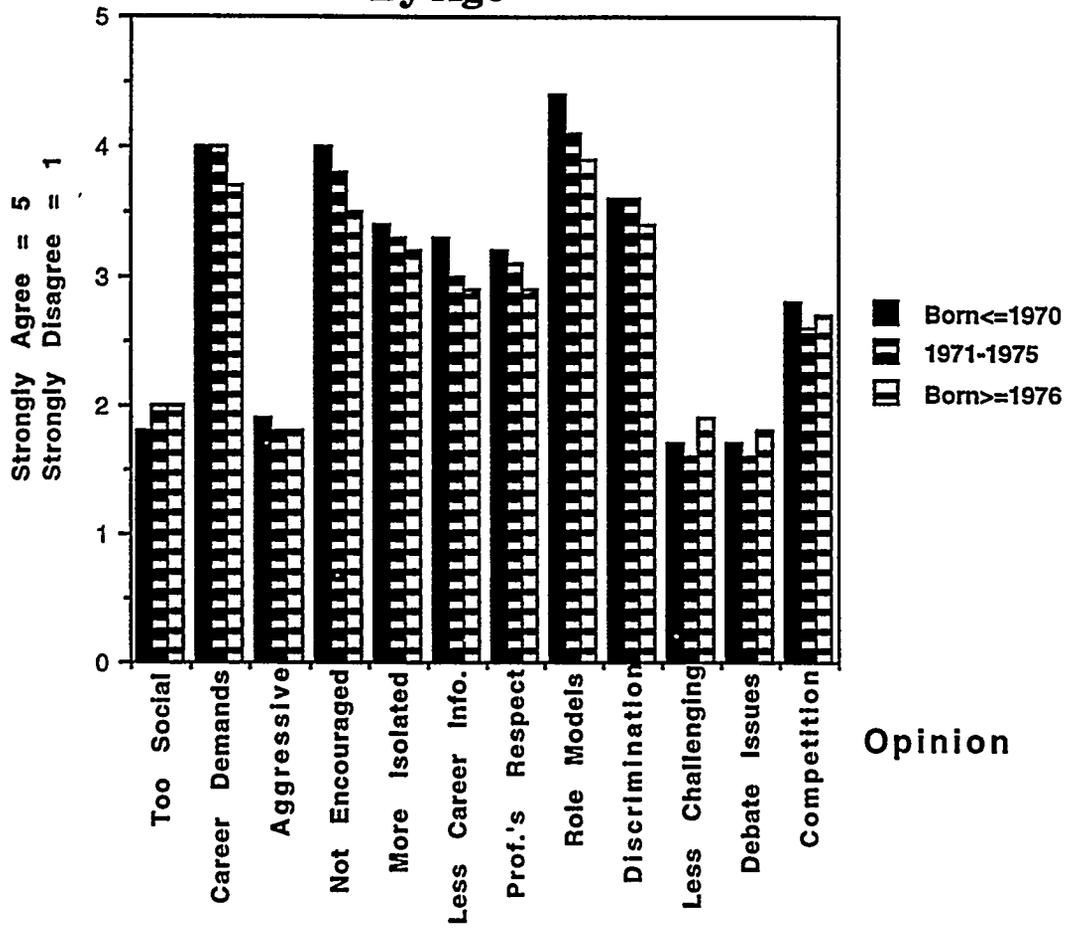
Agree Strongly	Agree Somewhat	Neither Agree Nor Disagree	Disagree Somewhat	Disagree Strongly
----------------	----------------	----------------------------	-------------------	-------------------

- |   |                          |                          |                          |                          |                          |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Women tend to be too social for the solitary nature of science and math careers..... | <input type="checkbox"/> |
| 2. Career and family demands cause more conflict for women.....                         | <input type="checkbox"/> |
| 3. The levels of science and math are too aggressive for women.....                     | <input type="checkbox"/> |
| 4. Women are not sufficiently encouraged to pursue math and science.....                | <input type="checkbox"/> |
| 5. Women are more isolated in math and science than men.....                            | <input type="checkbox"/> |
| 6. Women receive less career information than men in math and science.....              | <input type="checkbox"/> |
| 7. Science and math professors tend to respect women less than men.....                 | <input type="checkbox"/> |
| 8. Women have fewer role models than men in math and science.....                       | <input type="checkbox"/> |
| 9. Women are discriminated against in math and science in subtle ways.....              | <input type="checkbox"/> |
| 10. Math and science are academically less challenging for men.....                     | <input type="checkbox"/> |
| 11. Women do not know how to scientifically debate issues as well as men.....           | <input type="checkbox"/> |
| 12. Women enjoy the competition in science and math less than men.....                  | <input type="checkbox"/> |

## Science And Math As A Career Choice Men Vs. Women



## Science And Math As A Career Choice By Age



**D. FUTURE CAREER CHOICES**

**D1. Have you already (or do you plan to) attend graduate or professional school?**

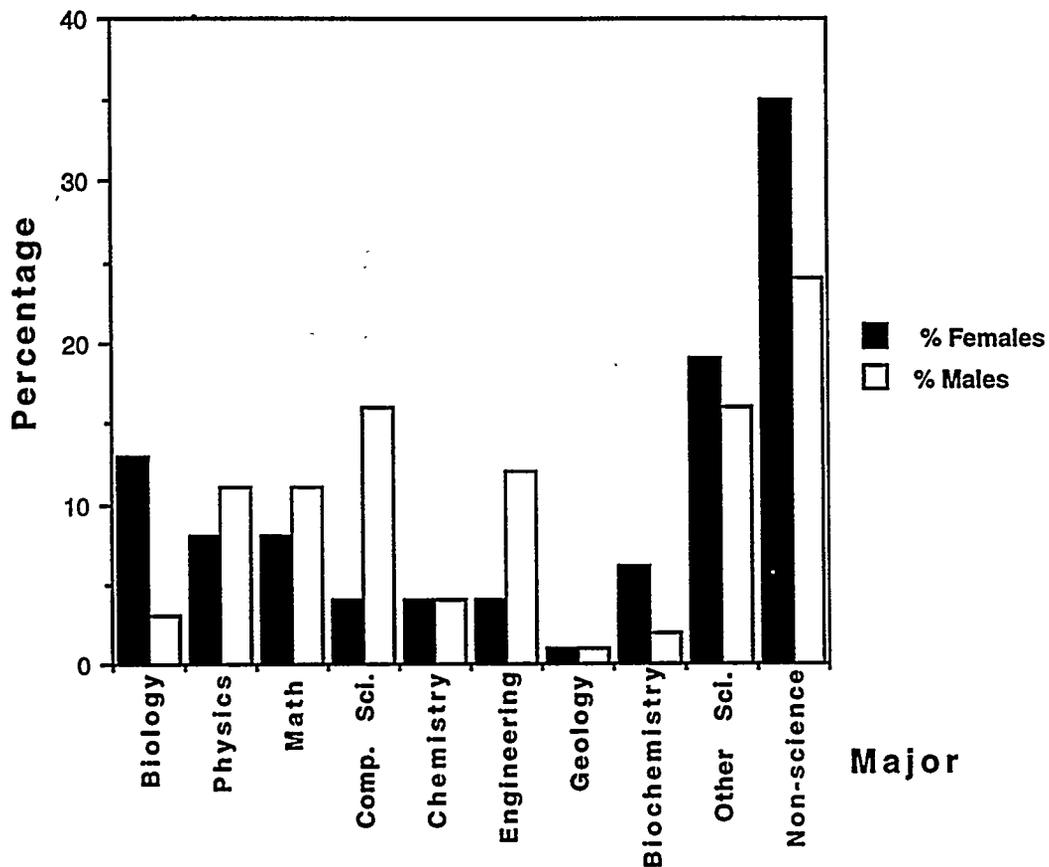
1  Yes, have or plan to

2  No, no plans to do so **SKIP to D2**

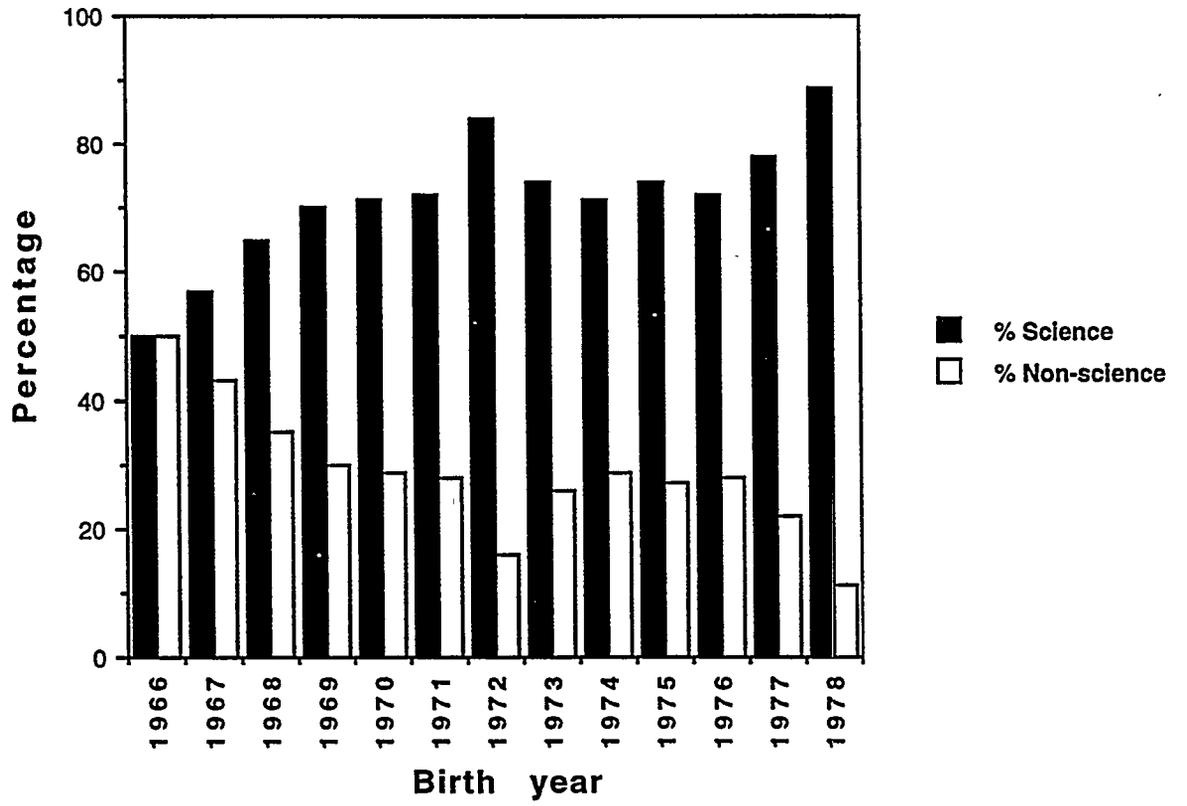
**D1a. (IF YES TO D1) In which field of study have you or do you want to pursue graduate or professional school studies?**

Field of Study: \_\_\_\_\_

### Current Or Intended Graduate Major



## Current or Intended Graduate Major



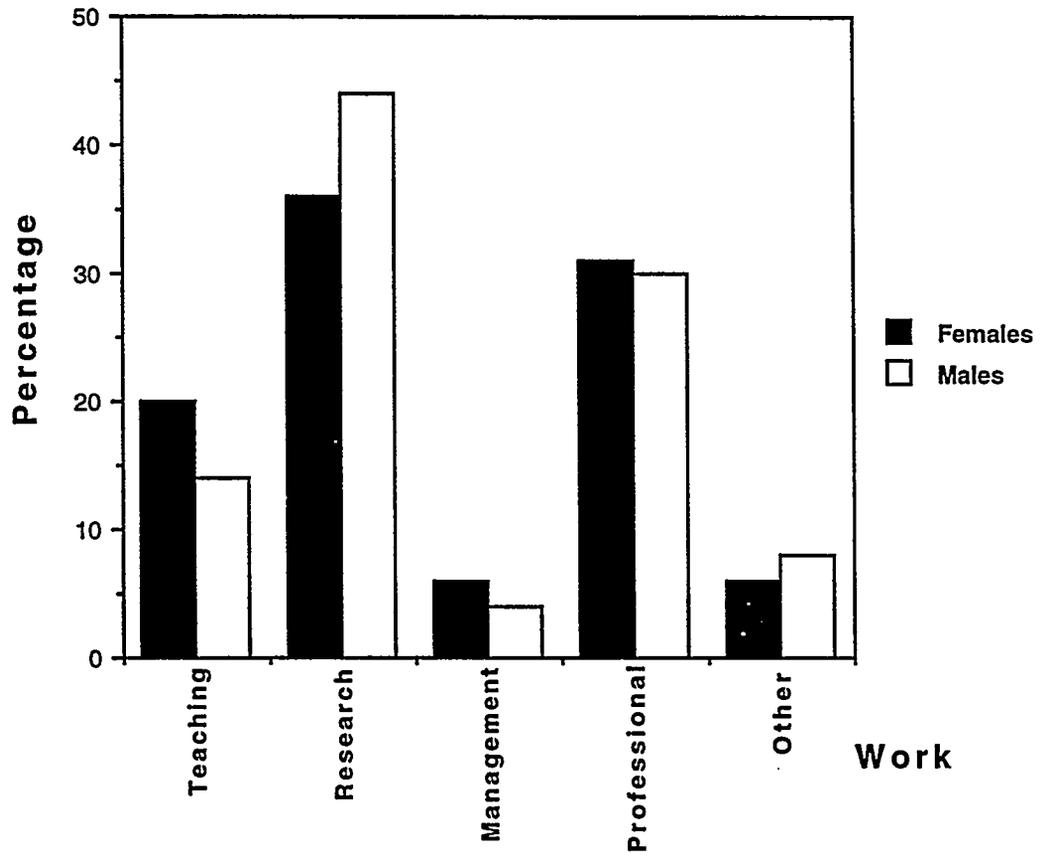
**D1b. Presently, what type of work would you MOST want to do after completing your graduate or professional studies?**

***MARK (X) one box***

- 1  Teaching
- 2  Research
- 3  Management/administration
- 4  Professional practice
- 5  Other time (*Specify:*

\_\_\_\_\_ )

## Work Chosen After Graduate School



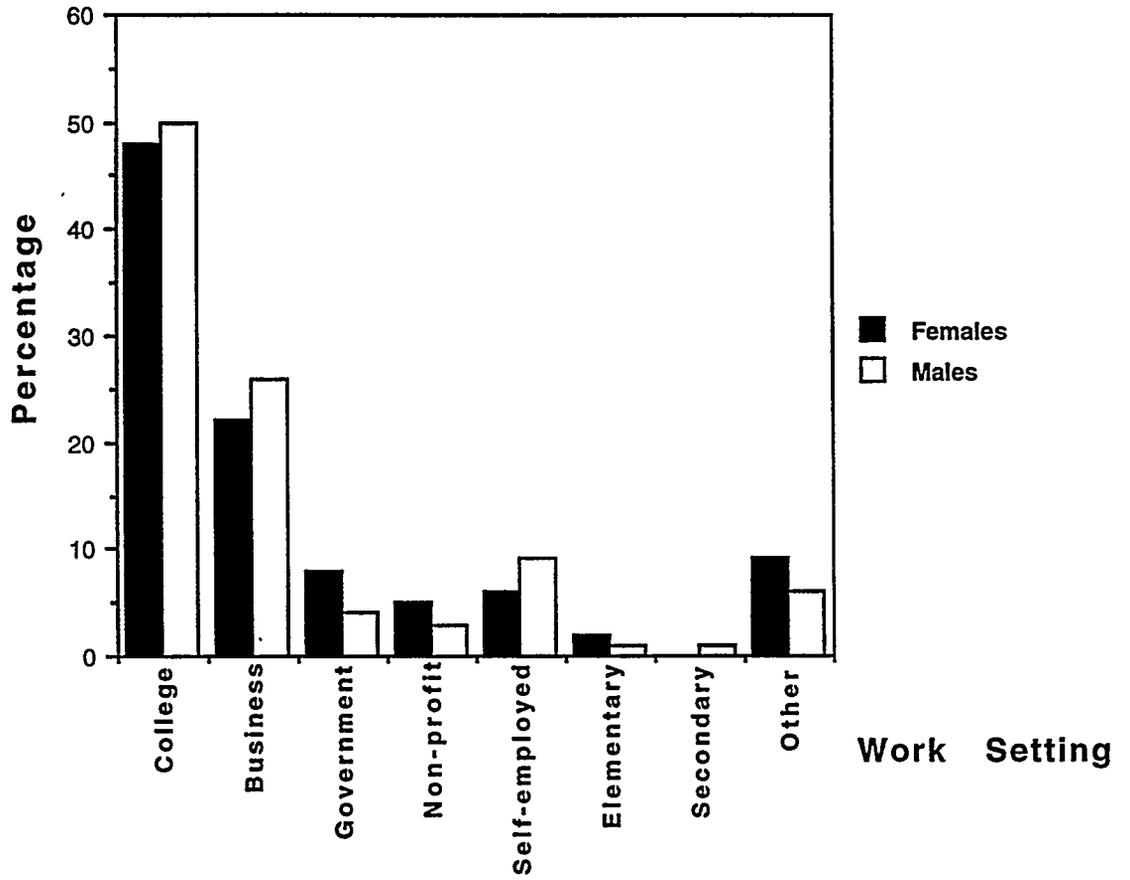
**D1c. Presently, in which type of setting would you MOST want to work after completing your graduate or professional studies?**

**Mark (X) one box**

- 1  College or university
- 2  Business or industry
- 3  Government
- 4  Nonprofit organization
- 5  Self-employed
- 6  Elementary school
- 7  Secondary or high school
- 8  Other (*Specify:*  
\_\_\_\_\_ )

→ **SKIP to D4**

## Desired Work Setting After Graduate Study



## E. CASE STUDIES

- E. Described below are 6 situations commonly faced by undergraduates. Thinking back to when you were an undergraduate (if you are not one now), read each situation and indicate your response.

