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ABSTRACT

This study demonstrates that a population of high-achieving young women with sufficient motivation and ability for acceleration in science may be readily identified and that acceleration in science is practical for such a group. To test the effects of participation in a research-oriented multi-disciplinary college course (Research Introduction to Science) by high-achieving female high school juniors, 324 students selected on the basis of grades and achievement test scores were administered the Strong Vocational Interest Blank for Women and the Careers Attitudes and Plans Survey. They were also offered the possibility of taking a free multidisciplinary college course. The 137 students definitely interested in taking the course were randomly divided into two groups: experimental (enrolled in the course) and control (not enrolled). They differed significantly from the 187 not interested on 32 of the 69 variables. Fifty-eight students (85%) successfully completed the course, and their grades and ratings of enjoyment of the course correlated significantly with 42 pre and post measures. Those sufficiently motivated for the course were significantly higher on "science" factor scores and more interested in careers in general than those not motivated. (Author)

Acceleration in Science for Achieving High School Women: Project RISE

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Acceleration in Science for Achieving High School Women: Project RISE[1]

Final Report

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The Problem

The question of why the majority of creative scientists are men is frequently discussed in terms of social norms for sex roles and of the interruption of careers which marriage and children have traditionally caused for women (Oppenheimer, 1970). Present systems of both technological and social support for mothers, and additional educational and vocational opportunities for women have obviated part of this problem, but sex differences in the degree of interest in science are still typical of college students today, with women students showing less interest and more negative attitudes, perhaps partly because of stereotyped ideas that science is a male domain. Such outmoded ideas work against the general progress of society, for the potential contributions of women to science are readily acknowledged, and are against the best interest of women college students, since many of them may be deterred from beginning productive careers in science.

This study was designed to effect a change in the attitudes of a sample of achieving high school juniors toward science. It was believed that an educational experience on the college level which involved these students in the design and completion of an independent research project would permit them to participate in the "fun" of science, and would also expose them to active and attractive scientists who may serve as role models. This study thus tested the following hypothesis:

> that women students who simultaneously are involved in a meaningful college level scientific problem-solving activity will develop greater interest in and more favorable attitudes toward scientific careers than will their classmates who do not have this experience.

Our thinking in relation to this hypothesis rested upon the following assumptions:

1. Scientific interests are a distinguishable and measurable characteristic.

Evidence for this assumption is summarized by Super and Crites (1962), who found similar scientific-theoretical factors to emerge in each of eight tests of values and interests, including the Strong Vocational Interest Blank. Robinson, Athanasion, & Head (1969) in their "smallest space" analysis of the SVIB and the Kuder Preference Record, likewise suggest dimensions in each which differentiate "scientific" and "commercial" types of people. In line with this evidence, it is assumed here that scientific interests and attitudes can be measured by the Strong Vocational Interest Blank for women, and by direct self-interest and evaluative ratings of scientific occupations.

2. Vocational interests are not completely set in adolescence.

Writing in relation to research with the SVIB, Campbell (1969) reports that changes are fairly frequently found in vocational interests between the ages of 16 and 20. Super's (1957) first stage of vocational development is one of "adolescent exploration." Thus, both empirical data and theory support this assumption, which implies that vocational interests may be changed among high school students, and is thus essential for our hypothesis.

3. Women's scientific interests and achievements are less than those of men and thus are sufficiently low to allow for improvement.

Evidence for this assumption is widespread and is summarized by Anastasi (1958), Super and Crites (1962) and Terman and Tyler (1954). One example from 30 years ago involves the Science Talent Search sponsored by the Westinghouse Corporation. While the contest was open to students of both sexes, there were two to three times as many boys as girls who applied. Yet, despite the greater selectivity of the female sample, there was a large and significant difference in favor of males on the Scientific Aptitude Test used to select the winners (Edgerton & Britt, 1944, 1947). Likewise, and again historic rather than current, of the 2607 scientists chosen for the directory of American Men of Science between 1903 and 1943, only 50 were women (Anastasi, 1958). More recent surveys support this imbalance (Oppenheimer, 1970: Mattfeld & Van Aken, 1965).

Currently, the research of the Stanley team at the Johns Hopkins University provides evidence that this sex difference persists. In their search for mathematically and scientifically precocious youth, males thus far have regularly outperformed females on selection tests (Fox, 1974). Astin (1971) for example, reports fewer girls applying and lower science scores for those who do apply. Fox (1974) confirms these differences, but reports an increase in both numbers and scores over the past three years. Fox's data are thus supportive of the possibility of change. Peiser (1973), working with Fox's subjects, reports significantly more favorable attitudes toward scientific careers among the males. All of these effects seem to replicate those found earlier, and to suggest that even among talented adolescents large sex differences in attitudes toward science are still the norm.

Scientific interests are more typical of men or boys to such an extent that the scales for masculinity-feminity of both the SVIB (Strong, 1943), and Terman's M-F Test (Terman & Miles, 1936) include interest in science as an integral part of the masculinity end of the scale. Boys likewise are repeatedly found to score higher on the Science scale of the Kuder test (Triggs, 1943; Traxler & McCall, 1941; Tuckman, 1944, for example).

Even elementary school boys show a greater preference for science class than do girls (Greenblatt, 1962) and more favorable attitudes toward science in general (Shrigley, 1972). Part of this effect may be due to the fact that the large majority of elementary school science textbooks show male persons at work (Gaetana, 1966). More favorable attitudes toward science among males are also found in the middle school years (grades 6 to 9) (Yamamoto, Thomas, & Karns, 1969).

It should be noted that these sex differences are generally thought to derive from social and cultural rather than biological mechanisms (Rossi, 1965). Although the contributions of women scientists are proportionately less numerous, they are sufficiently important to suggest that the encouragement of girls toward scientific careers is desirable.

Theoretical Model

Our belief that involvement in a high-participation research course will produce changes in the attitudes toward science among high school women is derived from research and theory in social psychology related to attitude change. Previous research indicates that participation, role-taking, and public commitment may be effective agents of attitude change. The effectiveness of participation was first demonstrated by Lewin's classic studies (reprinted 1966) which showed subjects making better use of organ meats, orange juice, and cod liver oil after they had participated in group discussions than had those subjects who attended lectures. Similar findings have been made by Pennington, et al, (1958). More recent studies by Janis (Janis & King, 1954; King & Janis, 1956; Janis & Mann, 1965; Mann & Janis, 1968) support the idea that role-playing also is more effective than passive observation in changing attitudes and behavior. Public commitment was involved in the Lewin studies and is also seen to be an effective change inducer in certain studies of Hovland (Hovland, Campbell, & Brock, 1957 for example). One could also argue that role-playing, since it occurs in a social situation, invariably involves public commitment.

In the present study, the experimental subjects will be making a public commitment by participating in the experimental course. Their role-playing will not be the artificial short-range act involved in the laboratory studies mentioned above, but will involve a long-range and serious effort involving the design, data collection, analysis and interpretation of a piece of research. Their participation in discussions, planning sessions, and the independent project is one of the central features of the experimental course. When they collect data, they will be playing the role of scientists. Thus, the research described above which indicates the effectiveness of participation, public commitment, and role-playing for attitude change supports our hypothesis.

Further consideration of the psychological processes underlying the hypothesized changes in attitudes would involve analysis of the dynamics of the face-to-face persuasive situation. McGuire (1969, p233) suggests that face-to-face contact is likely to involve greater activity on the part of the subject, more feedback to the subject, public commitment, social restraint against disagreement, observation of effects on peers, and more immediate rewards--all of these promoting greater change due, in part, to social facilitation. All of these factors are believed to be involved in our experimental treatment. More specifically, social reinforcement or reward, which has been demonstrated by Scott (1957, 1959) to facilitate attitude change, is considered to be the central psychological process involved in the changes hypothesized in this experiment. It is expected that the teachers will be closely involved with each student, thus able to reinforce positive efforts and attitudes.

Kelman's (1958) ideas about attitude change by identification also seem to apply here. Subjects will be exposed to teachers who will hopefully be prestigious and attractive role models, who will be rewarding the students' participation and research efforts, and who will also be evaluating these efforts, thus giving them a certain degree of fate control over the students. Imitation and attitude change by identification with these models may thus occur. This process, as well as those cited above, probably underlies the positive effects found for participation and is expected to play a part in bringing about positive changes in this experiment.

Method

Subjects

An initial pool of 479 female high school juniors in four high schools were selected by the guidance department of each school on the basis of grades and standardized test scores. All subjects were in the top half of their class and represented the highest achieving junior women in each school. Table 1 shows the number of subjects in the initial pool from each of the four high schools.

From this initial pool, 95 were removed by random procedures and served as a second, "after-only" control group. All others were invited to participate in the study. Of these, 86% (331) agreed to cooperate and 324 successfully completed the initial testing.

At the initial testing the free experimental course was described to the subjects and an opportunity given for those interested in taking the course to respond. Of the 324 tested, 137 (42%) expressed a definite interest in taking the course. This group was divided in half by random procedure with 68 selected to take the experimental course, and 69 serving as the first control group. Of the 68, 58 (85%) successfully completed the course, and of the 69 first control group, 62 (90%) successfully completed the second testing. Of the 95 subjects in the second control group, 68 (71%) cooperated and successfully completed the post tests (see Table 1).

Experimental Design

The experimental and first control groups were tested before and after the experimental group had completed the experimental course. The second control group participated in the second testing only.

Procedure.

Subjects were invited to participate in the study by means of a letter addressed to them and their parents at their homes (see Appendix A). Parents were asked to send a note to the school principal if they did not want their daughter to participate.

At the initial testing, a second letter (Appendix B) was given all subjects describing the experimental course. This letter was to be signed by student and parent and returned with a check mark indicating interest in enrolling in the experimental course.

Subjects selected for the experimental course were informed by letter (Appendix C) and subjects in the first control group were also sent a letter (Appendix D) explaining their continued importance to the study.

At both the pre and post testing sessions identical instruments were used, including the Strong Interest Blank for Women and the Career Attitudes and Plans Survey (see Appendix E) which was especially designed for this study. The latter was composed of three parts: (1) a rating of self-interest in 30 occupations, 10 clearly scientific, 10 clearly non-scientific, making use of a five-point scale

(2) ratings on 6 bi-polar adjective pairs from the evaluative scale of the Semantic Differential of 10 occupations, 5 scientific, 5 non-scientific making use of seven-point scale

(3) an open-ended question: "in a few sentences, describe your own career plans, giving reasons for your choice."

In addition, the experimental group rated their enjoyment of the course on a 10-point scale and indicated whether or not they were planning to take additional college courses in the field in question; their grades in the course were also recorded.

Scores and analyses

Scores from the ratings of 30 occupations in terms of personal interest were treated separately for some analyses and combined (10 scientific occupations, 10 non-scientific) for others. Scores for the semantic differential ratings were summed for each occupation and treated separately in some analyses, combined into scientific, and non-scientific categories in others.

The open-ended question was rated on a five-point scale in terms of degree of scientific career interest, with five points awarded to a definite interest in a career clearly scientific, three points to a definite interest in a career somewhat scientific or an interest in several careers, one of which is scientific, and one point to a definite interest in a career clearly non-scientific or complete vagueness and indecision about a career, with two and four points used as intermediary points.

From the Strong Interest Blank for Women, we used the 19 Basic Interest Scores and the 8 Scientific Occupational Interest Scores.

The following analyses were carried out:

(1) Subjects interested in taking the course were contrasted on all measures in the initial testing with those not interested in the course.