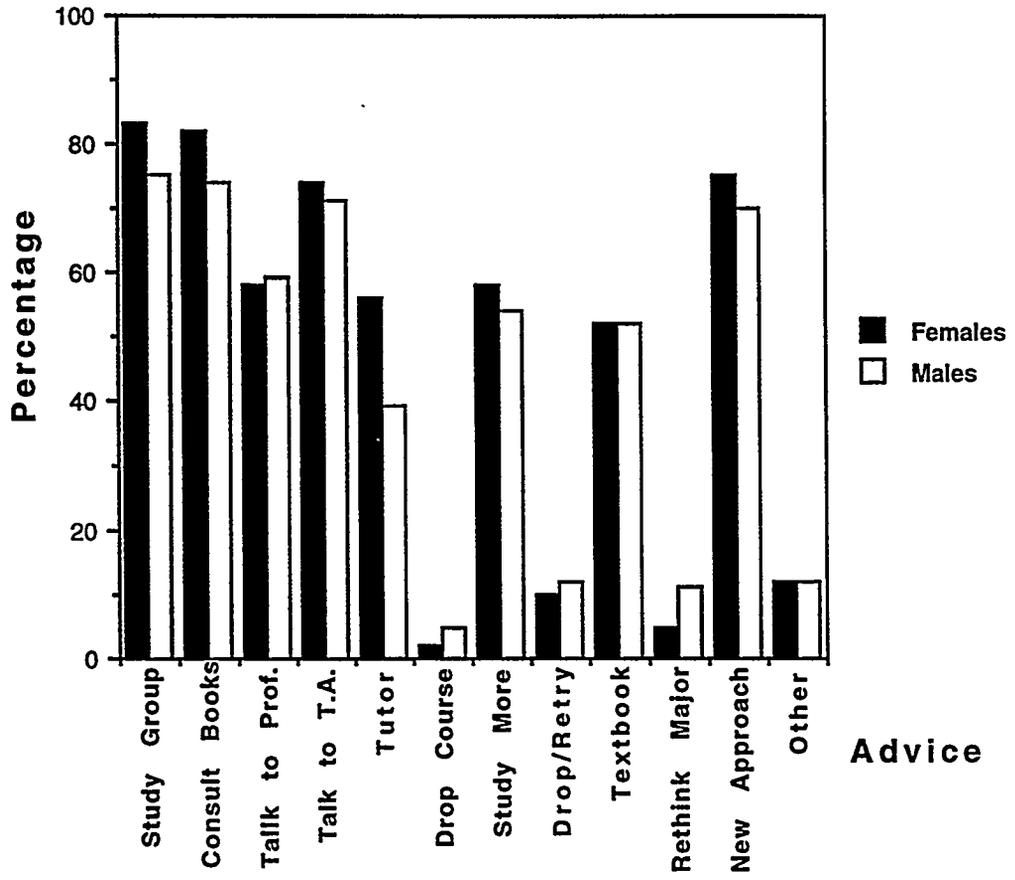
### E1. A Difficult Course

Although having taken the correct sequence of courses, Pelel has a problem with Mathematics 301, a required course for the chosen science major. The course material is rapidly paced and Pelel has trouble (like many others in the class) understanding more than a third of any class lecture. The textbook for the class is equally difficult to understand. Tutorials are somewhat helpful but problem sets take many hours. Pelel is feeling overwhelmed and questions further commitment to science studies. What would you advise Pelel to do?

**Mark (X) all that apply**

- 1  Become part of a study group to hear other explanations of the lectures
- 2  Consult other books for clearer and simpler explanations of the topics
- 3  Talk to the professor about the problem
- 4  Talk to the tutorial instructor about the problem
- 5  Find a tutor
- 6  Drop the course
- 7  Study with someone who is doing well in the course
- 8  Drop the course, take more background courses and try it again
- 9  Go over the textbook and lecture notes many times until the material can be understood
- 10  Rethink your choice of a science major
- 11  Advise Pelel not to lose confidence but try a new attack on the material
- 12  Other (*Specify:* \_\_\_\_\_)

## "A Difficult Course"



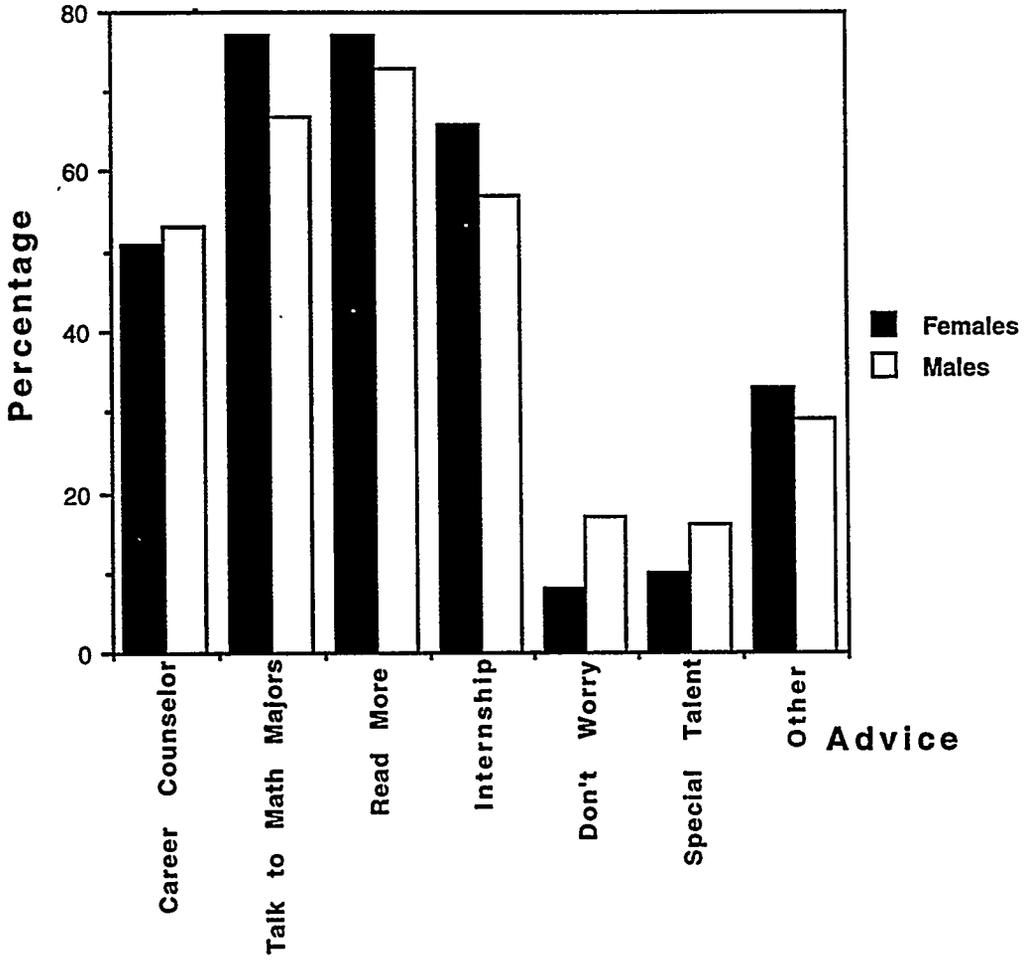
## E2. The Value of a Major

Marrin has been a mathematics major for two years and done well in the advanced math courses. Marrin enjoys math but has begun to question its relevance and value in the real world. Marrin is very talented in mathematics but is beginning to feel that math may not be the answer for solving some of mankind's problems. What would you say to Marrin?

**Mark (X) all that apply**

- 1  Talk to a career counselor
- 2  Talk to other math majors for their opinions
- 3  Read more about the options of a mathematics career
- 3  Work in a mathematics internship for the summer
- 5  Not to worry about relevance, it will come with time
- 6  Don't worry, mathematics is a special talent and should be used
- 7  Other (*Specify:* \_\_\_\_\_)

# "The Value Of A Major"



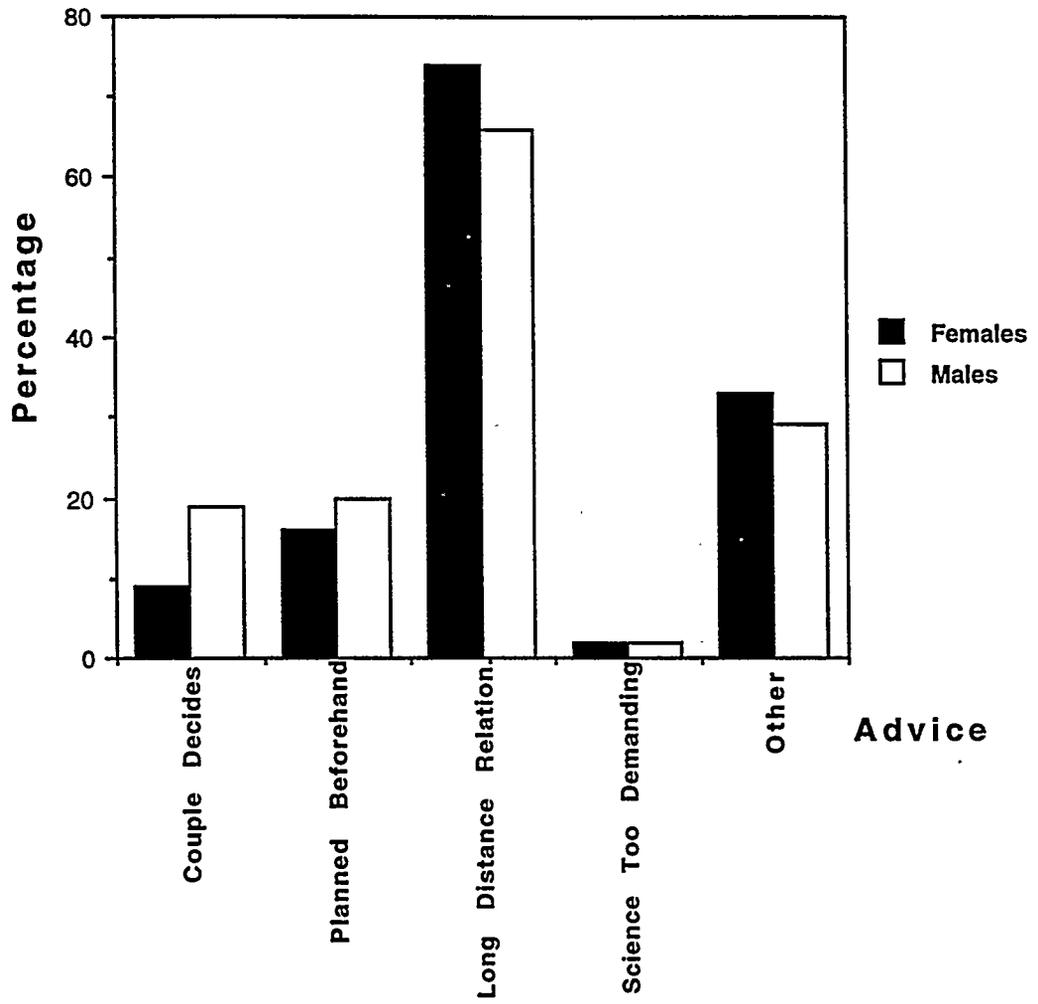
### E3. Conflicts in Family Needs

Sevra is graduating soon with a B.S. in electrical engineering and has been accepted into three excellent graduate programs. Sevra has a serious relationship with Byan who is finishing a degree in chemistry. Byan has also been accepted into two prestigious graduate programs but at different universities than Sevra. Sevra and Byan both want 1) the relationship, 2) to go to their first choice graduate program, and 3) children. What would you say to Sevra and Byan?

**Mark (X) all that apply**

- 1  They should decide who will be the primary earner and that one should have first choice of graduate programs and the other should be willing to compromise considering the care of children in the future
- 2  They should have planned beforehand to go to the same school—now it is too late
- 3  Each should go to his or her first choice graduate program and let the relationship continue at long distance
- 4  Science is so demanding they should not consider having a family
- 5  Other (*Specify:* \_\_\_\_\_)

### "Conflicts In Family Needs"



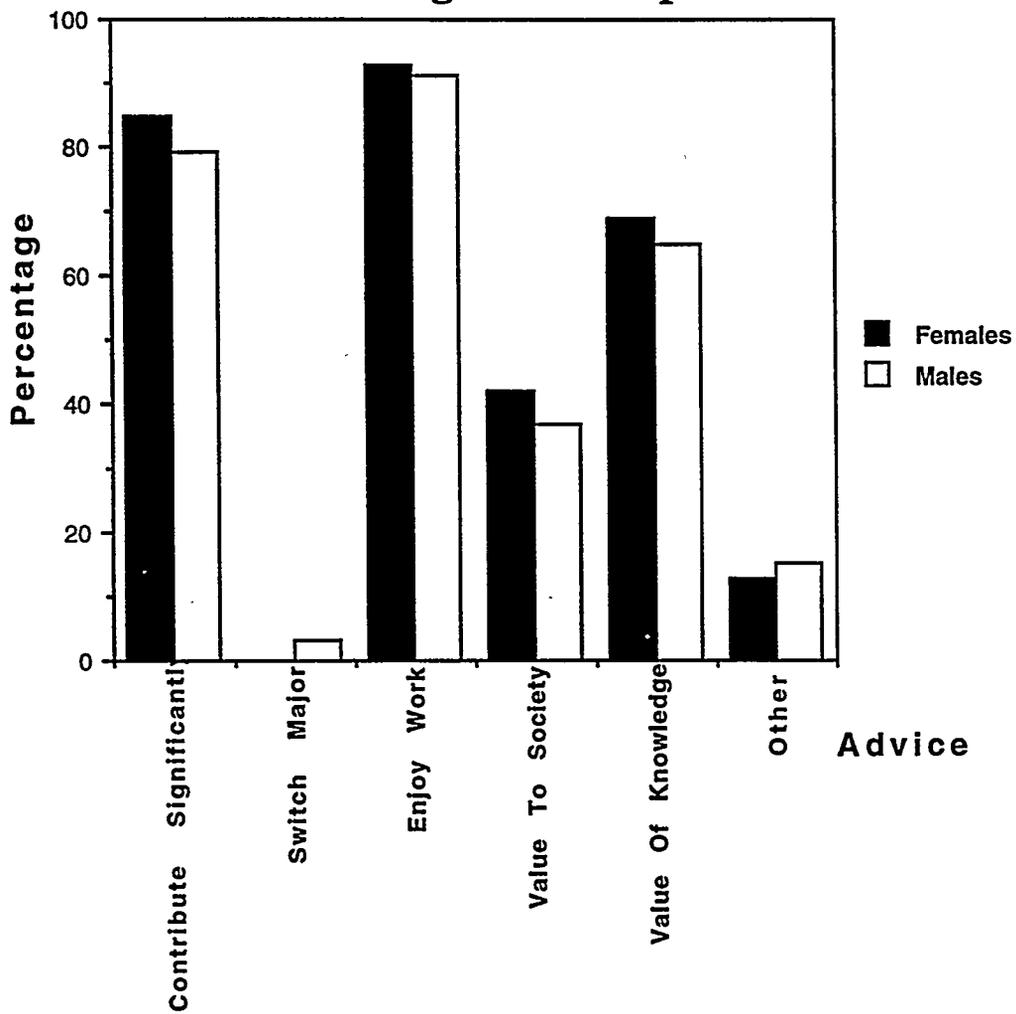
**E5. Not Being at the Top**

Fenyl was the high school class valedictorian and always considered an outstanding computer scientist. Fenyl went to a prestigious university and soon met others of equal or greater ability in computer science. Although gifted in computer science, Fenyl questioned whether to continue in the field because of no longer being at the top. What would you tell Fenyl?

**Mark (X) all that apply**

- 1  One can contribute significantly to a field without being the top performer
  - 2  It is best to be at the top of one's field so switching majors might be advisable
  - 3  It is important to enjoy your work and study -- not to worry about being at the top
  - 4  That computer science is valuable to society and not to consider only top positions
  - 2  To minimize the importance of the letter grade and reemphasize the importance and value of the knowledge gained.
  - 6  Other (*Specify:*
-

### "Not Being At The Top"



6) **Being a Minority**

Relan is a minority person of high ability. Although Relan has always pursued science studies in biophysics, always being the only minority, or one of a few has engendered feelings of isolation and loneliness. Relan finds it difficult to fit easily into study groups. Relan's social friends are not from biophysics; they are minority students in other majors. Relan feels "uncomfortable" with the other biophysics majors. This has started to take its toll on Relan's performance. Relan enjoys biophysics but is tired of the "struggle" to belong and succeed. What would you say to Relan?