(2) From all initial testing data, a factor analysis was carried out to determine the structure of these subjects' career interests.

(3) The experimental and first control groups were contrasted on all measures both pre- and post-experimental treatment.

(4) The second control group was compared to the post scores of the experimental and first control groups.

(5) For the experimental group, both grades and ratings of enjoyment were correlated with each other and with scores from pre and post testing. Grades were also analysed in relation to whether or not the student planned to take additional courses in the field.

The experimental course

The experimental course was designed to be multi-disciplinary and to involve the student in independent research in the discipline chosen, with each faculty member working with a small group of students. Faculty were eight members of the Goucher faculty distributed as follows over disciplines: 2 biologists, 1 chemist, 2 psychologists, 1 mathematician, 1 economist and 1 historian (history was presented as a science). All but two of the eight faculty members had their Ph.D.'s in the discipline in question. The other two were working on their dissertations. Seven of the eight were regular faculty members; the eighth was a parttime lecturer.

Subjects were initially assigned in relation to their preferences to either a Thursday or Saturday section of the course. Four faculty worked in each section.

The initial meeting involved both sections meeting together at which an explanation of the course was given, faculty were introduced, a tour of the campus was carried out and an informal reception with refreshments was held.

The next four meetings of the course consisted of a one-hour lecture and discussion led by each of the four faculty in turn, followed by a one-hour small group meeting in which the students were rotated among the four faculty. The purpose of these meetings was to acquaint the students with all four disciplines available to them in the remainder of the course.

After this, the students indicated their first, second and third choices for the faculty member they wanted to work with during the rest of the course. All students were placed in either their first or second choice. The fifth session included a film about the brain, and students were assigned to small groups.

There followed 15 additional sessions in which subjects worked in small groups with faculty. These sessions included lecture and discussion and the planning and carrying out of independent projects. Quizzes were given in some sections, and final reports were made in all, either written or oral or both.

One section had a guest lecture by a woman chemist.

The particular content of each section was as follows:

1. Mathematics. Students learned basic elements of FORTRAN programming for the IBM 1130, acquired a knowledge of number theory and carried out diophantine equations, Fibonacci numbers, congruences, prime and composite numbers, the Euler phi function, Pythagorean triples, and odd right-handed prime numbers.
2. Biology I. Students carried out experiments with reserpine-treated and non-treated crabs, observing the effects of reserpine on the chromatophores.
3. Biology II. Students worked with N. crassa developing a replica-plating technique which would be effective in isolating emitrol resistant mutants and analysed the genetic, functional and physiological characteristics of "unknown" mutants.
4. Chemistry. Students synthesized and studied an organic compound, did chemical studies of allagechrome, and did spectrophotometric studies of tertiary butanol.
5. History. Students studied two presidential elections, 1860 and 1972, and researched a question related to either or both elections, using statistical techniques.
6. Economics. Students focused on the economics of the ghetto, carried out a simulation, using the game Ghetto, and wrote an analytical biography of two characters generated by the game.
7. Psychology I. Students were introduced to statistical analysis and library research and carried out a variety of individual projects involving survey or laboratory techniques.
8. Psychology II. Students designed and carried out experiments in a variety of areas, involving human and animal subjects.

Complete syllabi for each of the eight sections are presented in Appendix F.

Results

Reliability of scores

Because subjects were tested twice (before and after the experimental treatment), it was possible to calculate test-retest reliability coefficients for the 30 ratings of occupations in terms of personal interest, the 10 semantic differential scores, the rating of the open-ended question in terms of scientific interest, and the 27 Strong scores. These 68 coefficients were all positive and ranged from +.13 (semantic differential ratings of economist) to +.89 (Strong occupational interest score for chemist). The reliabilities of the 30 ratings of occupations in terms of personal interest ranged from .41 to .83, with a median of .65. Those for the 10 semantic differential ratings ranged from .13 to .68, with a median of .55. The reliability coefficient for the rating of career plans in terms of scientific interest was .56. For the 19 Basic Interest scores from the Strong test, reliability coefficients ranged from .59 to .88, with a median of .78, while for the 8 scientific occupational interest scores from the Strong, from .66 to .89, with a median of .85.

Factor analysis

The 30 ratings of occupations in terms of personal interest, the 10 semantic differential ratings, and the 27 Strong scores described above from the 324 subjects in the initial testing session were subjected to a factor analysis. A scree test indicated that a seven factor solution was efficient; the first seven principal components were extracted and rotated to simple structure, according to varimax criterion. Oblique rotation altered the factor loadings very little; the variables thus appear to be well represented by orthogonal dimensions. The seven factors accounted for about 57% of the total variance.

The sixth factor, while well defined statistically, proved difficult to interpret psychologically; the other six factors were interpreted as follows: Factor 1: Science, Factor 2: Creative arts, Factor 3: Business, Factor 4: Helping people, Factor 5: Traditional female role, Factor 7: Evaluative science. The factor loadings of the various tests on these six factors are shown in Table 2.

The reliability of the factor scores over time was tested by correlating the before and after factor scores for the six meaningful factors for all of the subjects tested twice (N = 120). These coefficients were as follows: .86, .84, .84, .82, .86, .71, indicating substantial temporal stability.

Motivation for taking the experimental course

One set of analyses carried out among those initially tested contrasted those definitely interested in taking the experimental course (N = 137) with those not definitely interested (N = 187) on all 68 variables, making use of t-tests. Of the 68 *t*'s, 32 (47%) were significant at the .05 level or above. Those interested in taking the course rated the following occupations significantly higher in terms of personal interest: anthropologist, author, biologist, biology teacher, chemist, chemistry teacher, engineer, mathematics teacher, psychologist, psychiatrist, physician, airline pilot, and registered nurse. On the semantic differential, those interested in the course rated biologist and chemist significantly higher than did those not interested. Those interested were also significantly higher in the ratings of their career plans in terms of scientific interest. They were also significantly higher on the following Strong Basic Interest scores: public speaking, law/politics, numbers, physical science, mechanical, biological science, medical science, and writing. Those interested in the course were also significantly higher on all 8 scientific occupational interest scores from the Strong.