**Mark (X) all that apply**

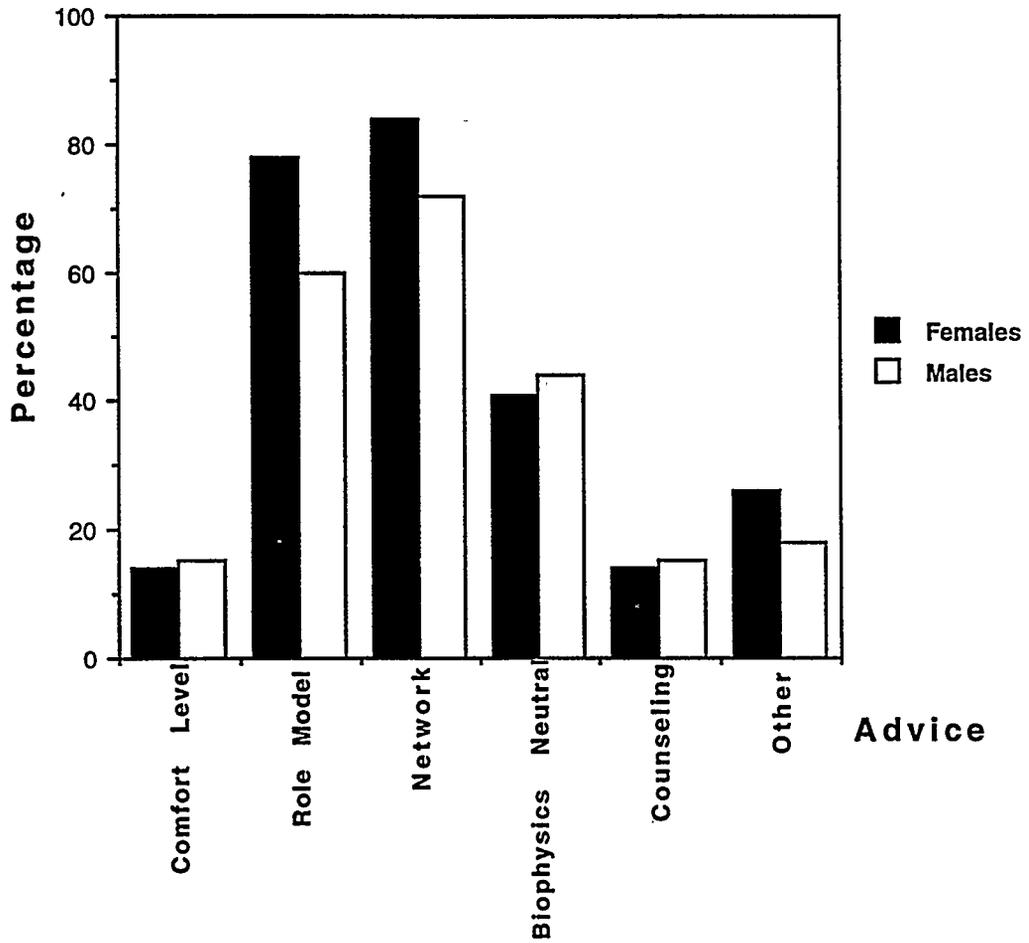
- 1  Your "comfort" level is important so find a major where you are comfortable
- 2  Try to find a role model and talk to that person
- 3  Try to network with other minority students interested in science
- 4  Biophysics has no color or sex or ethnicity—just its practice
- 5  Seek counseling, perhaps career counseling
- 6  Other (*Specify:*

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## "Being A Minority"



## SUMMARY OF RESULTS FROM QUESTIONNAIRE II

### A.1 Choice of intended major after high school as entering college/university.

#### A. Non-gender specific findings

1. By the end of the senior year as entering college, 10% of both RSI alumni men and women have decided to change to a non-science major.
2. Chemistry is a major equally chosen by both males and females

#### B. Gender specific findings

1. Gender specificity after high school in choice of undergraduate major is clearly defined for RSI alumni. Women choose a biology major three times as often as men (18% versus 7%) and a biochemistry major twice as often as men (17% versus 8%). Despite equivalent mathematical ability to their male counterparts, RSI women reflect the gender-specific choices of biologically related majors similar to the general population.
2. Men choose physics and mathematics as a major at a three to two ratio compared to women (18% versus 12%) and computer science and engineering approximately twice as often as women (9% versus 5% and 19% versus 11%, respectively).

### A.2.a. Most influential factor in choice of first intended major as entering college

#### A. Non-gender specific findings

1. The choice of interest in a major is the single most important choice for both RSI men and \*\*\* women (49% and 45%). This points to the importance of creating a strong interest in science and mathematics within the high school experience
2. The second most important factor is their ability, 28% for males and 22% for women. The perception to have the ability to succeed in science is also important in choosing a science/math career and must be part of the interest created in secondary education.
3. All other influences such as family, the RSI experience, teachers, peers, work experience, and parental careers are much less important (less than 10%).

#### B. Gender specific findings

1. For women an strong academic or life experience in science/math is much more important than for men (13% versus 5%).

### A.2.a. Second most influential factor in choice of first intended major as entering college

#### A. Non-gender specific findings

1. Both men and women choose their ability as the most important factor (approximately 30%) \*\*\* with other factors being interest and academic and life experience with science and mathematics.

2. Other factors as teachers, family, parental occupation, peers, work experience are less important influences in the early choices of the RSI alumni.

**B. Gender specific findings**

1. Women are more influenced by awards than men (10% versus 1%) perhaps providing an outside source of belief in their native ability and efforts and a human support network.

**A.4. Future work choices after high school on entering college/university.**

**A. Non-gender specific findings.**

1. Forty-five percent of both RSI men and women chose research as the type of work they most wanted to do after college or education indicating a strong early preference of an academic life.
2. Planning for a professional practice was the second most popular choice at 19%.
3. Sixteen percent of RSI alumni were unsure of their future plans on entering college.

**A.5. Future setting for work after college.**

**A. Non-gender specific findings.**

1. Almost 50% of both men and women chose college or an academic setting as their future place of work with a business setting as a second choice of 25%. These choices of setting are consistent with the initial choice of a research career of A.4.
2. It is interesting to note that women and men equally chose research and an academic life at the beginning of their college experience though their choices of science/math disciplines vary considerably. The experience of research and academic life at this point must be a positive and sought after way of life.

**B.2. Declared major in college.**

**B. Gender specific findings.**

1. Women continue to choose biology as the most popular major compared to men (20% versus 6%). The numbers of women in biochemistry drops one-third from the first declared major (17% to 12%). A small decrease is also observed in the number of engineering majors. There is a significant increase in non-science majors for women from 8% originally to 14%. Since the first declared major is often after the sophomore year, this reflects findings from initial Phase I of the study.
2. Men continue to choose physical sciences and mathematics compared to women. The greatest change for men is in the field of physics where a one-third loss is seen from the first intended physics major (18% to 13%) at the time of the first declared major. A small number of men also switch to a non-science major (8% to 11%).

### **B.5., B.6., B.6.a. Current or completed college major**

#### **B. Gender-specific findings.**

1. Women graduate with a biology degree 3 times that of males (23 % versus 8%). Women choose non-science majors 50% more often than men (18% versus 12%). One out of two women who planned for a biochemistry major after high school graduate with one (17% versus 9%). RSI women who begin in physics, mathematics, and computer science have a small attrition rate.
2. RSI men graduate from college with twice as many degrees in physics (12%), mathematics (20%), computer science (13%), and engineering (16%) than RSI women.
3. With the exception of the loss of women from biochemistry and men from physics the change of majors during college years for RSI students is small. The change in physics for men may reflect the poor job market in this area and not necessarily personal interest.
4. The important finding is that the creation of interest and belief in personal ability in women to  
\*\*\* be successful for women in mathematics, computer science, engineering, and physics must be done in high school to attract more numbers of women in these fields.

### **B.9. The reasons for switching to a new major from the first intended major.**

#### **A. Non- gender specific findings**

1. Of the RSI men and women who switched majors during undergraduate years it was due to a change in goal to a new type of work for their future. Item 15 relating major to future work was chosen 65% of the time by both men and women.
2. The reasons for the new work goal may be understood by the other reasons chosen as causative for changing the originally intended major. These include: Item 14, loss of self-confidence (women 45%, men 43%); Item 4, personal feelings of failure (women 40%, men 32%); Item 2, change in perception of a science/math career as fulfilling (women 34%, men 35%); Item 5, not comfortable with peers (women 30%, men 25%), and Items 6, 11, and 9 (potential value to society, no personal time for other interests, and job opportunities all around 30%).
3. The major cause of switching majors appears to be new future goals though the reasons for  
\*\*\* setting new goals appears to be a sense of not belonging in science due to lack of ability, loss of self confidence in ability, and loss of comfortable peers. These reasons reflect findings from cognitive interviews where students who switched majors more often did so because of lack of confidence and a "struggle" with science than for more positive reasons.

### **B.10.b. Contribution of courses to reasons for switching majors.**

#### **A. Non-gender specific findings**

1. RSI men and women ranked poor performance, lack of effort, lack of talent, and poor grade as reasons a course was influential in making the decision to switch from their intended science/math major.

## **B. Gender specific findings**

1. Women cited lack of interest in a course 50% more often than men (78% versus 54%). They were also cited their lack of sufficient background for a course as troublesome and reasons for switching 50% more often than men (52% versus 26%). Negative interactions with teaching assistants and students were also more often cited by women.
2. Women often remark as to the lack of creativity in teaching of science courses and in relation \*\*\* to section A findings the creation of interest in the discipline is the most important factor in major choice. Women have cited repeatedly their feelings of lack of sufficient background for a course whether this is founded in inadequate preparation from high school or lack of adequate guidance in choice of courses at the university level.

## **C.1. Perception by RSI alumni of a science/math career as entering college**

### **A. Non-gender specific findings**

1. Men and women strongly agree in their early perceptions of science and math careers as being time consuming, solitary in nature, competitive, demanding, and requiring long years of preparation.
2. Both RSI men and women see a science career as not too intellectually challenging and grounded in reality.
3. The equivalent perception of science careers by men and women demonstrates the initial \*\*\* perception by women that it is an appropriate career for them and not too intellectually challenging. Some of the negative aspects of time needed, self-discipline, and long years are appreciated early on by the RSI students, however, it does not change their choice initially.

## **C.2. Perception by RSI alumni of a science/math career today**

### **A. Non-gender specific findings**

1. Men and women agree today as they did early in their studies that science and math careers are time consuming, competitive, demanding, and require long years.
2. Over the years, there is a slight increase in appreciation of the time consuming nature of science \*\*\* and math and a definite appreciation by both men and women of the cost to personal time for other interests. The lack of personal time has been cited in personal interviews with students as a troublesome aspect of a science career.
3. Over time there is no real change in perception or experience of the challenging nature of science or its lack of reality.

## **C.3. Perception of difficulty of a science and math career as a choice for a woman**

### **A. Non-gender specific findings**

1. Both RSI men and women agree 65% that a successful career in science is "somewhat" more \*\*\* difficult for women indicating an acceptance of a popular perception by both sexes.

## B. Gender specific findings

1. In contrast to somewhat difficult, approximately 20% of women consider such a career much more difficult for themselves than men, and 20% of men consider the difficulty of this career equal for men and women. The differences in perception of women in science is at the extremes of no difficulties compared to men versus great difficulties compared to men.

## C.4. Points of difficulty for women in science and math careers

### A. Non-gender specific findings

1. The two major difficulties named by both men and women for women in science and math \*\*\* careers are conflicts of career and family and lack of role models for women. Five other difficulties are also agreed to by men and women as difficulties for women in science and math careers: lack of encouragement, subtle discrimination, a sense of isolation, less career information, and less respect by professors. The importance of these findings is that both men and women perceive these difficulties equally eradicating the possibility of charging women with being too sensitive to situations.

## D.1. Future or present major in graduate school

### A. Non-gender specific findings

1. In chemistry and geology men and women percentages of choice are similar, 5% and 1% respectively. In physics and math, men have a slightly higher percentage of about 11% compared to women at 8%, however, this reflect similar ratios of choices at the undergraduate level.

### B. Gender specific findings

1. The percentage of women now choosing or planning to choose non-science majors in graduate school is now 35% compared to 25% for men. Of the 23% of women who graduated with a biology major, 13% will continue in a graduate degree. Eighteen percent of women go on to do another science, mostly medicine. Women still comprise 8% of biochemistry degrees compared to men at 2%.
2. Men comprise the greatest number of future computer science majors compare to women (16% versus 4 %) and also in engineering (12% versus 3 %) similar in ratio to earlier undergraduate choices.
3. These findings demonstrate that early choices of biological sciences by women and \*\*\* physical/mathematical sciences by men continue through graduate school. The alarming finding is that for both RSI men and women with gifted mathematical and science ability that one-third for women and one-fourth for men will leave a science and math career by the time of graduate school. This represents a 3.5-fold attrition increase for women compared to time of entry of college and a 2.5-fold attrition for men.

### **D.1.b. Work plans after graduate school**

#### **A. Non-gender specific findings**

1. The first choice for both RSI men and women is again research compared to plans immediately after high school with a sharp increase in percentage of professional training planned (18% after high school to 30% now). This probably reflects the increased interest in medical school. There is also a considerable increase in teaching from 10% after high school to an average of 17% now.

#### **B. Gender specific findings**

1. The percentage of women choosing research at the graduate school level is decreases to 35%  
\*\*\* as compared to a planned 47% upon entering college. In contrast, the percentage of women interested in teaching after graduate school is 20% versus 9% when entering college. The reasons for this may be multifactorial including perceived difficulties of conflict of family and career, difficulties of a science/math career for women in general, or negative experiences that have shaken confidence and original interest of women in research and a science career.

### **D.1.c. Desired work setting after graduate school**

#### **A. Non-gender specific findings**

1. Although there is a shift in plans for men and mostly women from research to professional  
\*\*\* work or teaching both men and women remain committed to an academic life goal at a college or university. Business still remains a major second choice after graduate school compared to early college plans for both men and women.

**VI. INTERVENTION DESIGNS FOR RETAINING YOUNG  
SCHOLARS IN SCIENCE/MATH CAREER PATHS**

## POTENTIAL INTERVENTIONS TO MITIGATE LOSS OF HIGH -ABILITY WOMEN FROM SCIENCE AND MATH RELATED CAREERS

### **Interventions by Center for Excellence in Education**

1. During RSI experience provide half-day workshop for women and men on differences in men's and women's reactions in difficult academic situations, and methods of coping with difficulties and being a minority in class. That is provide information on what to expect in first two years of university.
2. Through Internet provide mentoring to younger RSI alumni by older RSI alumni.
3. In RSI newsletter sent to all RSI alumni, each issue feature 6 RSI alumni with personal stories about path of studies, career, etc. Make career path "real". One issue focus on physics, next chemistry, next computer science etc. (May be an excellent project for RSI alumni association)

### **Interventions by Universities**

1. Distribute contents of report to Provosts of major universities with findings of study so can validate need for intervention. Possible meeting with Provosts and Deans of Colleges of Science, Engineering, Mathematics, and Computer Sciences. Need attention and commitment to efforts of intervention by administration so can send message of importance of these efforts to all departments.
2. Universities must commit to hiring informed advisors for students in science and engineering. This is specially true at major research universities where faculty do not have quality time to devote to student advising because of pressures for research, grant funding, and publications.

### **Interventions by established Women in Science Advocacy groups**

1. Establish University Chapters of AWIS so young women students can identify early with other professional women scientists. This would 1) provide role models for students other than university faculty (few women faculty in math and sciences), 2) provide possible career path information for students, and 3) provide a professional identification for young women early in their careers.
2. The University Chapters would provide meetings four times a year. One of each of these meetings would be focused on:
  1. Possible careers in science/math for women
  2. Poster and Research reports by students for networking with each other
  3. Workshop on survival skills and success pathways in science/math
  4. Grants and grant writing

## **PHASE III: ACTION AND INTERVENTION -- RESOLUTION OF THE PROBLEM**

At present , even though these conclusions may be partially modified following the statistical analysis of data from Questionnaire II, the following represent the major action points for the Center for Excellence in Education on preventing the loss of women from science and math careers.

### 1. Increase Visibility of Study Results

Publish results of study in reputable educational research journals and present at Women's Leadership Conferences in science and higher education. Publish a guide book of interventions that can be used by universities and organizations.

### 2. Development of Targeted Success Skill Training for Women in Math and Science

The following content areas of professional education should be made available to young women aspiring to careers in sciences and math.

#### **a. Political savvy in how to be successful in a male-dominated environment:**

- How to use leadership skills to engage others to achieve your goals eg.  
Mentors and peer study groups
- Communication skills in presenting own views assertively
- Elimination of hidden messages conveyed by demeanor and need for approbation.
- Methods to handle aggressive comments and behaviors

This training will follow the advice of two eminent women scientists who offer suggestions on winning in a male-dominated disciplines.

#### **A. Professor of Chemistry, Harvard University, Dr. Friend**

First female to be granted tenure within the department

"When you want to score you have to play strategically and you have to play the percentages to change minority status"

#### **B. Professor of Physics, MIT, Dr. Mildred Dresselhaus**

"You are dealing with physicists who are single-minded, intensively competitive, and who consider themselves super elite"

#### **b. Purpose and goal formulation for short and long-term planning**

- How to set a goal and eliminate confusion caused by conflicting female role models
- Focusing on long goal attainment, present difficulties in proper perspective
- Help with plans for balancing career and family - reasonable time line plans
- Seek out those who excel - do not listen to those who discourage you

**c. Perseverance and Patience with Self**

- Appreciate that competition is intense
- New approaches are needed to learn and to succeed - mistakes will be made
- Science and the world is changing rapidly, a new era is coming, RSI women will see dramatic change in the position of women in this generation.
- Techniques for quick responses to change must be learned

Virginia Weldon

" change the context" of a world designed by men, leading by example rather than confrontation or competition"

This training may be most effective beginning in the freshman year of university.

**3. Continue the Longitudinal Study of RSI Alumni**

Secure funding for assessment every five years to determine if interventions change attrition rates of women and men and responses on Questionnaire II.

**4. Change the Environment for High Ability Women .**

- a. **Increase the representation of women** at upper echelons of companies and departments. This will eventually change the "minority" status of woman.
- b. **"Change the context"** of the practice of science and technology so women want to remain at these high levels of performance.