An analysis of variance, contrasting the experimental and first control groups (all of whom were definitely interested in taking the course) with those not interested, showed a significant effect (p = .001) for group on the first factor scores (science) derived from the factor analysis described above. The Duncan Range test showed the experimental and first control groups not to differ from each other but to be significantly higher on the scientific factor scores than those not interested in taking the course.

Enjoyment and success in the course

Of the 68 students who were initially enrolled in the course, 58 (85%) completed it successfully, thereby earning four hours of college credit. The final grades were distributed as follows: 15 A's, 27 B's, 15 C's and 1 D. All students completing the course rated their enjoyment of it on a 10-point scale (mean rating = 7.1). There was a positive and significant correlation between the students' ratings of enjoyment and the grades received (r = +.63). It should be noted that the ratings of enjoyment were made prior to the assignment of final grades, although students probably had some idea about how they were doing at that time.

Prior interest in science as a career, as measured by ratings of ten scientific occupations in terms of personal interest, also correlated positively and significantly with both grades (r = +.39) and ratings of enjoyment (r = +31).

Ratings of enjoyment were found to be positively and significantly related to ratings in the first testing of personal interest in the occupations of anthropologist and sociologist and negatively related to ratings of airline stewardess and kindergarten teacher. Ratings of enjoyment were also related positively to basic interest scores on the Strong in the first testing for public speaking, law/politics, physical science, and mechanical, and to occupational interest scores in the Strong for chemist and engineer. For the second testing enjoyment of the course was positive[illegible]d to ratings of personal interest in anthropologist and author, and to semantic differential ratings of novelist, poet, dancer, and artist.

Grades in the course were found to be positively and significantly related to ratings of personal interest in the occupations of anthropologist, author, accountant, psychologist, psychiatrist, airline pilot and sociologist in the first testing. Grades were also found to be related to positively to basic interest scores on the Strong for public speaking, law/politics, physical science, mechanical, and writing and to occupational interest scores for physician, chemist, and engineer in the first testing. In the second testing, grades were positively and significantly related to ratings of personal interest in the careers of anthropologist, author and journalist, and negatively related to ratings for airline stewardess. In the second testing, grades were also positively related to ratings of basic interest scales from the Strong for public speaking, law/politics, and writing, and negatively related to basic interest in homemaking. Grades were also positively related to occupational interest scores for physician, chemist and engineer in the second testing.

After the course was completed and grades received by students, evaluations of the course were distributed to those completing the course successfully and were returned by 47 of the 58. (Evaluations were mailed to the 10 dropouts, but were returned by only one.) As may be seen in Table 3, all 10 of the respondents who received A's are interested in or planning to take additional college courses in the particular field in which they participated in the RISE course; 21 of the 25 respondents who received B's, and only 7 of the 12 receiving C's plan to take additional courses in the specific field.

Effects of course

Several analyses of variance of the type for repeated measures were carried out contrasting the experimental and first control groups on the before and after measures. So far as these trial by group (2 X 2) analyses of the factor scores were concerned, for factor one (scientific) a significant effect (p = .05) was found for trial, with scores being significantly lower in the second testing. For factor two (creative arts) a similar significant effect was found for trial (p = .01) with the scores being significantly higher on the second testing. No significant effects were found for factor three (business). For factor four (helping people), a group by trial interaction was found (p = .01) with the experimental group being higher on the initial testing and lower on the second testing than the control group. For factor five (traditional roles), group, trial, and group by trial effects were significant at the .05 level. The experimental group was significantly higher than the control group; the second testing significantly higher than the first, with the latter effect seen only in the experimental group.

Two (2 X 2 X 2) additional analyses of variance were carried out contrasting the experimental and control groups on the before and after testing for (1) ten scientific vs ten non-scientific occupations rated in terms of personal interest, and (2) five scientific vs five non-scientific semantic differential ratings.

The first analysis showed a significant effect for scientific vs non-scientific (p = .001), with the scientific occupations rated higher, and a significant trial by scientific-nonscientific interaction (p = .05). As may be seen in Table 4, this interaction may be largely attributed to an increase over time in the ratings of non-scientific occupations, particularly by the first control group.

For the analysis of the semantic differential ratings, only one significant effect was found--scientific occupations were rated higher than non-scientific (see Table 5).

Table 6 shows that both experimental and control groups declined slightly in ratings of scientific interest of careers in the open-ended question. Table 7 also shows slight declines in both groups for the eight scientific occupational interest scores on the Strong. Tables 4, 5, 6, and 7 also show that the second control group (randomly selected from the original pool of subjects and tested only in the second testing) were generally lower in scientific interest whether measured by ratings in terms of personal interest, the semantic differential, the open-ended question or the Strong test.. This difference, which will be discussed below, obviated the usefulness of the second group as a control; therefore no statistical analyses were carried out with this group.

Tables 4, 5, 6 and 7 also show that the 10 dropouts from the experimental course were also consistently lower in all scores related to interest in scientific careers. t-tests were carried out on all 68 measures contrasting the 10 dropouts with the 58 students who completed the course successfully. Significant differences, however, were found for only four of the 68 variables. Dropouts were significantly higher in ratings of airline stewardess, airline pilot, and registered nurse, and significantly lower in the religious activities basic interest score on the Strong. While the dropouts were lower than those completing the course successfully on 8 of the 10 scientific occupations rated in terms of personal interest, 4 of the 5 scientific occupations rated by the semantic differential, ratings of career plans, and four of the 8 scientific occupational interest scores from the Strong, these differences were not significant.