**VII. SUMMARIES OF PANELS, LECTURES, AND  
PRESENTATIONS CREATING PUBLIC AWARENESS  
OF DEPARTMENT OF ENERGY STUDY RESULTS**

## **EXTERNAL PRESENTATIONS OF DEPARTMENT OF ENERGY STUDY RESULTS**

1. Women in Engineering Conference,  
June 1-4, 1996 Denver, Colorado
2. Presentation and Panel at "Women in Science and Technology Conference"  
October 14, 1995 Boston, Massachusetts
3. Presentation to CEISMIC Advisory Board and Steering Committee  
October 29, 1995 Atlanta, Georgia
4. Panels on scientific careers and DOE study at RSI Tenth Anniversary Conference  
July 29 and 30, 1994 Boston, Massachusetts
5. Presentation to Winter Brain Conference , "Women in Neuroscience:Ebbing the Exodus"  
January 24, 1994 Snowbird, Utah
6. News release copy distributed to Associated Press during and following RSI Tenth Anniversary Reunion, July. 1994

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

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**Center for Excellence in Education, McLean, Virginia  
Emory University, Atlanta, Georgia**

## **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".

## **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 team 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.

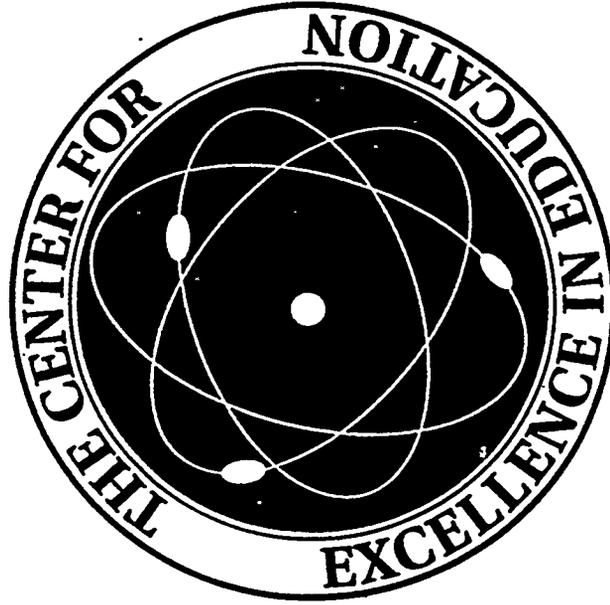
Although not complete, the RSI study is a singular and highly significant study. Its cohort of ability-matched males and females facilitates gender comparisons of personal attributes essential for career success and differences in gender responses to environmental and social challenges in a math/science 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.

*Symposium on Women in Science, Business, and Technology*  
*October 14, 1995*

- 8:30-9:00 am Registration and Continental Breakfast
- 9:00-9:10 Welcome from the **Center for Excellence in Education**  
Joann P. DiGennaro, Esq., President CEE
- 9:10-9:40 Introduction and Presentation: Keynote Address  
Dr. Mary DeLong, Principal Investigator, DOE Grant  
Director of Laboratories, Emory University  
The Rollins School of Public Health
- 9:40-10:00 Audience Participation and Discussion
- 10:00-10:10 Break
- 10:10-10:40 "Techniques for Success in Science-Related Careers:  
Business, Academia, and Government"  
Moderator: Dr. Denise Garland, Director of Education,  
Biomedical Engineering Program, City University, NY  
Dr. Maria Kukuruzinska, Associate Professor,  
Boston University Medical School  
Dr. Janet Joy, Program Officer, Nat'l Research Council  
Dr. Abigail Stack, Post Doctoral Fellow,  
Center for Biologics Evaluation and Research,  
The Food and Drug Administration
- 10:30-10:50 Audience Participation and Discussion
- 10:50-11:20 "Keys to Success in Science and Technology"  
Moderator: Dr. Denise Garland  
Ms. Susan Lee, RSI '91, Economics and Math,  
Harvard University  
Ms. Desiree Gouletas, MBA Candidate,  
Northwestern University  
Ms. Diana Detwiler, RSI '84, Executive Director,  
Detwiler Foundation  
Ms. Kathy Seggerson RSI '86, PhD Candidate,  
Yale University
- 11:20-12:30 Audience Participation/Discussion and Refreshments

*Women in Science, Business, and  
Technology:  
Pathways to Success  
Presented by  
Center for Excellence in Education  
and  
Department of Energy*



## PATHWAYS TO SUCCESS

Center for Excellence in Education and Department of Energy  
October 14, 1995, Conference on Women in Science  
Dr. Mary J. DeLong  
Royal Sonesta Hotel, Cambridge, Massachusetts

### INTRODUCTION

1. What trying to accomplish --To have excellent women in science  
When say science mean science, math, computer science and practice in  
all arena of academics, business, and government  
Ultimately to stop having such meetings
2. What about Women -- why have they attracted such attention?  
Personal level; woman's full potential  
Job opportunities: news commentators, athletes, astronauts  
Daughters to work  
Personal justice: sexual harassment, battered women  
Center for Excellence in Education  
National level: national need  
Trade ---> Technology -----> Science Engine of industry  
Workforce now almost 80% of women, 50% with children not 5  
Need gifted women  
World level - Beijing Conference - worry of 2nd class citizens  
  
Still need work on billboards, childcare, advancement, pay
3. What about women in science and engineering?  
Positive trends but women in room are first step along new paths

#### Trends in Advanced Placement Exams 1986-1993

Biology	Men 19,344 +51%	Women 22,495 +77%	1:1 to 1:1.2
Chemistry	16,684 +81%	10,646 +132%	2:1 to 1.6:1
Physics	18,134 +106%	6,788 +224%	4:1 to 3:1
Mathematics	54,529 +74%	42,474 +118%	1.5:1 to 1.2:1

#### Trends in Science Degrees 1978 - 1991

Undergraduate Men	262,930 -9%	Women 249,662 +8%
Graduate	52,087 -12%	Women 51,523 +34%

#### Trends in Mathematics Degrees 1978-1991

Undergraduate Men	7,430 +11%	Women 6,776 +40%
Graduate	1,850 -13%	Women 1,217 +15%

More and more in sciences but no department chairs, professors, only 12%  
Women in Science and Engineering: Increasing Their Numbers in the 1990s

Science	Men	Women
Grade 4	81%	78%
Grade 8	72%	64%
Grade 12	74%	57% (60,000 women lost)
Math		
Grade 4	72%	71%
Grade 8	59%	55%
Grade 12	53%	49%

**PART ONE: THE CENTER FOR EXCELLENCE IN EDUCATION DECIDES TO DO A LONGITUDINAL STUDY OF THE CAREERS OF HIGHLY ABLE WOMEN.**

What is the Center for Excellence in Education and what is the RSI?

- Admiral Rickover and a "Nation at Risk" Report
  - Rickover Institute for Educational Excellence Established
1. What is the RSI? Now 10 year history.
    - 1984 Summer Science Research Institute, RSI
      - Students entering senior year in high school
      - Fifty U.S. students; twenty foreign students
      - One week university lectures; five weeks research
    - 1986 Rickover Institute changes name to "Center for Excellence in Education"
  2. Who attends the RSI?
    - Cohort of 550 extremely gifted men and women
    - Native ability: PSAT F=1444 M=1450
    - Self-selected for science/math interests
    - Self-motivated; self-confident
    - Outstanding performance in science/math
    - Performing at college level in high school

**PART TWO: THE DEPARTMENT OF ENERGY STUDY - QUESTIONNAIRE ONE**

In the spring of 1992, the U.S. Department of Energy awarded a grant to CEE to support two projects designed to keep high ability students who are alumni of the Research Science Institute involved in science and mathematics. The first project involves a three-year study to identify the factors that enter into a student's decision regarding his or her career path in science or mathematics. A special focus

of the study is to determine reasons for the high attrition rate of female students from post-secondary science and mathematics studies. And in turn to identify and prioritize the most effective interventions in preventing this talent loss.

In October of 1992, CEE sent a preliminary questionnaire to all 1984 through 1992 alumni of the Research Science Institute. The RSI alumni constitute a particularly appropriate sample insofar as they represent an evenly matched high ability group of males and females but are geographically diverse representing a cross section of socioeconomic status and high school experience. In addition, this group is a longitudinal cohort group from first year undergraduate through fourth year of graduate school, providing an opportunity to observe each stage in the process of choosing a field of science and subsequently a career. The following are preliminary conclusions that were drawn from the available data received.

- A few more than one RSI alumni in ten will choose a non-science/math major. Out of this group, women are responsible for almost all of the movement away from science. Only 7.6% of all male RSI alumni have given up a science related career whereas 20% of women have done so. Astoundingly, even in this very high mathematically and gifted group of RSI women, they are leaving science at a rate three times greater than that of men.
- Male interests are evenly distributed among the scientific fields, but females choose biology twice as often as males. However, from an original interest in biology in their RSI experience only 1 in 3 women will finish with an undergraduate major in biology.
- At the undergraduate level, the first choice of a major for RSI women is a non-science field, for RSI men a non-science major ranks as the seventh most popular choice.
- The critical years in deciding to leave science for RSI females begins after the sophomore year of undergraduate studies and continues unmitigated through the years of graduate study. For RSI males, the decision to switch from science seems to be a consistently low rate through both undergraduate and graduate years.

For the RSI women early indicators of future success in math and science such as SAT scores, advanced placement exams, and level of academic performance show no significant difference from RSI male scores. What are the reasons then for this exaggerated attrition of high ability women from math and science. The factors that may be suggested as causative are lack of native intelligence, an unsupportive environment, or personal psychological and personality factors of the individual incompatible with a career in science or math.

## **PART THREE: RELEVANT FINDINGS FROM OTHER RESEARCHERS**

### **Social Factor One Chilly Climate and Microinequalities**

#### 1. Lack of role models

National Research Council 1991 Perception that women do not succeed.  
 Matyas, and Shirley Malcom 1991  
 University of Michigan Dept of Mathematics and Physics 1991  
 AWIS studying of mentorships

#### 2. Extreme competitiveness

UCLA Study Linda Sax and Helen Austin showed girls less competitive  
 Alverno College in Milwaukee  
 Wellesley College - Hands on  
 Shirley Tilghman, 1993

#### 3. Lack of encouragement

Fort Lewis College in Colorado 40% Chemistry majors  
 University of Michigan - Women in Science program  
 Douglas Project for Rutgers Women in MS&E Ellen F. Mappen

#### 4. Cultural Differences of mentor and student

University of Michigan and Gender Bias 1993 Frazier and Kousai 1991  
 Proceedings of Beijing Conference

### **Social Factor Two- Expectations**

"Science, 1992, The attitude held by men and often internalized by women  
 a. Women don't have what it takes to get to the top  
 b. Double burden of career and family - woman places family ahead of career  
 Linda Spear State University at Binghamton

#### 1. Mixed messages of media

-Shirley Malcom - media messages on women, isolated worker, science is  
 endless with no socially redeeming characteristics  
 -Beth Ruskin Dept of Mathematics at Lowell how stereotypes affect science  
 participation of women

#### 2. Family expectations and influences

-Ethington and Wallie (1987) 2000 sophomore women "Parents discourage  
 daughters from entering quantitative fields"  
 -Benbow and Cindy Raymon (1993) Fathers were more involved in  
 quantitative areas, mothers more in encouragement in verbal areas. Actions  
 speak louder than words

#### 3. Academic authority

-Shirley Malcom and the "Neuter Computer" 40% boys, 8% girls

- Myra and Sadkar UCLA boys have more eye contact in classroom
- Sheila Tobias (1993) What really is a scientist - cumulative disadvantages

Therefore: Confused signals of job ahead; lower expectations of 2nd rate citizen.

#### **Personal Choice One: Early critical decisions**

Science and math classes - early patterns create self esteem

Choice of supportive institutions

Academic performance

-Valarie Lee and Norma Ware - math grades biggest item in persistence

-Boisset and Annick - blame self for poor grades

#### **Personal Choice Two: Motherhood and Marriage**

Career holding patterns - part-time work and underemployment

Geographic restrictions

Day care and supportive services

-NSF Study with Zuckerman, Illinois Valedictorian Project

#### **Overall Summary: Accumulation of advantages and disadvantages**

Harriet Zuckerman and Jonathan Cole , 1987 and 1991

J. Cole. 1975 "Fair Science: women in the Scientific Community"

Push from cumulative disadvantage and pull from easier life promise

### **PART FOUR: QUESTIONS OF THE RSI ALUMNI, COGNITIVE INTERVIEWS AND LETTERS OF TESTIMONY**

Since myriad of possibilities limit second questionnaire by what is found out in two types of preliminary surveys of RSI alumni -- cognitive interviews and letters of testimony.

Looking for lead of what type of questions should be asked on the questionnaire?  
National studies may not be applicable to this group.

Einstein: "Must first understand everything in the past to create in the future"

Tried to find out chief concerns of RSI alumni by two methods: Cognitive interviews and testimonial letters.

#### **COGNITIVE INTERVIEWS**

What did we find from cognitive interviews? In January of 1995 spent time in Boston asking young men and women of RSI their views of science and what it takes to succeed in personal interviews. Most interviews were individual some in small groups of two or three appropriate for level of education. Interviews went from general to particular i.e. persons--> women--> you. Summary of results follow

	Men	Women
Why choose science?	Ability Interest Encouragement Early Success Social Scene	Ability Interest Encouragement Early Success  Respect of Peers
Why PERSONS leave science?	Perceptions of science and scientists (M & W) No independence Not able to be at the top	"Struggle" Aggression Social Isolation
Why WOMEN leave science?	Women are social; science is "asocial" (M & W) "Old boy network" "Men need career"	"Beat by System" "Insecure in Ability"
Why YOU would leave (left) science?	No financial support for studies (M & W) No job available	Other interests Family needs Lonliness
What is needed to succeed?	"Tough, assertive, competitive" (M & W)	"Presentation" Not to stand "down"
How do you handle difficulties in studies?	"Wash over me" "Understand later" Read widely Blame others	"Overwhelmed" "Impossible" Reread, reread material Own the problem
<b>Summary: Lonliness, struggle, family, aggression, lack of confidence in ability, skills in trying addressing problems, lack of comfort in confrontation, other interests</b> <b>Change: First comes lack of comfort, the push, second comes the pull, new zone of comfort</b>		

## LETTERS OF TESTIMONY

Asked students to respond by E-mail and/or letters to similar questions or own interpretation of science. Why they would switch out of science.

### **Climate, no women models, science is masculine, comfort level lacking**

- Out of math because of an "unfriendly" atmosphere
- Out of chemistry because courses uninteresting and "taught by all men" - no women  
Politics more accepted
- Out of mechanical engineering because only "a bunch of old men"
- Near Ph.D. in Physics at Berkley but culture is very masculine - thinking of switching "Science rips persons apart, isolation, no family, wants change"
- Switching from electrical engineering because no women - need less technical field to find women.
- In both physics and music, very competitive, dropping science major because "all men and very intimidating"

### **Relevance of science and math**

- Leaving computer science to help people.
- People more important than problem sets in physics.

### **Too much work**

- Physics -- to many problem sets, loads of calculations - like concepts better
- Finishing physics degree but so tired, burned out - love science
- Can succeed in economics so much easier than in math and science
- Turned off by rigor and lack of imagination of courses in physics

### **Focus on goal**

- I will never leave because I am too stubborn (woman)
- Mathematics is good, good teachers

## CONCLUSIONS FOR SECOND QUESTIONNAIRE CONTENT

Not too disimilar from noted researchers of the past Problems not from ability or love of science, problems coming from comfort level -- where I belong

We will use information from second questionnaire to document reasons but now ask panels how to fix. Will look at at attributes, not environment of classroom, not

Will contain: 1) If changed and why changed - compare men and women

No comment on ability, just attributes and environment

- 2) When changed - what was the push and what was the pull
- 3) What could have made the difference

## **PART FIVE: PATHWAYS TO SUCCESS - WHAT IS NEEDED TO DEAL WITH MESSAGE SENT BY RSI ALUMNI**

Have come a long way -- intelligence not enough, have to deal with injustice  
**NEED A PLAN OF ACTION FOR NOW** - Avoid push and pull syndrome  
 Create an atmosphere where women in science are "comfortable" --  
**CANNOT ACHIEVE EXCELLENCE WHEN TRYING TO BELONG** --  
 Science requires psychic energy for excellence

### **AUDIENCE IS TOP OF GEOMETRIC PYRAMID OF INFLUENCE WANT WOMEN TO STAY SO CAN CHANGE THE GAME RULES**

#### **A. KEEP THE VISION, OWN THE VISION NOT THE DIFFICULTY**

- 1.a. Keep the dream "Optimism"- Focus on Goal not temporary setbacks  
 Emotional Quotient Time Magazine, has to be true -- the hope of success  
 Book, Emotional Quotient. Do not have to be on top --  
 Keep your dream and try to realize that dream.  
 Life is a box of chocolates -- keep looking for the good piece  
**Socially mature and independent**  
**Not intimidated by challenge - low math anxiety**
- 1.b. Relate your life to science and its workings, your reactions  
 Own It -- not something you do but something you are -- both feet in  
 Live it  
 Others may have a dream for you but you have your own  
 Don't be afraid of success, of social consequences for women  
**Math and science are important as a career**  
**Make own perception of science and math, not TRADITIONAL ONE**  
**Adaptive management of home, school, career - success is important**

#### **BELONG TO THE PEOPLE OF SCIENCE**

- 2.a. Network with peers - take away the lonely feeling - comradeship under stress  
 Expressing feelings of injustice diffuses anger and frustration and creates  
 support groups. If you talk to yourself long enough about your own inability  
 you will eventually convince yourself of this problem.  
 Support sessions for many disabilities, minorities, give them strenght  
 Dorms at Rutgers, University of Colorado very successful  
 Mildred Desseldorf MIT -- Science article on minorities  
**Peers are important, comfort level in working with things and people,**  
**do not fear unity versus collective - no fear of rejection**
- 2.b. Belong to a lab, a team, a department -- the inside loop in science/math  
 Persons most satisfied at school belonged to team, coach etc.  
**Teacher encouragement or believer important factor**  
**Find an accepting climate -- don't worry about others choices**

**BELIEVE IN YOURSELF, HAVE OTHERS BELIEVE IN YOU**

3.a. Believe in yourself -- the problem is not you but the game rules.

You are a minority - it may be uncomfortable but you do belong.

Nothing wrong with me but with the way science is practiced

Effort or owning of life initially is true for law, finance, politics - Achievement has a cost

3.b. Bond to someone who believes in you - a role model, a believer in you

AWIS, American Physiology Society mentoring project

Can be man or woman, does not have to be scientist but someone who knows your dream. Someone believes in you will believe in yourself

**PART SIX: WHAT WILL BE REALIZED**

HOW WOULD WE LIKE IT TO BE SO EVERYONE WHO WANTS TO BE A SCIENTIST CAN FEEL THAT IS TOTALLY ATTAINABLE

**A. In Society**

- Will be able to focus on career, societal expectations will support career.
- The woman scientist will be attractive and bright at same time

**B. In Science**

- Neither an old boys or an old girls network -- the special telephone network.  
Women will not be lonely, they will "belong"  
There will be no women in science conferences as there are no men in science conferences now.
- Advancement clock will include children, no need for "supermom"  
Will be able to focus on career without guilt of children. -- Discussions of children and career will be a mute point.  
There will be available child care

**C. In the Woman**

- Women will not be angry, no sense of injustice.  
No "battered" women in science - women will not talk of their career advances as battle victories -- the trading of horror stories.

WE HAVE VISITED MANY IDEAS BUT THE PARTING THOUGHT -- DON'T LET LIFE CHANGE MIND ABOUT A SCIENCE CAREER BUT DO CHANGE SCIENCE -- MAKE IT THE WOMANS PLACE! MAKE IT THE PLACE FOR EXCELLENCE!

NOW DENISE GARLAND AS MODERATOR OF PANELS.

Collective wisdom of those who have succeeded and those who will succeed.  
in following panels.

*A Center for Excellence in Education Symposium*

*Sponsored by the U.S. Department of Energy*

*Women in Science & Technology*

*October 14, 1995*

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*Introduction*

Mrs. JoAnn DiGennaro, President of the Center for Excellence in Education, introduced the symposium with a summary of the history of the Department of Energy study. The purpose of the project is to study the factors necessary for the Research Science Institute (RSI) students retention in the fields of science and technology. This study places special emphasis on retention of women in science who have been characterized in the past as a high risk group for attrition from science and technology careers.

Mrs. DiGennaro then introduced Dr. Mary DeLong, Principal Investigator of the Department of Energy study and keynote speaker. Dr. DeLong has recently been appointed Director of the Laboratories of the Emory University School of Public Health. Previously, she was an Assistant Dean of Johns Hopkins University.

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*Department of Energy study: Findings and Discussion*

Dr. DeLong summarized the initial findings of the study and emphasized that this forum was not just a presentation, but also a workshop in which to explore ideas and possibilities for further consideration. During the proceedings science and technology would be defined broadly, encompassing not only the academic study of these areas, but also the applications of science and technology to business and government. Presentations and discussions within the symposium are to identify key factors necessary for continuation in a science career so to create within the disciplines of science and technology a place where both men and women can feel comfortable. The Department of Energy is especially interested in identification of these key factors for retention of gifted individuals within science careers because the number of research scientists in the U.S. is low relative to that of other countries. It is known that womens' attrition rates from science far exceed those of men in the U.S. For the nation. to be scientifically competitive, women must be retained in science and technology career paths.. To do so, scientific fields must be made palatable and consistent with women's value systems. With present government statistics, approximately 60,000 more scientifically talented women than men leave the science and technology careers each year. This represents a formidable loss of brain power and talent for our nation and missed opportunity for the individual.

The initial survey from the Department of Energy study of over 500 RSI alumni and their present career path resulted in the following findings.

- Slightly more than 10% of RSI alumni/ae eventually leave the sciences, and women make up almost all of the 10%.
- While 7.6% of RSI males have left the sciences, 21% of RSI women have left.
- Men tend to choose evenly among the different fields of science and technology. In contrast, women choose biology twice as often as men, but only 1/3 of these women complete a biology undergraduate major..
- The first choice of field of study among RSI women is non-science.
- RSI women begin to leave the sciences at a high rate from the sophomore year of college through the graduate study years. Men have a low rate of attrition throughout the undergraduate and graduate years.

These findings are remarkable because the RSI alumni represent an evenly matched cohort of high-ability men and women who while still in high school distinguished themselves in science and mathematics and chose it as a career path, self-selected for competition for a place in the Research Science Institute and all represented the top 1% of the nation in mathematical ability. Considering that factors of native ability would not be a valid difference between men and women as a reason for leaving science one is left with either external factors such as social expectations or internal issues such as value systems in conflict with a science career.

Three sources of information were used to identify the key social factors or personal value systems that may be operative in the high attrition rate of RSI women from science and technology studies and careers compared to men. These are findings of former research studies on the topic, cognitive interviews of RSI alumni, and RSI women personal testimonials. Social factors identified in literature as causative of or associated with women's attrition from science and technology studies include lack of sufficient role models, lack of support, an intensely competitive atmosphere, women's portrayal in the media and concerns about balancing family and work.

Cognitive interviews of 29 male and female RSI alumni produced the following results.

- Clear differences between men and women emerged in answers to the question, "What does it take to be successful in science?" Men answered that one must be "tough, aggressive, competitive." Women answered that "you can't stand down," but that this expectation makes women uncomfortable.
- Men and women also had different ways of dealing with difficult material. Men indicated that they were willing to blame bad teachers for their lack of understanding and would read supplementary texts to better grasp the difficult material. Women were apt to react by dismissing the material as overwhelming or impossible and would often blame themselves for their lack of understanding. Generally, women did not consult supplementary reading materials.
- Other reasons suggested of why RSI women have left the sciences:
  - Women are generally social, science is viewed as asocial.
  - There is an old boys' network in the sciences.
  - Women are insecure about their ability.
  - Women are "tired of the struggle" and feel "beaten by the system."

Testimonial statements from RSI women indicated that they perceived the science culture as very masculine and very intimidating. This created a sense of "loneliness".

In summary, although many social and personal reasons can be suggested as reasons for the greater attrition of RSI women from the sciences than RSI men, the key importance of the findings is to be able to design a system or systems to mitigate this loss. That is, WHEN women start to drop out of science and technology and we can understand WHY they leave, then we can begin to design interventions to prevent this tragic loss of scientific gifts and talent. Suggestions that have been advanced or tried for stopping this attrition are:

- Women must achieve a critical mass of approximately 25% so to be able to make changes in science & technology environments.
  - Women must maintain contacts with other women and supportive men in scientific fields. Women must be mentors to each other.
  - Women must believe in the people who are in science.
  - Women must believe in themselves.
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## ***PANEL DISCUSSIONS***

### ***Panel One***

#### ***Professional Panel: Secrets of Success***

***Moderator: Dr. Denise Garland***

**Panel I participants:** Each panel participant is successful in having established a science career and so can share their experiences and wisdom with the audience on steps to successful scientific career.

- Dr. Maria Kukurazinska, Associate Professor, Boston University
- Dr. Janet Joy, National Research Council
- Abigail Stack, RSI '84, Post-doctoral student, Food & Drug Administration

#### **Dr. Maria Kukurazinska**

The three keys to success in science are commitment, patience, and interest. The application of these attributes give rise to three successful tactics for a successful career. First have a vision of where you would like to be in 20-30 years, but at the same time, have short-term priorities. Second, manage time and people effectively. Good management of your own finances is also extremely important. And thirdly, maintain an

interesting, fulfilling life. This includes creating professional support systems of mentors and colleagues. If a personal life is preserved in friendships and relationships a balance will be maintained which energizes the hours at work. Seek relaxation in hobbies and extracurricular interests

#### **Dr. Janet Joy**

Dr. Joy noted science education, training, and job markets are all changing, rapidly. This is especially true in the differing demands of graduate and undergraduate education. Undergraduate and graduate education are completely different in that as an undergraduate, one receives feedback regularly through tests, problem sets, and grades; however, as a graduate student, one may very seldom receive feedback. Therefore, the skill set needed for undergraduate education is completely different from the graduate skill set. During college, a student gains credibility by fighting concrete battles (grades, awards, fellowships, etc.). As a graduate student, merit is not recognized in such a structured way. "People skills" thus become much more important as one progresses up through the science career ladder.

Science is hardly asocial; in fact, modern science depends on teamwork. For this reason one way to judge whether a scientific career would be appealing is to gauge whether you like the leaders in your field of interest. An identification with various leaders and peers in your scientific field of interest is especially important for a feeling of belonging in a science career.

#### **Abigail Stack**

The most important thing is that one must really love science to be able to commit to a scientific career. This is the overriding principle. On the practical side for the graduate students some practical advice can be helpful. First, choose a mentor carefully. The mentor determines, in large part, how long your program will take and how much support you will have. The mentor may actually be more important than the research you would be conducting under him/her. Second, develop a thick skin. You will face difficulties and it is important to be able to let them "roll off your back." Third, remember that your career is your own. Do not let other people tell you what to do! Decide what your definition of "success" is. Be flexible about your career path.

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**Panel Two**  
**Pathways to Success**  
**Moderator: Dr. Denise Garland**

**Panel II participants:** Panel members are presently successfully engaged in science studies at the undergraduate or graduate level. They share with the audience personal experiences and ideas on how to achieve and persist in scientific academic studies.

- Susan J. Lee, RSI '91, Harvard University student
- Desiree Gouletas, MBA candidate, Kellogg School of Management (?)
- Diana Detwiler, President, Detwiler Foundation
- Kathy Seggerson, Ph.D. candidate, Yale University

**Susan J. Lee**

Susan recounted some of her academic and work experiences since her first year at Harvard. During her freshman year she tried several types of sciences classes and found that she really enjoyed her math classes. She has found that a strong quantitative background is useful for almost any field. During the summer after sophomore year, she worked for the Carlyle Group as a consultant and found that business is just as hard, if not harder, than being in science. She cited the long hours as being particularly demanding. During the summer after her junior year, she worked for Salomon Brothers and witnessed the "Old Boys' Network" firsthand. Women were definitely excluded from this aspect of the work environment.

Some advice for women in the sciences or business: Ask and be insistent about what you want.

**Desiree Gouletas**

Desiree outlined three points which have worked to motivate her: do something interesting and challenging; demand respect; and set personal goals. At all times be confident, persistent, and determined. It's okay to be competitive. There are challenges in any industry. Whatever field you choose, dig your heels in and remind yourself often about why you love your job. Focus on what appeals to you about your work not on what sacrifices it demands. It is very important to find at least one stress reliever to balance an intense commitment to your goals and profession.

**Diana Detwiler**

Diana was formerly in banking, but decided to change careers because she wanted to do something that would bring tangible results. The important skills for success are "people skills" used in marketing and communications. You never escape politics and must learn to uncover hidden agendas. Intelligence and or technical skills are not always the most important. You must remain positive and constructive and try to avoid personal conflict and never underestimate the power of one person to change an entire group. Be aware of your strengths and weaknesses when formulating your definition of "success." Ask yourself, "What traits and qualities do I admire?" Aim for them.

**Kathy Seggerson**

Kathy offered advice that is particularly relevant to those interested in academia: Choose an advisor based on academic work and the extent of professional support you will receive from him/her. During your years of study seek emotional support from peers, family, church, etc. Keep a sense of humor. Hold on to your idealism; remember why you decided to go into science. You need to be competent but you must also be assertive.

A final word from Dr. Garland: If you have opened a door, leave it open so that others can peek inside.

Notes submitted by Susan S. Lee, RSI '91; aka "Susan Lee Rhode Island"

## Friday, 29 July SURVIVAL, SANITY, AND SUCCESS – Women in Science

4:00-6:00 pm

Moderator: Mary J. DeLong

Panelists: Dr. Beverly Hartline, Associate Director  
Continuous Beam Accelerator Facility  
Dr. Katherine Hammer, President and CEO  
Evolutionary Technologies, Inc.  
- Dr. Maria Kukurusinska, Assistant Professor  
Boston University Medical Center  
Dr. Virginia Weldon, Sr. Vice-President  
Monsanto Company, Public Policy

Audience: Young, highly gifted, science students between 18-29 years of age who have attended the Research Science Institute and are now in training for or working in scientific careers.

### Objectives of Panel

1. To inform students of the many areas of within science careers including industry, academia, government, and public policy.
2. To inform students of the similarities and differences needed in preparation and interest for success in these arenas now and in the future.
3. To provide for the students successful women role models in each of these scientific arenas and exposure to the personal choices they have made and experiences they have had during their journey to success.
4. To learn from the student response to the panel the issues of most concern to them in choosing a scientific arena for a career.

### Structure of Panel

1. Introduction: Mary DeLong
2. Introduction of each panel member - DeLong
3. Panel presentations - Hammer, Hartline, Kukuruzinska, Weldon
4. Introduction to question and answer period - DeLong  
Directed to panel, DeLong intervene if hear common concern among many students.
5. Question and answer period – panel and audience
6. Thank you
7. Mentor/Mentee meeting

## INTRODUCTION - FRIDAY PANEL

It is my distinct honor and pleasure to welcome all of you to our panel on SURVIVAL, SANITY, AND SUCCESS – Women in Science. And I wish to thank this evening Joann DiGennaro and Gayle Wilson for giving all of us this opportunity to have this distinguished panel share with us their expertise and experience. The overall purpose of this session is to have these very accomplished women in science share with us their secrets for success.

From the title of this session SURVIVAL, SANITY, AND SUCCESS, it would seem we should decorate our panel members with combat medals for success. That is they not only survived a scientific career but have been so successful while doing so. As our panel speaks I think you will hear an additional, deeper message that has made their sometimes difficult journey through a scientific career worthwhile. It is the reason we are all here. WE ALL like science. We are as a group a curious lot. We love to know why and how.

From our panel members we will learn that this journey through a scientific career can take many turns and science can be practiced in many arenas or environments. To mention just a few there is industry, academia, government, and and enterprenareal endeavors. Today we have asked four women who personify success in these four different arenas to share with us their lives and suggest essentials for a successful career. We have asked our distinguished panel to address three major questions:

1. Why they chose science and the arena in which they practice it?
2. What they have personally found identified as factors for success?
3. What the future holds in their arena of science for young persons, especially women?

## INTRODUCTION OF PANEL

See individual Biosketches

## FOLLOWING PANEL INTRODUCTION

We insure adequate time for a question and answer period we ask that the audience hold questions until all the panel members have presented. At that

time we will open the floor to questions from the audience to be addressed directly to the panel member. During the course of questioning, I may ask the audience to confirm the importance of an issue that repeatedly is voiced. We will end the session at 5:50pm with mentors meeting their mentees.

## Saturday, July 30 CLOSING THE GAP IN SCIENCE EDUCATION

9:45 - 11:00 a.m.

Coordinator: Mary DeLong

Panel Members: Dr. Mildred Dresselhaus, Professor of Physics  
Massachusetts Institute of Technology  
Dr. Denis Evans, Business Unit Executive  
IBM Corporations  
Dr. Denise Garland, Professor of Chemistry  
City College, University of New York  
Dr. Katherine Hammer, President and CEO  
Evolutionary Technologies  
Dr. David Potter, Professor of Neurobiology  
Harvard Medical School  
Dr. Neil Todreas, Professor of Nuclear Engineering  
Massachusetts Institue of Technology

### Objectives of the Panel

1. To enlist panel members and the audience to assist CEE with study of attrition of women from science and prioritize possible interventions to mitigate attrition
2. To identify important areas of inquiry for second questionnaire for RSI alumni on reasons for attrition of women in science.
3. To inform audience of importance of CEE study on intervention of attrition of women from science.

### Structure of the Panel

1. Welcome, results of DOE funded CEE study, panel objectives  
DeLong
2. Introduction of each panel member - Garland
3. Presentations by panel members - Dresselhaus, Evans, Garland, Hammer,  
Potter, Todreas
4. Summary statement - DeLong Response - Glashow
5. Questions and Answers - Garland

Overall objective for CEE: To identify the likenesses and differences in why men and women choose and remain in a scientific career and to identify and prioritize methods of intervention that can be used to mitigate the attrition of women from science.

## WELCOME AND INTRODUCTION: SATURDAY PANEL

### Introduction:

A. Welcome - See women and men in audience

Structure of time and panel

Thank you, Mrs. D, Board, Rich Simon, Peggy Hsia

Terry Broiky, Maite

## DOE RESEARCH PRELIMINARY RESULTS

In the spring of 1992, the U.S. Department of Energy awarded a grant to CEE to support two projects designed to keep high ability students who are alumni of the Research Science Institute involved in science and mathematics. The first project involves a three-year study to identify the factors that enter into a student's decisions regarding his or her career path. A special focus of the study is to determine reasons for the high attrition rate of female students from post-secondary science and mathematics studies. And in turn to identify and prioritize the most effective interventions in preventing this talent loss. The second part of the grant establishes a summer placement program to provide research opportunities for RSI alumni.

In October of 1992, CEE sent a preliminary questionnaire to all 1984 through 1992 alumni of the Research Science Institute. The 577 RSI alumni constitute a particularly appropriate sample insofar as they represent an evenly matched high ability group of males and females but are geographically diverse representing a cross section of socioeconomic status and high school experience. In addition, this group is a longitudinal cohort group from first year of undergraduate through fourth year of graduate school, providing an opportunity to observe each stage in the process of choosing a field of science and subsequently a career. To date more than 80% of the questionnaires have been received. The following are some preliminary conclusions drawn from the available data received to date:

- A few more than one RSI alumni in ten will choose a non-science/math major. Out of this group, women are responsible for almost all of the movement away from science. Only 7.6% of all male RSI alumni have given up science as their chosen field, whereas 20% of women have done so. Astoundingly, even in this very high mathematically and scientifically gifted group of RSI women, they are leaving science at a rate three times greater than that of men.
- Male interests are evenly distributed among the scientific fields, but females have a marked preference for biological sciences. A woman is twice as likely to be in biology as she is in any other science/math field. However, from an original interest in biology in RSI only 1 in 3 women will finish with an undergraduate major in biology.
- At the undergraduate level, for RSI females the highest percentage of selected majors is in non-science areas. In contrast, RSI males have the highest percentages of majors in science, engineering, and mathematics rather than in non-science. That is, for RSI women non-science majors rank number one, and for RSI men non-science majors rank number seven.
- The critical years in deciding to leave science for RSI females begin after the sophomore year of undergraduate studies and continue unmitigated through the years of graduate study. For RSI males, the decision to switch from science seems to consistently be at low levels through both undergraduate and graduate years.