Reactions to the experimental course

Both faculty and students were polled in relation to their evaluation of the experimental course. In general, the faculty considered the course to be successful, although certain problems were recognized. Three suggestions for future courses of this kind were made: (1) Two successive offerings of an experimental course of this kind are recommended, since the first time a course is run unanticipated but correctible problems appear, thus providing less than optimum conditions for testing the course. In other words, a two-trial format seems more practical because the second trial allows the faculty to get the "bugs" out of various operations. (2) Certain faculty felt that the RISE course would have been more successful if it had been offered to a more select (on the basis of teacher recommendations, grades, standardized test scores, and individual interviews) group of students. Faculty noted that in certain cases the work seemed to be beyond the ability and interest of the students, although good students got a good introduction to research and performed well. (3) A more flexible and concentrated schedule was also recommended, with more hours per week scheduled into fewer weeks. The RISE course, in the opinion of several, did not schedule sufficient hours at a time for the work to be done, and class meetings were too stretched out over the weeks for the maintenance of maximum interest.

The student evaluations contained two questions: (1) "What did you like best about the RISE course?" and (2) "What suggestions do you have for changes if we ever should offer the course again?" For a full appreciation of the range and flavor of the responses to these questions, it is necessary to read the verbatim comments which are presented in Appendices G and H, arranged according to the grade received in the course.

Students in general enjoyed what they termed the "college atmosphere", the small classes, and the individual attention. The majority also seemed to enjoy working with scientific equipment, such as the computer and electronic calculators. There were also criticisms about the hours, length of periods, etc. Several commented on the difficulty of concentrating in an after-school course.

A year after the course subjects were polled and asked, "Has the RISE course that you took last year influenced your plans for college and career in any way? If so, please briefly describe how." Replies were received from 41 of the 58 who successfully completed the course, with 26 describing effects of the course and 15 replying "no" (although some of the "no's" also commented on benefits from the course. One comment, for example, was "No - It added to my growing interest in science"). These comments are presented in Appendix I, and in general reveal that the RISE course showed a few students that science was not for them, but reinforced and facilitated an interest in science among others, with 21 of the 26 comments indicating such positive effects.

Additional analyses

Since all subjects tested provided information about career plans, these data provide an opportunity to examine career plans of a fairly large sample of high-achieving high school women. In order to facilitate an understanding of this mass of data, the career mentioned first in the open-ended questions in the first and second testing, was categoried making use of (1) a system of categories derived from the factor analysis carried out in this study, and (2) Holland's system of occupational classification (Holland, 1966). The system derived from the factor analysis provided five categories: scientific, creative arts, business, helping people, and traditional roles as well as a sixth "undecided" category. Holland's system involves six categories: realistic, investigative, artistic, social, enterprising and conventional and was supplemented by an "undecided" category (see Tables 8 and 9).

It is interesting to note that 13% of the subjects in the first testing and 10% in the second were completely undecided about careers. In the first testing, using the first system, the modal category for the experimental and first control groups was the "scientific", similarly the modal category for these groups in the Holland system was "investigative" in the first testing. The second most popular category for the experimental and first control was "helping people" and "social", respectively, with these categories becoming the modal response for the experimental group in the second testing.

For those not interested in taking the course, on the other hand, "creative arts" was the modal response for the first system and "social" for the Holland system, with "scientific" second in our system and "artistic" in Holland's. For these subjects, careers were distributed about equally over the categories in the system derived from the factor analysis (and including the "undecided" category).

In order to contrast this group who were not interested in the course with those who had a definite interest (the experimental and first control groups), two chi squares were computed, one for each system of categories. These were found to be 13.1 (df = 5; p - .05) for the factor analysis system and 16.2 (df = 5, p - .01) for the Holland system, indicating once again the difference between those interested in taking the course and those not.

Discussion

The central hypothesis of this study was that participation in a college-level experimental course featuring independent research projects would increase interest in science for a group of high-achieving high school juniors in comparison to a group equally high-achieving and equally interested in taking such a course. When one inspects the quantitative data (Tables 4-7), it is evident that interest in science, as measured in these ways, did not increase for the experimental group, nor did the experimental and first control groups differ in the post testing. Therefore, on the basis of these data, one cannot reject the null hypothesis regarding the effects of the course on scientific interests and attitudes.

This lack of positive results is further emphasized when one notes that in one of the analyses of variance (that involving the first science factor) a significant decline in scores was found over trials for the experimental and first control groups. In order to understand this decline, it is necessary to examine the process by which the experimental and first control groups were selected and to note that they were significantly different from the other subjects in the initial testing group. Since the criterion for selection was a definite interest in taking the experimental course, it is not surprising that those who were selected were already high in an interest in science, significantly higher on numerous measures than those not interested. This difference rendered the second control group, selected at random from the original pool of subjects, relatively useless as a control group, since their interest in science was considerably lower than that of the experimental and first control groups.

In effect, then, we selected subjects for the experimental and first control groups on the basis of a high interest in science. When subjects are selected (even though in this case it was a matter of self-selection) on scores on one set of variables and then tested at a later date, one would expect a regression to the mean, since the height of the initial scores can be partly attributed to chance. The decline in scores in these groups from the first to the second testing thus appears to be a regression effect, due to chance factors operating in both testings.

In contrast to the negative results revealed by the testing immediately after the course are the comments made by the students when polled a year later (see Appendix I). These responses were generally positive, with a number of students spontaneously volunteering that the course had increased their interest in science. Thus, it is possible that an increase in interest in science did occur, among the group, despite the failure of the quantitative data from the testing immediately after the course to reveal it.

One may speculate that the discrepancy between the two sets of data may be due to inadequate instruments, the basic weaknesses of a before-after design, or to a delayed impact of the course on the students. Thus, it may be that the effects of the course were not realized immediately but developed only after a period of time.

Whether or not one accepts this last supposition, however, Project RISE has important implications for increasing interest in careers in science among high-achieving women. It should be noted that for the experimental subjects, the RISE course represented an acceleration in science, since it involved a college-level course, while the participants were high school juniors. Since the instruments used in our initial testing clearly differentiated those interested in such acceleration from those who were not, this study demonstrates quite clearly that achieving women who are motivated for acceleration in science can be identified from a relatively inexpensive, single testing session. That the great majority (85%) of those who entered the course finished it successfully demonstrated that both motivation and ability were high enough in the majority of the experimental subjects to make acceleration in science (even when done at some inconvenience to the subject in terms of travel and time) a feasible educational venture.

Another area of interest in this study resides in the instruments used. In general, reliabilities were substantial enough for accurate testing. The factor analysis indicates that an interest in science as a career (the first factor) is clearly different from a positive evaluation of scientists (factor 7). Subjects in this study evaluated scientists more favorably than what seem to be equally prestigeous non-scientific professions. However, not even in the experimental and first control groups did all subjects have an interest in a career in science. Thus, if it is desirable to identify those high school women with an interest in science as a career, one should not use the semantic differential (even though subject with high motivation for the course rated chemist and biologist significantly higher on the semantic differential than did those with less motivation).

The factor analysis in this study also provides an interesting picture of how career interests among high school women can be categorized. As may be seen in Tables 8 and 9, the categories suggested by this analysis provide a better fit to the career interests of the subjects in this study as indicated by the open-ended question (which was not included in the factor analysis) than does Holland's system. This is true because very few subjects were interested in two of the Holland categories--what Holland terms "realistic" and "conventional" careers.

Along with the Strong test, which has much data from earlier studies supporting its validity, the simple rating of 30 occupations in terms of personal interest seems to provide an efficient way to identify high school women who are motivated for careers in science. This scale has the advantage of ease of administration since it is self-administering and takes only 10 minutes (as compared with the hour required by the Strong). Scoring is also simple since subjects respond in terms of a numerical scale. These ratings have also been found in this study to be fairly reliable.

Two questions which arise in reference to these ratings are how they are related to measures of intellectual ability and to the election of science courses in college. These questions were not amenable to study in the RISE project since, although subjects were selected by guidance counselors on the basis of grades and standardized test scores, the experimenter did not have access to these data. The positive relations found in this study, however, between grades in the course and certain ratings suggests that ratings may relate to ability, since grades would presumably reflect ability.

In order to investigate these questions directly, however, additional research was needed. Accordingly, the rating scales for 30 occupations was administered to 176 freshman women entering Goucher College, as a part of the testing session in orientation week. The 30 ratings were correlated with verbal and mathematical SAT scores, grade point average in the first semester, and number of science and math courses elected in the first semester.

The ratings were not found to be related to grades from the first semester, nor to grades in science and math courses, but were significantly related to SAT scores and to the number of science courses elected. Specifically, verbal SAT scores were found to be positively related to ratings of author and negatively related to ratings of kindergarten teacher and executive secretary. More interesting from the standpoint of this study were the relations found for mathematics SAT, which was positively related to ratings of biologist, biology teacher, chemist, chemistry teacher, engineer, math teacher, and physician (and negatively related to ratings of actress). Number of science and math courses elected the first semester was positively related to ratings of biologist, biology teacher, chemist, chemistry teacher, engineer, math teacher, physician, and registered nurse. Number of science courses elected was also found to be negatively related to ratings of actress, author, business executive, English teacher, guidance counselor, journalist, and social worker.

Higher ratings of scientific occupations in terms of personal interest thus appear to reflect both a greater mathematical ability and a higher motivation for science. The study of the Goucher freshmen thus adds to the data from the RISE project, indicating that motivation and ability are both involved in aspirations for careers in science among adolescent women, as seen in the ratings of various scientific occupations in terms of personal interest.

Practical Implications

In summary, the RISE project demonstrates clearly that acceleration in science is practical for substantial numbers of achieving high school women. It also shows that high school women with sufficient ability and motivation for acceleration in science can be readily identified. This study also suggests that perhaps only about 30% of these women with sufficient motivation for acceleration in science are planning careers in the biological, medical and physical sciences. About an additional 25%, however, are aiming for the professions dubbed in this study "helping people," (such as social work, guidance counselor, etc.) which may be considered to be science-based, even though not investigative. Acceleration in science, however, would also benefit those not aspiring to scientific or science-based careers, since they presumable would be better informed about science as a result.

In planning for future experiments in acceleration, our experience suggests that two successive trials are needed to get an experimental course running smoothly, that a more selective group than in this study would be better able to benefit from college-level courses, and that a more concentrated schedule than ours would facilitate interest and learning in such courses.

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FOOTNOTE

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TABLE 1

Number of Subjects Participating in the various phases of Project RISE

High Schools	Original Pool	2nd Control Group (a)	Revised Pool	Tested Oct. 1974	Experimental Group (b)	1st Cont Group (
A	130	35	95	89	17	14
B	113	14	99	83	17	12
C	111	16	95	74	12	18
D	125	30	95	85	22	25
Total	479	95	384	331	68	69

(a) 2nd control group was selected by random procedures from original pool

(b) Experimental and 1st control groups were selected by random procedures from those tested who were definitely interested in taking the course.

TABLE 2

The Six Interpretable factors with factor loadings of scores from occupational ratings, Semantic Differential Rating and the Strong Vocational Interest Blank.