Preliminary analyses suggest that women are leaving math and science not because they are incapable of intellectual rigors accompanying these fields, but for other reasons. What are these reasons? Many have been suggested by national experts studying this issue but results are not always conclusive. When one disregards differences in ability between male and female as with RSI alumni then two major categories of reason for the higher attrition of females can be proposed – these are external social factors and those intrinsic to the the personality or makeup of the woman. We have all heard the listing of negative external influences on women in sciences within institutions such as the "chilly climate" and missing role models. There are as well many commentaries on the mixed messages given women by society and lower expectations of performance by authority figures. Then there are those negative personal influences on a scientific career such as lack of self-confidence or self-esteem and inner conflicts of career and family. The list of possibilities is very long for explaining the reasons for the attrition of women from science but for the this very special group of RSI females the real answers are unknown.

It is for this reason that we have convened this expert panel on careers in science this morning. We ask the the members of the panel with their years of expertise to respond to this study with suggestions for the reasons this attrition may be occuring and also what interventions may be effective in slowing this exodus. The suggestions of this panel and ensuing audience responses, united with findings from other studies will be assembled this fall into a second questionnaire to be sent to our RSI alumni in an attempt to define the causes of the attrition and interventions needed to stop this attrition for this singularly gifted group of potentially extraordinary scientists and mathematicians.

#### INTRODUCTION OF PANEL MEMBERS

Dr. Denise Garland, a faculty member for the RSI Instutute for the last four years will now introduce the various panel members. We ask that the audience refrain from questions until all panel members have spoken. At that time we will open the floor to the audience for questions and answers. Dr. Garland will moderate the question and answer period (following Dr. Glashows response to the summary of the panel statements).

Dr. Maria Kukuruzinska, Ph.D  
Assistant Professor of Biochemistry  
Boston University Medical Center

Dr. Kukuruzinska came to her present position in 1990 at Boston University after finishing postdoctoral work at the Center for Cancer Research at MIT. Since her arrival at Boston University she has been awarded the coveted Research Career Development award from the National Institutes of Health and has also been the recipient of both RO1 and R29 grant awards. Her interest in forwarding the training of young persons in biomedical research is reflected in her positions as program codirector for a training program for minority and women dental students and also program co-investigator for postdoctoral students in medical sciences. She is the author of numerous journal articles, chapters, and abstracts.

Her expertise expands beyond research and teaching to invited lecturer at both a national and international level. Because of her expertise in gene expression she has served as a consultant to Biotechnology firms and was a cofounder of Pyxis Consulting firm, a biotechnology and venture capital consulting company. This September, Dr. Kukuruzinska will be involved as a consultant and fellow with the World Health Organization in Geneva, Switzerland. Dr. Kukuruzinska's began her training at Bryn Mawr College majoring in chemistry and biology and then earned a Ph.D. from Johns Hopkins University in 1983.

Dr. Katherine Hammer  
President and CEO  
Evolutionary Technologies

In 1990 Dr. Hammer took her position as President and CEO of Evolutionary Technologies Incorporated after obtaining the necessary agreement to spin the EXTRACT technology which she had previously developed out of MMC. Evolutionary Technologies has grown steadily under Dr. Hammer's leadership. The company now has sixty-eight professionals and nine US offices and an international office in Paris, France. Dr. Hammer has been successful in obtaining capital funding from top-notch venture capital firms such as Menlo Ventures. Her Board Members and investors include such luminaries such as Admiral Bobby Inman. Dr. Hammer was one of the 300 participants of President Clinton's economic summit in 1992 and was named Incs regional Entrepreneur of the Year in 1993.

Although she now moves easily in the high-technology world, Dr. Hammer began her career as a student of linguistics at the University of Iowa and then taught college for ten years. After receiving tenure from Washington State University, Dr. Hammer made a transition to software, spending a year studying parsing theory as a Visiting Scholar at the Center for Cognitive Science at the University of Texas. She joined Texas Instruments in 1981 as a systems programmer and moved quickly through the ranks to section manager in 1983. In 1984 she joined the VLSI CAD program at MMC as team leader responsible for designing the user interface subsystem for an interactive CAD system and finally in 1988 obtained funding from MMC to pursue the EXTRACT technology. The rest is history.

Virginia V. Weldon, M.D.  
Senior Vice President, Public Policy  
Monsanto Company

Dr. Virginia Weldon became Senior Vice President of Public Policy for the Monsanto Company in 1993 and became responsible for identifying issues that would affect the company, set priorities, and plan for dealing with these issues. In this role her influence is exerted in many committees including the Executive Management Committee, the as an Advisory Director for the Board of Directors, is Chairman of the Biotechnology Steering committee and the Advisory Committee for the Agricultural Group and the Chemical Group. She is also on the Board of Directors of the GD Searle Co., The NutraSweet Company and the Monsanto Fund. Dr. Weldon came to Monsanto and a public policy career in 1989 from a pediatric medical career.

Prior to joining Monsanto she was professor of pediatrics, deputy vice chancellor for medical affairs and vice president of the Medical Center at Washington University Medical School and Center. She joined the Faculty of the School of Medicine of Washington University in 1967 in the department of pediatrics and steadily moved to the top. She received her initial training from Smith College and her MD from the State University of New York at Buffalo. Her residency in pediatric endocrinology was at Johns Hopkins Medical Institutions.

Dr. Weldon has a long list of awards related to both medicine and economics. She is an honored member of many distinguished organizations and commissions including the Association of American Medical Colleges, the Institute of Medicine of the National Academy of Sciences, and in 1993 was appointed by the NIH to serve as Chairman of the Women's Health Initiative Program Advisory Committee. She is equally at ease as a member of organizations as the Board of Directors of General American Life Insurance and Southwestern Bell Corporation. It is an honor to present to you Dr. Virginia Weldon.

Denise C. Evans  
Business Unit Executive  
IBM Corporation

Denise Evans has been a Business Unit Executive at IBM since 1992 first in the Computer Services Aerospace Business Unit and then the Computer Services Business unit responsible for insuring customer satisfaction. Denise Evans major clients are software vendors and network dealers. Since 1989, Denise EVans has worked in the Washington DC area in many capacities for IBM. A significant contribution of Denis Evans technical, marketing, management and leadership skills was her management of the Higher Education/Health unit of IBM to win the Atlantic Area and Higher Education Industry's first commercial systems integration bid. The proposal for a turn-key integrated student information system included extensive IBM services and project management, competitive hardware, and database software as well as business partner application software. For these types of agreements, Denise Evans had to negotiate with many Divisions within IBM and other computer firms. This ability to understand the diverse needs of many types of industries has enabled Ms. Evans to move quickly through the IBM ladder.

Denise Evans began this very successful career with studies of applied mathematics and economics at Brown University and then earned her MBA at Stanford University.

Dr. David Potter, M.D.  
Robert Winthrop Professor of Neurobiology  
Harvard Medical School

Dr. Potter has been the Winthrop Professor Neurobiology since 1984 and was chairman of the prestigious neurobiology department of Harvard Medical School from 1982-1990.

Dr. Potter was and is a distinguished lecturer and was the Potter of Potter, the famous and notorious neuroscience course of Harvard Medical School.

Dr. Potter continues to publish not only his own articles but now fosters many students doing research under his direction.

Dr. Potter began his journey through science at Swarthmore College majoring in Zoology. He then journeyed to Harvard to finish his Ph.D. in Biology. After a postdoctoral fellowship at University College in London and Johns Hopkins University he returned. He joined the Harvard Medical School faculty in 1959 and moved quickly to full Professor Neurobiology by 1969 where he has remained.

***Survival, Sanity, and Success:***

***Women in Science***

**Sponsored by the Center for Excellence in Education**

# **Survival, Sanity, and Success: Women in Science**

Sponsored by the Center for Excellence in Education  
RSI Ten-Year Conference/Reunion  
Boston Marriott Cambridge  
Friday, July 29, 1994

## Panel Moderator

**Dr. Mary J. DeLong**  
*Professor of Environmental Health Science*  
*Emory University*

## Panel Members

**Dr. Katherine Hammer**  
*President and CEO*  
*Evolutionary Technologies, Inc.*

**Dr. Beverly K. Hartline**  
*Associate Director & Project Manager*  
*Continuous Electron Beam Accelerator Facility*

**Dr. Maria A. Kukuruzinska**  
*Assistant Professor*  
*Center for Advanced Biomedical Research*  
*Boston University Medical Center*

**Dr. Virginia V. Weldon**  
*Senior VP of Public Policy*  
*Monsanto Company*

Dr. Mary DeLong opened the session by thanking Ms. Joann P. DiGennaro, President of the Center for Excellence in Education, and Mrs. Gayle Wilson, Chairperson of the Center's Board of Trustees. Dr. DeLong stated that the objective of bringing together these four eminently successful women scientists was to have them share what it takes to succeed. The three questions presented to the panel members were: (1) why did they choose their particular field/arena of science?; (2) during their journey down the career path, what did they identify as key factors of success?; (3) in their estimation, is there an opening for up-and-coming science scholars and if so, where? Dr. DeLong then asked members of the audience to hold their questions for the end of the panel presentations, and introduced the four members of the panel.

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### **Why did you choose your particular field/arena in science?**

**Dr. Kay Hammer** began by noting that when she was growing up as a woman from Louisiana in the 60s, the visions of the successful woman and success in science were not compatible. In 1979, a divorced mother of two she began to wonder why she was in a field (academia) with "single-figure raises and double-figure inflation," and started to look about for something that would give her "mobility and money." She decided that computers would be one avenue, and went to the U. Texas at Austin because they were the friendliest and offered her the resources and support to do what she wanted.

What she likes best about working in software development is that it is a creative field, more like an art than a science. She likened the field to sculpture, where one is somewhat limited by the materials one chooses, but once having understood those limitations, one is also empowered to create one's own vision. Similarly, in software development, given constraints, you can create your own world. Furthermore, it is a rewarding field in which one is given the opportunity to help people do things they weren't capable of doing before, or to help them do their work more efficiently.

**Dr. Beverly K. Hartline** is the director of Continuous Electron Beam Accelerator Facility

we know you'll be tough enough?" out of concern that a female professor would be more lenient in grading than a male professor.

**Dr. Virginia Weldon** is currently the Senior Vice President of Public Policy for Monsanto, Co. and U.S. Presidential Science Advisory Committee. She began her career in academic medicine as a pediatric endocrinologist. She joined Monsanto in 1989 after serving as deputy vice-chancellor for medical affairs and vice president of the Medical Center at Washington University School of Medicine. Dr. Weldon opened her remarks by urging a commitment to excellence. She viewed this as a challenge for the audience since most carry the subjective baggage of a world designed by dad and run by mom.

**What would you identify as key factors of success during your journey down the career path?**

According to **Dr. Hammer**, a difficult aspect of software development is that most projects are done with a team of people. Teams must work so closely together that it's like "you're married, but you don't get to have sex." Teams can be very rocky emotionally, with many strong feelings. To be a leader in such an environment, one needs to address not only the technical issues, but also the strengths, emotions, and needs of each member of the team. Another difficulty is the pressure of time and deadlines. And finally, the field is difficult b/c of the volatility of the economic climate. There is no job security, and consequently, there is little job loyalty/longevity, which is a problem in a field where more than half of the product is locked into the designers' heads.

**Dr. Hammer** also shared her concept of the professional journey as a balance of an intellectual and a spiritual journey, and exhorted students not to neglect the liberal arts in forwarding their academic careers. She noted that while in science the passion is for generalization and the principle, in the arts the passion is for particulars and the detail of characters. When dealing with people, it is important to be able to take both perspectives. **Dr. Hammer's** own studies in

itself: one must be able to sell one's science, to package oneself and one's work.

In addition Dr. Kukuruzinska stated that there are several other roles that the successful research scientist must play. She stated the necessity of being a "people-person," or one who is able to be an effective employer and mentor for those who worked in one's lab. One also has to be a good teacher. And finally, one has to be able to work with the administration.

One of the greatest challenges in academia, though, is of a psychological nature. Dr. Kukuruzinska stressed the necessity and difficulty, especially for women, of developing the self-confidence, tenacity, and determination to continue along one's chosen path despite rigorous evaluations or discouragements. Dr. Kukuruzinska noted that this challenge increased as one progressed along the career path in academia, and that the challenge was particularly acute to maintain self-esteem in the face of unfavorable peer reviews of grant proposals. Whereas in college Dr. Kukuruzinska never noticed differences between men and women, in graduate school she saw more disparity in the way men and women were treated or had to perform, and as a faculty member, she has seen even more. Indeed, Dr. Kukuruzinska feels that in some cases women need to do twice as much as men to achieve the same level of recognition or success, and this is definitely a problem. But Dr. Kukuruzinska is somewhat heartened by the observation that there are more women coming into the sciences.

Dr. Kukuruzinska also wanted to state that being a scientist does not mean being locked up in a laboratory. One can combine anything--family, a career, outside interests and relationships. But, she noted, it is a matter of choices. In her own past, she has been married and has served as a mother-figure. Currently, she devotes time as a consultant to the World Health Organization of the United Nations, where she sees a direct application of basic science.

Dr. Weldon compared the status of women upon entering scientific careers (whether in industry, the government, or academia) to that of the "away team" at a baseball game: we play on their field, and in front of their fans. Whereas it was possible to get a degree (in medicine), once a

## QUESTIONS from the AUDIENCE

Q1: "How can one go about changing the context without a favorable [male:female] ratio or an atypical environment?"

Dr. Hartline: Work within whatever sphere of influence you have and work consistently within your envisioned world.

Dr. Hammer: It is easy for colleague/supervisor to deal with a woman in a subordinate or equal position of power, but once the power lines start changing there are problems--you will feel this as you progress. But know that you cannot win power by making enemies of the people who have it; direct confrontation is therefore not an option. You must develop your own theories of war. Develop the skills to make an enemy in such a way that you gain allies. And always be aware of who your enemies are, because an unknown enemy is much more dangerous than a known enemy.

Also: the first sign of sexism is when you have tried repeatedly to communicate with someone else, and you find yourself thinking, "I must have said this wrong--am I really inarticulate or is this guy just having a problem hearing me?"

And finally: if it's going to take therapy to fix your boss, leave.

Dr. Hartline: People do things for their own reason: find that which will motivate them to achieve your ends, and go at it from that angle. All you need are the results.

Dr. Kukuruzinska: The win-win situation is very important. You have to be able to swallow your pride sometimes. Learn to pick your battles and save your energies for those times when it really matters.

Q2: "Any advice on balancing family/professional lives? What about the sacrifices involved?"

Dr. Weldon: I have two daughters. They knew I would do everything possible to be at the important stuff (plays, etc.), but they also understood that there would be times when I would not be able to be there, that they would have to help bake the cookies. I didn't travel a lot. You make compromises and

## **CLOSING REMARKS**

Mrs. Gayle Wilson, First Lady of California, noted that most of the audience questions focused on issues of lifestyle and the balance of careers and families and other pursuits. She then thanked the panel members, the moderator, and the audience for their participation, and adjourned the meeting.

FOR APPROVAL ONLY

CONTACT: Bob Henderson

Eileen Milling

FOR USE: A.M.s Saturday, July 30

**WOMEN ABANDON POTENTIAL CAREERS IN SCIENCE THREE TIMES FASTER THAN MEN**

CAMBRIDGE, Mass., July 30 -- Young women with high abilities in mathematics and the sciences are nearly three times as likely as young men with the same abilities to abandon these interests and opt for careers in other fields, according to preliminary findings from a three-year study funded by the U.S. Department of Energy that will be made public here today.

The study, which surveyed several hundred American students between their senior year in high school and fourth year of graduate school, found that fewer than one man in ten with high potential for a career in science, about 7.5 percent, will give it up as his chosen field.

By contrast, one woman in five with the same potential, a full 20 percent, will choose another career.

- more -

**Women Abandon Potential Careers In Science  
Three Times Faster Than Men**

- 2 -

These findings and other results from the first two years of the DOE-funded study will be announced here today by Dr. Mary J. DeLong of Emory University at a conference being attended by more than 300 undergraduate and graduate students and several dozen prominent scientists, educators and executives from major and mid-sized corporations.

The conference is the 10th anniversary reunion/celebration of the Research Science Institute, a program that annually invites 50 high school juniors with outstanding potential to spend six weeks at the Massachusetts Institute of Technology in the summer before their senior year.

The first Research Science Institute was organized and held in 1984 under the leadership of the late Adm. H. G. Rickover, known as the father of the nuclear Navy, who was concerned that America was falling behind other nations in the race to train the scientists and mathematicians needed for the future.

Founded Center for Excellence in Education

To address the problem, Adm. Rickover founded the Center for Excellence in Education (CEE), McLean, Va., a non-profit organization that conducts the annual Research Science Institute (RSI).

In 1992, the U.S. Department Energy awarded CEE a grant to fund a three-year study to identify the factors that enter into a student's decisions regarding his or her career path. A special focus of the study is to determine reasons for the high attrition rate of female students from post-secondary science and mathematics studies.

- more -

Dr. DeLong, professor of biochemistry at Emory University, is the project's principal investigator.

In October of 1992, CEE sent a preliminary questionnaire to all 1984-1992 RSI alumni.

"The RSI alumni constitute a particularly appropriate sample for the study insofar as they represent a geographically diverse and uniformly very high ability group," Dr. DeLong said.

"In addition, the RSI alumni group includes students at every level from the senior year of high school to the fourth year of graduate school, providing an opportunity to observe each stage in the process of choosing a field and subsequently a career.

"To date, more than 80 percent of 527 questionnaires have been received, and over 70 percent of respondents have provided sufficient data to be included in the sample to compare RSI research interest with college major."

#### Female Preference for Biology

Today, Dr. DeLong will announce the following preliminary conclusions:

- o A little more than one RSI alumni in ten will choose a non-math/science major. Out of this group, women are responsible for almost all of the movement away from science. Fewer than one man in ten (7.66%) has given up science as his chosen field, whereas one woman in five (20%) has done so. Women leave math/science fields at a rate three times greater than that of men.