Factor I		Scientific Career
.91	St	physical science
.85	St	engineer
.85	St	chemist
.83	St	medican technician
.79	R	chemist
.78	St	physician
.77	St	dentist
.71	St	mechanical
.69	R	biologist
.66	St	medical science
.65	St	computer programmer
.58	St	math-science teacher
.56	R	chemistry teacher
.54	St	numbers
.54	R	physician
.51	R	biology teacher
.51	R	engineer
.46	SD	chemist
.44	R	anthropologist
.43	SD	biologist

Factor II		Creative Arts
.85	St	Performing arts
.78	St	writing
.68	St	art
-.63	St	math-science teacher
.60	R	author
.58	St	music
.57	St	public speaking
.56	SD	dancer
.54	SD	novelist
.52	R	actress
.51	SD	artist
.50	SD	poet
.49	R	dancer
.48	R	journalist

Note: R = ratings of interest in occupations

SD = Semantic Differential ratings (evaluative scale)

St = Interest or occupation scores from the Strong Vocational Interest Blank for Women

Factor III		Business
.74	St	office practice
.68	St	merchandising
.67	R	business executive
.67	R	accountant
.60	R	sales manager
.56	R	executive secretary
.54	St	numbers
.52	R	life insurance salesman
-.48	St	physician
-.44	St	mathematician

Factor IV		Helping People
.80	R	psychologist
.78	R	sociologist
.74	R	psychiatrist
.66	R	social worker
.60	R	guidance counselor
.50	R	journalist
.40	R	author

Factor V		Traditional Roles
.77	St	social sciences
.71	St	teaching
.61	R	kindergarten teacher
.59	St	sports
.54	St	homemaking
.47	R	registered nurse
.47	St	medical science
-.46	St	mathematician
.44	St	outdoors

Factor VI		Evaluative Science
.63	SD	biologist
.60	SD	chemist
.57	SD	economist
.53	SD	sociologist
.47	SD	psychologist

Table 3

Distribution of grades in relation to intention and desire for taking additional courses in field

Grade	Total Number	Number Responding	Going to take more courses? Yes	No	?
A	15	10	10	0	0
B	29	25	21	2	2
C	15	12	7	5	0
D	1	0			

Table 4

Means for pre and post test for the dropouts (N = 10), experimental group (N = 58), first control group (N = 62) and second control group (N = 68) for the ratings of interest in ten scientific and ten non-scientific occupations.

	Pre	Post
Experimental Group		
Scientific	27.3	26.8
Non Scientific	22.2	22.7
Dropouts		
Scientific	25.3	
Non Scientific	23.9	
First Control Group		
Scientific	27.0	27.8
Non Scientific	21.9	23.7
Second Control Group		
Scientific		23.1
Non Scientific		21.0

Table 5

Means for pre and post test semantic differential ratings for five scientific and five non scientific occupations for the experimental group, dropouts, first control group and second control group

	Pre	Post
Experimental group		
Scientific	168.0	164.1
Non scientific	144.7	149.7
Dropouts		
Scientific	167.0	
Non scientific	143.6	
First Control group		
Scientific	166.4	171.0
Non Scientific	140.2	144.9
Second Control group		
Scientific		162.6
Non scientific		145.1

Table 6

Ratings of career plans for scientific relevance.

Pre and post test for the experimental group, dropouts, first control group, and second control group

	Pre	Post
Experimental	3.64	3.45
Dropouts	2.80	
First Control Group	3.27	3.16
Second Control Group		3.00

Table 7

Pre and post scores for eight scientific occupations from the Strong Vocational Interest Blank for Women for the dropouts, experimental group and two control groups.

Occupation	Experimental		Dropouts	First Control		Second Control
	Pre	Post	Pre	Pre	Post	Post
Physician	31.1	28.1	28.1	30.7	29.8	24.4
Dentist	25.1	21.8	24.5	26.5	25.9	22.8
Medical Technician	32.4	29.2	32.7	33.5	31.5	29.1
Chemist	12.0	8.6	9.7	13.3	12.2	5.3
Mathematician	17.3	14.9	17.0	19.0	18.1	13.6
Computer Programmer	33.1	31.1	31.8	33.7	32.3	31.7
Math-Science Teacher	33.9	31.9	35.6	35.2	33.4	33.6
Engineer	23.7	22.1	23.7	26.2	25.0	19.7

Note: These are standard scores derived from samples of women in the occupations in question, who showed a mean score of 50, and standard deviation of 10.

TABLE 8

Career Choices from Open-ended Question arranged over categories derived from the Factor Analysis

Groups	Successful Experimental N = 58 Testing 1	Successful Experimental N = 58 Testing 2	First Control N = 59 Testing 1	First Control N = 59 Testing 2	Second Control N = 66	Others N = 196	Total 1st Testing N = 313	Total 2nd Test N = 183
Categories								
Scientific	18 (31%)	15 (26%)	17 (29%)	19 (32%)	18 (27%)	33 (17%)	68 (21%)	52 (28%)
Creative Arts	6 (10%)	7 (12%)	7 (12%)	8 (14%)	10 (15%)	43 (22%)	56 (17%)	25 (14%)
Business	5 (9%)	3 (5%)	10 (17%)	6 (10%)	9 (14%)	30 (15%)	45 (14%)	18 (10%)
Helping People	15 (26%)	16 (27%)	9 (15%)	11 (19%)	11 (17%)	30 (15%)	54 (17%)	38 (21%)
Traditional Roles	9 (15%)	9 (15%)	9 (15%)	9 (15%)	14 (21%)	31 (16%)	49 (15%)	32 (17%)
Undecided	5 (9%)	8 (14%)	7 (12%)	6 (10%)	4 (6%)	29 (15%)	41 (13%)	18 (10%)

Note: N's are somewhat smaller than total tested because certain subjects answered the open-ended question facetiously.