Women Abandon Potential Careers In Science  
Three Times Faster Than Men

- 4 -

- o Male interests are fairly evenly distributed among the scientific fields in both high school and college, but females have a marked preference for biology. A woman is twice as likely to be in biology as she is in any other math/science field.
- o A female is more likely to major in a non-science field than in any other single math/science field. In contrast, men are more likely to major in engineering, mathematics or physics than in a non-science field.

The mean PSAT scores for RSI men are 146 and 143 for RSI women, Dr. DeLong said. Both means are in the top one percent of all PSAT scores and are within two percentage points of each other.

As far as PSAT scores can be used as a standard of ability, the two populations, male and female, of RSI students are very similar. This dimilarity should preclude the possibility of attrition due to inability on the part of females, Dr. DeLong concluded.

###

## PHASE II -- Why do Students Drop Out of Science and Math Careers?

The preliminary findings of CEE's Department of Energy-sponsored research, published and distributed in the spring, presented the researchers with fertile ground for further investigation: alumni of CEE's *Research Science Institute* (RSI) pursue non-math/non-science majors at a rate of ten percent, and women are responsible for almost all of the movement away from science. Since the RSI alumni display no significant gender-based differences with regard to scientific or mathematical ability, young men and women must be making these choices for other reasons. Discovering these factors is the goal of Phase II of the study.

CEE held two workshops this past July designed to encourage female students to continue their scientific and mathematical endeavors during the RSI Tenth Anniversary Reunion/Conference, in Cambridge, Massachusetts. In order to provide a forum for RSI alumnae to share their experiences and develop strategies for facing challenges in academia and the workplace, **Dr. Mary DeLong**, Professor of Environmental Health Science at Emory University and lead Project Investigator for the DOE study, organized a session titled "Survival, Sanity, and Success: Women in Science." This standing-room-only program opened the weekend conference and featured four prominent female scientists who discussed the influences and experiences leading to their chosen careers.

**Dr. Katherine Hammer**, President and CEO of Evolutionary Technologies, Inc., stressed the importance of balancing scientific prowess with interpersonal communication and leadership skills. Reflecting on her lifelong passion for the sciences, **Dr. Beverly Hartline**, Associate Director and Project Manager for the Continuous Electron Beam Accelerator Facility, urged the young women present to pursue their interests with zeal, seek out those who excel in their fields, and avoid those who might try to discourage

them. **Dr. Maria Kukuruzinska**, Assistant Professor at Boston University's Center for Advance Biomedical Research, outlined three major challenges in the scientific arena: to strive for excellence in science, to be a good teacher, and to be an effective administrator. All of these endeavors hinge upon the greatest challenge facing young women scientists: the necessity of developing the confidence, tenacity, and determination to continue along one's chosen path. **Dr. Virginia Weldon**, Senior Vice President of Public Policy for the Monsanto Company, focused on the need to "change the context" of a world largely designed by men, leading by example rather than by confrontation or competition.

The discussion continued the following morning with a session on "Closing the Gap in Science Education," coordinated by **Dr. DeLong** and moderated by **Dr. Denise Garland**, Professor of Chemistry at the City College of New York. The panel's speakers addressed the challenges as well as opportunities awaiting both male and female students pursuing scientific majors. **Dr. Mildred Dresselhaus**, Professor of Physics at MIT; **Ms. Denise Evans**, IBM Business Unit Executive; **Dr. Katherine Hammer**, President and CEO of Evolutionary Technologies; **Dr. David Potter**, Professor of Neurobiology at Harvard University Medical School; and **Dr. Neil Todreas**, Professor of Nuclear Engineering at MIT, shared their experiences and perspectives with the young Rickoid scientists in the audience.

The next phase of the DOE study will be to design and administer a second, more detailed questionnaire to the RSI alumni. The goals of this questionnaire are to identify key factors in students' decision making with regards to science and to determine several courses of action for intervention. The questionnaire will be developed by the Princeton Research Group with input from RSI alumni, Steering Committee, and Advisory Board of the DOE study.

**VIII. OTHER PROJECTS OF CEE SUPPORTING YOUNG  
SCHOLARS IN SCIENCE/MATH CAREER PATHS**

**SUPPORTING ACTIVITIES OF THE CENTER FOR EXCELLENCE IN EDUCATION  
FOR STUDENTS IN SCIENCE/MATH CAREERS**

1. **Role Models and Leaders Program - Now in the District of Columbia and Los Angeles - future site Chicago, Illinois**
2. **Junior Ambassadors Program**
3. **Newsletters**
4. **Summer Job/Mentorship Opportunities**
5. **Scholarship and Fellowship Publication**
6. **Teaching Assistantships and Counselorships at RSI Summers**
7. **Teaching Assistantships at Mini-Math Programs now in China, Bulgaria, Switzerland**
8. **Networking of Minorities with the Mathematics Association**
9. **E-mail Scholarship opportunities available**
10. **Continuity of support and membership in special high-ability cohort group**

**Following services provided:**

1. **Early-Action Recommendations**
2. **Support for Westinghouse Scholarship Competition**  
**In the last four years two grand prize winners from RSI**  
**RSI most successful group in Competition**
3. **Support college visits with RSI alumni at college**
4. **Regional parties and discussion sessions for RSI alumni**
5. **Holiday Parties (regional)**
6. **Orientation sessions at colleges**
7. **Parents-support group providing housing for schools visits and interviews**

\* \* \* \*

## Employment Contacts - DOE Grant

As of November 1, 1996, the following organizations have said they would consider RSI alumni for summer employment:

	<u>Company</u>	<u>Contact</u>
1.	Amgen Inc.	Mr. Stephen Watkins
2.	Bank of California	Ms. Adriana M. Boeka
3.	Bell Atlantic	Mr. Champe McCulloch Ms. Delores Watson Ms. Denise Bailey Ms. Dottie McCaleb Ms. Wanda Lucas
4.	Boeing	Mr. John Alter
5.	Booz, Allen and Hamilton	Dr. John Savage
6.	BTG	Dr. Ed Bersoff Mr. Gary Garifalo
7.	CACI	Ms. Val Derringer
8.	CTA	Mr. Dean Harger
9.	DELTEK	Mr. Donald deLaski
10.	Dresser Industries	Mr. John Murphy
11.	Duracell	Mr. James Donahue, Jr.
12.	Fuentez Systems Concepts	Mr. Joe Hildebrand
13.	Fujitsu	Mr. Masaaki Murata
14.	Gemsyn	Dr. Robert Moore
15.	GTE Laboratories	Dr. Peter Cukor
16.	Hamilton Group	Mr. Ronald Boguski
17.	Hewlett-Packard	Ms. Nancy Thomas

- |     |                                    |   |
|-----|------------------------------------|---|
| 18. | Hitachi                            | Ms. Julie A. Banzhaf<br>Mr. Masayuki Kohama   |
| 19. | Honda America                      | Ms. Kathy Carey   |
| 20. | Howard University Hospital         | Ms. Robyn Webb-Williams   |
| 21. | Hughes Information Technology      | Mr. Wayne Shelton   |
| 22. | IBM                                | Mr. Lou Durden  |
| 23. | Intellitech                        | Mr. Wadih Tannous   |
| 24. | Interpro, Inc.                     | Mr. David Lucien  |
| 25. | Irving Group                       | Mr. Dale Powell   |
| 26. | Kraft General Foods                | Ms. Tuckie Bartlett<br>Mr. Robert MacVicker<br>Mr. Michael Mudd<br>Mr. Boyd Hollingsworth |
| 27. | Kenan Systems Corp.                | Mr. Kenan Sahim   |
| 28. | Landmark Systems                   | Ms. Pat McGettigan  |
| 29. | Life Cycle Technology              | Dr. Douglas S. Ingram<br>Ms. Beth Reid  |
| 30. | Litton Industries                  | Mr. M. J. Diederich<br>Ms. Brenda Anderson  |
| 31. | Lockheed                           | Ms. Barbara Reinike<br>Ms. Trudy Sibley   |
| 32. | Loral Corporation                  | Mr. George Monahan  |
| 33. | Mercedes-Benz                      | Mr. Jerry Giaquinta   |
| 34. | McGuire, Woods, Battle, and Boothe | Mr. Richard C. Baker  |
| 35. | Miller Brewing                     | Mr. Don Tearno  |
| 36. | MITRE                              | Ms. Edna Davis  |

37. Mitsubishi Mr. Akira Tsukada
38. Mobil Ms. Mary Morgan Springer
39. Montgomery County High Technology Council Dr. Walter Plosila  
Ms. Shannon Savage
40. MRJ Inc. Dr. Edward McMahon
41. National Endowment for the Humanities Mr. Ralph C. Canevali
42. National Medical Enterprises Dr. William S. Banowsky  
Ms. Sharon Melcher
43. National Science Foundation Dr. Barbara Butler  
Dr. Robert Russell  
Dr. Hymen Field  
Mr. Costello Brown
44. National Technologies Corporation Mr. Arthur Rogers
45. NEC Ms. Sylvia Clark
46. Nissan Motor Corp. Ms. Julie Meyer
47. Northern Virginia Technology Council Mr. Mike Sesher
48. Parsons-Main Mr. James Callahan
49. PennCorp Financial Ms. Carol Spencer
50. Pepsi West Mr. Lupe De La Cruz
51. Phillip Morris Ms. Kathleen Lenahan
52. Putney Group Mr. Zimri Putney
53. Rockwell Corporation Ms. B. J. May
54. Sequa (Atlantic Research Corporation) Ms. Linda Fernald
55. Smith Corona Mr. William Henderson
56. Southern California Edison Ms. Tani Welsh
57. SEMA Mr. J. Link White

- |     |   |   |
|-----|---|---|
| 58. | Technology Service Organization             | Mr. Fred Nathanson  |
| 59. | Toyota USA                                  | Ms. Christine Abe<br>Ms. Gretchen Thompson  |
| 60. | TRW, Inc.                                   | Mr. Michael Jackson<br>Ms. Sarah Farnsworth<br>Mr. Joseph Yates<br>Ms. Toni Murto<br>Mr. Christopher D. Holley<br>Ms. Kelly Ambrose<br>Ms. Lisa Johnson |
| 61. | Unocal                                      | Ms. Judith A. Barker  |
| 62. | Vanguard Research                           | Mr. Mel Chaskin   |
| 63. | Virginia's Center for Innovative Technology | Mr. Peter Fitzpatrick<br>Mr. John Jerke   |
| 64. | Virginia Space Grant Consortium             | Mr. Mary Sandy  |
| 65. | Vitro Corporation                           | Mr. Art Rossi<br>Ms. Carolyn Hobbs  |
| 66. | Watkins-Johnson Company                     | Williams Telecommunications<br>Group  |
| 67. | Xerox                                       | Mr. Gary Aslin<br>Mr. Dean Hamingsen  |
| 68. | Washington Technology                       | Mr. John Sanders<br>Ms. Esther Smith  |
| 69. | West*Group                                  | Ms. Kathryn MacLane<br>Ms. Alice Starr  |

## **IX. APPENDIX**

**A. Advisory and Steering for DOE Study**

**B. Complete Questionnaire II of Phase III**

# DOE Study Advisory Board

## ADVISORY BOARD MEMBERS

Ms. Pam Bee	RSI Alumna
Dr. Linda Brody	Director, SET, Center for Talented Youth
Mr. Wilbert Bryant	Deputy Secretary of Education, Commonwealth of Virginia
Dr. Beatrice Cameron	Regional Education Officer—South America, Office of Overseas Schools
Ms. Denise Evans	Branch Manager, International Business Machines Corporation
Dr. Jane Hannaway	Director of Educational Policy Research, The Urban Institute
Ms. Peggy Hsia	DOE Coordinator, Center for Excellence in Education
Dr. Jane Butler Kahle	Director, Project Discovery, Miami University
Dr. Sally Kilgore	Senior Research Fellow, Hudson Institute
Dr. Martha Krebs	Director, Office of Energy Research
Dr. Maria A. Kukuruzinska	Boston University Medical Center
Dr. William Layson	Senior Vice President, SAIC
Dr. Barbara B. Lazarus	Associate Provost for Academic Projects, Carnegie Mellon University
Ms. Amy Levine	Legislative Aide, Senator J. Bennett Johnston
Ms. Ann Mathison	RSI Alumna
Dr. William F. McComas	Director, Science Education Programs, USC
Ms. Ashley Reiter	1990 Westinghouse Talent Search Winner
Ms. Gretchen Rigol	Executive Director, Administrative & Guidance Services, The College Board
Dr. Rae Lee Siporin	Director of Undergraduate Admissions, UCLA
Mr. Chris Skinner	1988 Westinghouse Talent Search Winner
Dr. Marion Thurnauer	Argonne National Laboratory
Dr. Betty M. Vetter	Executive Director, Commission on Professionals in Science & Technology
Dr. Mary L. Walshok	Associate Vice Chancellor, University of California, San Diego

# Steering Committee Members

## STEERING COMMITTEE MEMBERS

Mrs. Gayle Wilson	First Lady of California, Hon. Chairperson
Dr. Mary J. DeLong	DOE Principal Investigator, Emory University School of Public Health
Dr. Bruce M. Alberts	President, National Academy of Science
Dr. Michael C. Behnke	Director of Admissions, Massachusetts Institute of Technology
Dr. Constance E. Clayton	Harvard University/Medical College of Pennsylvania
Dr. Nancy Cole	President, Educational Testing Services
Ms. Joann P. DiGernaro	President, Center for Excellence in Education
Dr. David Pierpont Gardner	President, The William and Flora Hewlett Foundation
Dr. Denise Garland	Professor, The City College of New York
Dr. Beradine Healy	Former Director, National Institutes of Health
Dr. Penelope Kegel-Flom	President, Association of Women in Science
Dr. Cheryl L. Kubelick	Manager, Corporate Relations, Westinghouse Foundation
Dr. Samuel Metters	Chairman & CEO, Metters Industries, Inc.
Dr. Long Nguyen	President, Pragmatics, Inc.
Dr. Virginia Weldon	Vice President of Public Policy, Monsanto Company

RESEARCH SCIENCE INSTITUTE ALUMNI STUDY:  
MAJORS AND CAREER CHOICES



**Funded by:**

**Department of Energy**

**Center for Excellence in Education**

Name

Current Mailing Address

Current Phone and FAX

Permanent Mailing Address (If different from above)

Permanent Phone and FAX

E-mail Address

Male or Female

Date of Birth

Year of Research Science Institute

Present Year at College/University (If applicable)

Present Employment (If applicable)

Undergraduate University

Degree

Year

Major

Graduate University

Degree

Year

Major

# A CHOICES AT THE END OF THE SENIOR YEAR IN HIGH SCHOOL

A1. At the end of your senior year in high school, in what field of study had you decided to major when you entered college?

First Intended Major: \_\_\_\_\_

A2. How much did each of the following influence your decision to select that field for your first intended major?

POSSIBLE CATEGORIES	Mark (X) one for each		
	Very Influential	Somewhat Influential	Not Influential At All
1. Encouragement of family member(s).....	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>
2. Encouragement of teacher(s).....	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>
3. Winning awards and scholarship.....	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>
4. Influence of mother's career.....	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>
5. Influence of father's career.....	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>
6. Research experience at RSI.....	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>
7. Your ability or talent in the field.....	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>
8. Work experience.....	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>
9. Your strong academic or life experience in this area.....	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>
10. It was interesting to you.....	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>
11. Perception of future job market.....	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>
12. Influence of peers.....	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>
13. Other factor (Specify: _____)	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>

A2a. Which TWO factors in A2, exerted the MOST influence upon your decision to pick that first intended major? ENTER THE APPROPRIATE CATEGORY NUMBER FROM A2 IN THE BOXES BELOW.

First reason:

Second reason:

A3. Using the scale below, please indicate how committed you felt toward your first intended major as you entered college.

Mark (X) one box

Very Committed	Neutral			Not At All Committed		
7 <input type="checkbox"/>	6 <input type="checkbox"/>	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>

A4. As you entered college, what type of work did you think you most wanted to do after you would complete your degree or degrees?

Mark (X) one box

- 1  Teaching
- 2  Research
- 3  Management/administration
- 4  Professional practice
- 5  Other (Specify: \_\_\_\_\_)
- 6  Had no idea

A5. As you entered college, in which type of setting did you think you most wanted to work after completing your degree or degrees?

Mark (X) one box

- 1  College or university
- 2  Business or industry
- 3  Government
- 4  Nonprofit organization
- 5  Self-employed
- 6  Elementary school
- 7  Secondary or high school
- 8  Other (Specify: \_\_\_\_\_)

**A6. For which of the following reasons were you attracted to that type of work and setting at that time? How much did each of the following influence your decision?**

Mark (X) one for each

Very Influential	Somewhat Influential	Not Influential At All
------------------	----------------------	------------------------

- 1. Intellectual challenge..... 1  2  3
- 2. Opportunity to shape policy in a school, corporate, or public arena..... 1  2  3
- 3. Potential for a high income... 1  2  3
- 4. Availability of jobs..... 1  2  3
- 5. Low stress work environment 1  2  3
- 6. Team work with colleagues... 1  2  3
- 7. Opportunity to help people... 1  2  3
- 8. Potential for flexible hours... 1  2  3
- 9. Opportunity for responsibility 1  2  3
- 10. Opportunity for creative initiative..... 1  2  3
- 11. Work you enjoyed doing..... 1  2  3
- 12. No need for lengthy training... 1  2  3
- 13. Opportunity to work independently..... 1  2  3
- 14. Solve important problems..... 1  2  3
- 15. Chance to win recognition..... 1  2  3
- 16. Opportunity to create new knowledge..... 1  2  3
- 17. Opportunity to pursue own projects..... 1  2  3
- 18. Opportunity to be in a family business..... 1  2  3

**A6a. Thinking back to when you entered college, which THREE reasons listed in A6, attracted you the MOST to that type of work and setting?**

ENTER THE APPROPRIATE CATEGORY NUMBER FROM A6 IN THE BOXES BELOW.

First reason:

Second reason:

Third reason:

**B. MAJOR FIELDS OF STUDY WHILE AN UNDERGRADUATE**

**B1. On entry into college/university, when do you or did you first formally declare a major field of study?**

Mark (X) one box

- 1  End of your first year
- 2  Start of your second year
- 3  End of your second year
- 4  Other time (Specify: \_\_\_\_\_)

**B2. Was your first formally declared major the same as your intended major when you entered college as listed in A1?**

IF YOU HAVE NOT YET FORMALLY DECLARED A MAJOR, CHECK THIS BOX →  **SKIP to C1 (page 6)**

- 1  Yes, the same → **SKIP to B4**
- 2  No, not the same

**B3. What was your first formally declared major field of study?**

First Formally Declared Major: \_\_\_\_\_

**B4. Using the scale below, please indicate how committed you felt toward your first formally declared major at the time you formally declared it**

Mark (X) one box

Very Committed							Not At All Committed
7 <input type="checkbox"/>	6 <input type="checkbox"/>	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>	

**B5. Have you completed your undergraduate degree?**

- 1  Yes → *SKIP to B7*
- 2  No

**B6. Is your current major the same as your first formally declared major?**

- 1  Yes → *SKIP to B6c*
- 2  No

**B6a. What is your current major field of study?**

Current Major: \_\_\_\_\_

**B6b. When did you declare that major?**

*Mark (X) one box*

- 1  In your first year
- 2  In your second year
- 3  In your second year
- 4  Some other time (*Specify:* \_\_\_\_\_)

**B6c. Using the scale below, please indicate how committed you feel at this time towards your current major?**

*Mark (X) one box*

- |                            |                            |                            |                            |                            |                            |                            |                            |
|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| Very<br>Committed          |                            | Neutral                    |                            |                            |                            |                            | Not<br>At All<br>Committed |
| 7 <input type="checkbox"/> | 6 <input type="checkbox"/> | 5 <input type="checkbox"/> | 4 <input type="checkbox"/> | 3 <input type="checkbox"/> | 2 <input type="checkbox"/> | 1 <input type="checkbox"/> |                            |

**After completing B6c, SKIP to B8**

**B7. Was your undergraduate degree in the same field as your first formally declared major?**

- 1  Yes → *SKIP to B7c*
- 2  No

**B7a. In what field of study did you complete your undergraduate degree?**

Undergraduate Major: \_\_\_\_\_

**B7b. When did you declare that major?**

*Mark (X) one box*

- 1  At time of your enrollment in college/ university
- 2  In your first year
- 3  In your second year
- 4  In your second year
- 5  Some other time (*Specify:* \_\_\_\_\_)

**B7c. Using the scale below, please indicate how committed you were toward that field of study at the time you graduated?**

*Mark (X) one box*

- |                            |                            |                            |                            |                            |                            |                            |
|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| Very<br>Committed          |                            | Neutral                    |                            |                            |                            | Not<br>At All<br>Committed |
| 7 <input type="checkbox"/> | 6 <input type="checkbox"/> | 5 <input type="checkbox"/> | 4 <input type="checkbox"/> | 3 <input type="checkbox"/> | 2 <input type="checkbox"/> | 1 <input type="checkbox"/> |

**B8. BASED ON YOUR ANSWERS TO B2 OR B6 OR B7, DID YOU EVER SWITCH FROM YOUR FIRST INTENDED MAJOR TO ANOTHER FIELD OF STUDY?**

- 1  Yes, made a switch → *GO to B9 (page 5)*
- 2  No, did not switch → *SKIP to C1 (page 6)*

**B9. Why did you switch from your first intended major (A1) to another field of study?**

Mark (X) "Yes" or "No" for each

- |  | YES                        | NO                         |
|--|----------------------------|----------------------------|
| 1. Insufficient academic foundation in your first intended major .....                         | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 2. No longer perceived a science/math career to be as fulfilling as you once did .....         | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 3. Concerned your grades would suffer .....  | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 4. Personal feelings of success or failure .....   | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 5. Did not feel particularly comfortable with your peers in that field .....                   | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 6. Your new major is of greater potential value to society .....                               | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 7. You were encouraged by friends/family to switch majors .....                                | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 8. You were encouraged by faculty to switch majors .....                                       | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 9. Your first intended major left too little time for other interests, personal pursuits ..... | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 10. A career in the new field will be more compatible with someday having a family .....       | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 11. More job opportunities in your new field .....   | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 12. Better income potential in the new field .....   | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 13. More opportunities to be at the top of your field in this new area .....                   | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 14. Feeling less self-confident about your abilities in first intended major .....             | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 15. My current major relates more directly to the work I would like to do.....                 | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 16. Financial impact of education cost to obtain the career goal.....                          | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 17. Too long of a period of preparation for a career.....                                      | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 18. Other (Specify: _____) .   | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 19. Other (Specify: _____) .   | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |

**B9a. Which two reasons in B9 exerted the MOST influence upon your decision to switch from your first intended major to another field? ENTER THE APPROPRIATE CATEGORY NUMBER FROM B9 IN THE BOXES BELOW.**

First reason:

Second reason:

**B10. Did any of the courses you took in your first intended major contribute to your decision to switch from that field to another?**

- 1  Yes  
 2  No → **SKIP to C1 (page 6)**

**B10a. Which courses that you took in your first intended major contributed to your decision to switch from that major?**

IF MORE THAN TWO: RECORD THE TWO THAT CONTRIBUTED THE MOST

Course: \_\_\_\_\_

Course: \_\_\_\_\_

**B10b. In what ways did taking these courses contribute to your decision to switch majors?**

Mark (X) "Yes" or "No" for each

- |   | YES                        | NO                         |
|---|----------------------------|----------------------------|
| 1. Course was not well organized and/or informative.....                | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 2. Negative (direct or indirect) interactions with the professor.....   | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 3. Negative interactions with the teaching assistants.....              | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 4. Teaching assistants not organized/helpful.....                       | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 5. Did not give my best effort.....                                     | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 6. Not particularly interested in the topic.....                        | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 7. Not as talented in this area as I thought.....                       | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 8. My background in this topic was insufficient.....                    | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 9. Lack of a sense of belonging/not comfortable with my classmates..... | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |
| 10. Didn't do as well as I expected...                                  | 1 <input type="checkbox"/> | 2 <input type="checkbox"/> |

11. Other (Specify: \_\_\_\_\_) ... 1  2

12. Other (Specify: \_\_\_\_\_) ... 1  2

## C. SCIENCE AND MATH AS CAREER CHOICES

C1. To what extent would you have agreed or disagreed with each of the following statements back when you were entering college after your senior year in high school?

*Mark (X) one for each*

Would Have Agreed Strongly	Would Have Agreed Somewhat	Would Have Neither Agreed Nor Disagreed	Would Have Disagreed Somewhat	Would Have Disagreed Strongly
----------------------------	----------------------------	---	-------------------------------	-------------------------------

1. Science and math studies/careers are time consuming.....	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>
2. Science and math careers are generally more solitary in nature...	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>
3. Science and math careers tend to be too intellectually challenging...	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>
4. Science and math colleagues/students are very competitive...	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>
5. Science and math studies are not well grounded in reality.....	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>
6. Science and math studies do not leave enough time for other electives and personal pursuits.....	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>
7. Science and math studies tend to be more intellectually demanding than other disciplines.....	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>
8. Science careers require long years of formal preparation.....	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>
9. It is almost impossible to become highly visible in science and math...	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>

**C2. To what extent would you agree or disagree with those same statements today?**

*Mark (X) one for each*

Agree Strongly	Agree Somewhat	Neither Agree Nor Disagree	Disagree Somewhat	Disagree Strongly
----------------	----------------	----------------------------	-------------------	-------------------

1. Science and math studies/careers are time consuming.....	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>
2. Science and math careers are generally more solitary in nature than are other careers.....	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>
3. Science and math careers tend to be too intellectually challenging...	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>
4. Science and math colleagues/students are very competitive...	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>
5. Science and math studies are not well-grounded in reality.....	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>
6. Science and math studies do not leave enough time for other electives and personal pursuits.....	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>
7. Science and math studies tend to be more intellectually demanding than other disciplines.....	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>
8. Science careers require long years of formal preparation.....	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>
9. It is almost impossible to become highly visible in science and math...	5 <input type="checkbox"/>	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>

**C3. Which statement BEST describes your current thoughts on careers in science and math for men and women.**

*Mark (X) one box*

- 1  For a variety of reasons it is much more difficult for women to have successful careers in science or math
- 2  For a variety of reasons it is somewhat more difficult for women to have successful careers in science or math
- 3  For a variety of reasons it is equally difficult for women and men to have successful careers in science or math

**C4. To what extent do you agree or disagree with each of the following statements.**

*Mark (X) one for each*

Agree Strongly	Agree Somewhat	Neither Agree Nor Disagreed	Disagree Somewhat	Disagree Strongly
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1. Women tend to be too social for the solitary nature of science and math careers..... 5  4  3  2  1

2. Career and family demands cause more conflict for women..... 5  4  3  2  1

3. The fields of science and math are too aggressive for women..... 5  4  3  2  1

4. Women are not sufficiently encouraged to pursue math and science..... 5  4  3  2  1

5. Women are more isolated in math and science than men..... 5  4  3  2  1

6. Women receive less career information than men in math and science..... 5  4  3  2  1

7. Science and math professors tend to respect women less than men..... 5  4  3  2  1

8. Women have fewer role models than men in math and science..... 5  4  3  2  1

9. Women are discriminated against in math and science in subtle ways..... 5  4  3  2  1

10. Math and science are academically less challenging for men..... 5  4  3  2  1

11. Women do not know how to scientifically debate issues as well as men..... 5  4  3  2  1

12. Women enjoy the competition in science and math less than men..... 5  4  3  2  1

**D. FUTURE CAREER CHOICES**

**D1. Have you already (or do you plan to) attend graduate or professional school?**

- 1  Yes, have or plan to
- 2  No, no plans to do so **SKIP to D2**

**D1a. (IF YES TO D1) In which field of study have you or do you want to pursue graduate or professional school studies?**

Field of Study: \_\_\_\_\_

**D1b. Presently, what type of work would you MOST want to do after completing your graduate or professional studies?**

**MARK (X) one box**

- 1  Teaching
- 2  Research
- 3  Management/administration
- 4  Professional practice
- 5  Other time (Specify: \_\_\_\_\_)

**D1c. Presently, in which type of setting would you MOST want to work after completing your graduate or professional studies?**

**Mark (X) one box**

- 1  College or university
- 2  Business or industry
- 3  Government
- 4  Nonprofit organization
- 5  Self-employed **→ SKIP to D4**
- 6  Elementary school
- 7  Secondary or high school
- 8  Other (Specify: \_\_\_\_\_)

**D2. In which of these areas are you currently working?** IF YOU HAVE MORE THAN ONE JOB, INDICATE THE KIND OF WORK WHERE YOU WORK THE MOST HOURS.

IF CURRENTLY NOT WORKING, CHECK THIS BOX →  AND **SKIP to E1 (page 9)**

**MARK (X) one box**

- 1  Teaching
- 2  Research
- 3  Management/administration
- 4  Professional practice
- 5  Other time (Specify: \_\_\_\_\_)

**D3. In which of the following settings are you currently working?** IF YOU HAVE MORE THAN ONE JOB, INDICATE THE SETTING YOU WORK IN THE MOST HOURS.

**Mark (X) one box**

- 1  College or university
- 2  Business or industry
- 3  Government
- 4  Nonprofit organization
- 5  Self-employed
- 6  Elementary school
- 7  Secondary or high school
- 8  Other (Specify: \_\_\_\_\_)

**D4. For which of the following reasons are you attracted to that type of work or setting?**

*Mark (X) one for each*

	Very Influential	Somewhat Influential	Not Influential At All
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- 1. Intellectual challenge..... 1  2  3
- 2. Opportunity to shape policy... 1  2  3
- 3. Potential for a high income... 1  2  3
- 4. Great availability of jobs..... 1  2  3
- 5. Low stress work environment 1  2  3
- 6. Team work with colleagues... 1  2  3
- 7. Opportunity to help people... 1  2  3
- 8. Potential for flexible hours..... 1  2  3
- 9. Opportunity for responsibility 1  2  3
- 10. Opportunity for creative initiative..... 1  2  3
- 11. Work you enjoyed doing..... 1  2  3
- 12. No need for lengthy training... 1  2  3
- 13. Freedom to chose own work... 1  2  3
- 14. Solve important problems..... 1  2  3
- 15. Chance to win recognition..... 1  2  3
- 16. Opportunity to create new knowledge..... 1  2  3
- 17. Opportunity to start own business..... 1  2  3
- 18. Other (Specify: \_\_\_\_\_) 1  2  3

## E. CASE STUDIES

- E. Described below are 6 situations commonly faced by undergraduates. Thinking back to when you were an undergraduate (if you are not one now), read each situation and indicate your response.

### E1. A Difficult Course

Although having taken the correct sequence of courses, Pelel has a problem with Mathematics 301, a required course for the chosen science major. The course material is rapidly paced and Pelel has trouble (like many others in the class) understanding more than a third of any class lecture. The textbook for the class is equally difficult to understand. Tutorials are somewhat helpful but problem sets take many hours. Pelel is feeling overwhelmed and questions further commitment to science studies. What would you advise Pelel to do?

**Mark (X) all that apply**

- 1  Become part of a study group to hear other explanations of the lectures
- 2  Consult other books for clearer and simpler explanations of the topics
- 3  Talk to the professor about the problem
- 4  Talk to the tutorial instructor about the problem
- 5  Find a tutor
- 6  Drop the course
- 7  Study with someone who is doing well in the course
- 8  Drop the course, take more background courses and try it again
- 9  Go over the textbook and lecture notes many times until the material can be understood
- 10  Rethink your choice of a science major
- 11  Advise Pelel not to lose confidence but try a new attack on the material
- 12  Other (Specify: \_\_\_\_\_)

### E2. The Value of a Major

Marrin has been a mathematics major for two years and done well in the advanced math courses. Marrin enjoys math but has begun to question its relevance and value in the real world. Marrin is very talented in mathematics but is beginning to feel that math may not be the answer for solving some of mankind's problems. What would you say to Marrin?

**Mark (X) all that apply**

- 1  Talk to a career counselor
- 2  Talk to other math majors for their opinions
- 3  Read more about the options of a mathematics career
- 3  Work in a mathematics internship for the summer
- 5  Not to worry about relevance, it will come with time
- 6  Don't worry, mathematics is a special talent and should be used
- 7  Other (Specify: \_\_\_\_\_)

### E3. Conflicts in Family Needs

Sevra is graduating soon with a B.S. in electrical engineering and has been accepted into three excellent graduate programs. Sevra has a serious relationship with Byan who is finishing a degree in chemistry. Byan has also been accepted into two prestigious graduate programs but at different universities than Sevra. Sevra and Byan both want 1) the relationship, 2) to go to their first choice graduate program, and 3) children. What would you say to Sevra and Byan?

**Mark (X) all that apply**

- 1  They should decide who will be the primary earner and that one should have first choice of graduate programs and the other should be willing to compromise considering the care of children in the future
- 2  They should have planned beforehand to go to the same school—now it is too late
- 3  Each should go to his or her first choice graduate program and let the relationship continue at long distance
- 4  Science is so demanding they should not consider having a family
- 5  Other (Specify: \_\_\_\_\_)

#### E4. A Low Grade in a Course

Penan was an outstanding student through high school and the first year in university. Penan is now taking advanced courses in Geology. These courses have been difficult and Penan received a grade of C in Geology 302. Penan is devastated. Penan's self confidence is shaken and as a result, is thinking about switching to a less difficult major. What would you say to Penan?

**Mark (X) all that apply**

- 1  Take it in stride, try to study harder next time and find out where the problems were
- 2  A grade of C in your major may be an indication of insufficient talent, perhaps another choice of major is in order
- 3  Talk to the professor about other courses and ways to strengthen weak background areas
- 4  Don't be so surprised, you should have asked for help all along the way
- 5  Many persons earn low grades when they first encounter very difficult material and then learn how to study more effectively, especially if studies have always come easily
- 6  Talk to other geology majors, many are not straight A students
- 7  Other (Specify:  
\_\_\_\_\_  
\_\_\_\_\_)

#### E5. Not Being at the Top

Fenyl was the high school class valedictorian and always considered an outstanding computer scientist. Fenyl went to a prestigious university and soon met others of equal or greater ability in computer science. Although gifted in computer science, Fenyl questioned whether to continue in the field because of no longer being at the top. What would you tell Fenyl?

**Mark (X) all that apply**

- 1  One can contribute significantly to a field without being the top performer
- 2  It is best to be at the top of one's field so switching majors might be advisable
- 3  It is important to enjoy your work and study – not to worry about being at the top
- 4  That computer science is valuable to society and not to consider only top positions
- 2  To minimize the importance of the letter grade and reemphasize the importance and value of the knowledge gained.
- 6  Other (Specify:  
\_\_\_\_\_  
\_\_\_\_\_)

#### 6) Being a Minority

Relan is a minority person of high ability. Although Relan has always pursued science studies in biophysics, always being the only minority, or one of a few has engendered feelings of isolation and loneliness. Relan finds it difficult to fit easily into study groups. Relan's social friends are not from biophysics they are minority students in other majors. Relan feels "uncomfortable" with the other biophysics majors. This has started to take its toll on Relan's performance. Relan enjoys biophysics but is tired of the "struggle" to belong and succeed. What would you say to Relan?

**Mark (X) all that apply**

- 1  Your "comfort" level is important so find a major where you are comfortable
- 2  Try to find a role model and talk to that person
- 3  Try to network with other minority students interested in science
- 4  Biophysics has no color or sex or ethnicity—just its practice
- 5  Seek counseling, perhaps career counseling
- 6  Other (Specify:  
\_\_\_\_\_  
\_\_\_\_\_)

"Some of the questions may not have provided sufficient choices or opportunity for you to express your thoughts on a particular issue or the extent to which your attitudes and goals have changed though the years. In the space below, please add additional comments on any questions and an expanded explanation on how your attitudes and goals have changed though the years."