TABLE 9

Career Choices from Open-ended Question arranged over categories derived from Holland

Groups	Successful Experimental N = 58 Testing 1	2	First Control N = 59 Testing 1	2	Second Control N = 66	Others N = 196	Total First Testing N = 313	Total Second Testing N = 183
<u>Categories</u>								
Realistic	0 (0%)	1 (2%)	0 (0%)	0 (0%)	2 (3%)	0 (0%)	0 (0%)	3 (2%)
Investigative	22 (37%)	18 (31%)	22 (37%)	23 (39%)	19 (29%)	38 (19%)	82 (25%)	60 (32%)
Artistic	6 (10%)	7 (12%)	7 (12%)	6 (10%)	10 (15%)	44 (22%)	57 (18%)	23 (12%)
Social	20 (34%)	21 (36%)	14 (24%)	18 (30%)	22 (33%)	55 (28%)	89 (28%)	61 (33%)
Enterprising	5 (9%)	3 (5%)	6 (10%)	4 (7%)	7 (11%)	22 (11%)	33 (10%)	14 (8%)
Conventional	0 (0%)	0 (0%)	3 (5%)	2 (3%)	2 (3%)	8 (4%)	11 (3%)	4 (2%)
Undecided	5 (9%)	8 (14%)	7 (12%)	6 (10%)	4 (6%)	29 (15%)	41 (13%)	18 (10%)

Appendix A. Initial letter inviting subjects to participate in project. These letters were mailed to the potential subjects at home.

Towson
Baltimore
Maryland 21204
(301) 825-3300

GOUCHER COLLEGE

September 23, 1974

Dear Student:

I am pleased to inform you that you have been selected to participate in Project Rise, which is a study of career development in women being carried out by Goucher College in cooperation with the National Science Foundation. The study will have several phases, which will be explained to you as we go along. The first step is a testing session to be held Period 1 on Wednesday, October 2. I will be looking forward to seeing you there.

Barbara H. Long
Project Director

Dear Parents:

I am pleased to inform you that your daughter was selected by random procedures from among those girls in her class above average in achievement and ability to participate in Project Rise, a study of career development in women being carried out by Goucher College in cooperation with the National Science Foundation.

The only tests to be administered in this study will be those related to vocational interests and attitudes toward various careers. We will also be asking the students to supply information about occupations and education of parents, so that we can see how these variables relate to career development. All test scores and other information will be kept strictly confidential, and the study will report group averages, not individual responses. In June, 1975, standardized vocational interest test scores will be returned to the guidance counselor, and will be available to you and your daughter.

The study will go on for several years, so that we can see how careers develop. We will explain each phase to you as we go along. Also, if you ever need to contact us, Mrs. Susan Horn, assistant director of the project, lives on the Goucher campus, and is usually available to the telephone (825-3300) in the evening.

Participation in this project is, of course, strictly voluntary. We hope that all those invited to participate will cooperate. If you do not want your daughter to participate, please send a note to that effect to Dr. Neary. Otherwise, we will be looking forward to seeing your daughter on October 2.

Appendix B. Letter given all tested subjects describing course

PLEASE RETURN BY ______________________

An interdisciplinary college course, Research Introduction to Science, will be offered, tuition free, to certain students in this group by Goucher College. There will be two sections (a student would attend one of these) (1) Thursday, 3:30-5:30PM (2) Saturday, 9:30-11:30AM each week from October until April. Transportation will be provided from your high school to the Goucher College campus. Four hour transferable college credit will be given to those who complete the course.

The course is designed for capable students of your age. It will include an introduction to a variety of the natural and social sciences, and will provide an opportunity to carry our independent research and to use certain scientific equipment and the Goucher computer. The two hour period each week will permit a large portion of the work to be completed in class, although some assignments out of class will be made. The emphasis is to be on student participation. There will be no charges for materials--the course is free to those selected.

Please indicate your interest in participating in this course, if you should be selected. (Selections will be made by random procedures from among those interested. Not all those interested can be selected).

Definitely Yes__________ No__________

Probably Yes __________

____
Student's Signature

____
Parent's Signature

Appendix C. Letter informing Experimental group of their selection

Towson
Baltimore
Maryland 21204
(301) 825-3300

GOUCHER COLLEGE

October 10, 1974

Dear ______________________:

I am pleased to inform you that you have been selected by means of random procedures from among those interested to enroll in the Research Introduction to Science course at Goucher College. We were able to enroll only about half of those interested, so you were lucky to be chosen, and I hope will enjoy the course.

Because of the school holidays next week, we plan to hold the opening session of the course on Monday afternoon (3:30 to 5:30), October 21. Both Thursday and Saturday sections will attend this important initial session. On this occasion we plan to explain procedures, introduce faculty and student teaching assistants, show you around the campus, and have a reception (with refreshments). This meeting will be held in Kelly Lecture Hall (next to the library). The reception will be held in the lounge of Heubeck Dormitory.

Transportation will be provided from your high school to the Goucher campus and back for each of the twenty-one (21) sessions. Detailed information about the dates of these sessions and about the buses are enclosed. Because the course involves learning research techniques and using scientific equipment, class participation is very important. Therefore, attendance at all sessions is expected, and is necessary for an optimum learning experience. If you have to miss due to illness, please inform us and bring a note from your parents.

We are pleased to welcome you to the course and are looking forward to seeing you and getting better acquainted on Monday, October 21.

Yours truly,

Barbara H. Long

Barbara H. Long

Project Director

You are assigned to the ______________________ section.

Appendix D. Letter to first control group

Towson
Baltimore
Maryland 21204
(301) 825-3300

GOUCHER COLLEGE

December 19, 1974

Dear

This letter is addressed to those students in our study who indicated that they were definitely interested in taking the experimental course at Goucher, but who were not chosen by the random procedures we used for the final selection. We were quite pleased at the response to the course - about twice as many indicated a definite interest than we were able to accomodate in the course. We were sorry not to be able to include all who were interested.

We want you to know that even though chance did not favor you for the course, you are still important to our study. We are interested in following you for several years as your career develops, and will be testing you again in the spring. I'll be looking forward to seeing you then.

Yours truly,

Barbara H. Long

Barbara H. Long
Director, Project RISE

Appendix E. Career Attitudes and Plans Survey

NAME ______________________________

ADDRESS ______________________________

____

TELEPHONE ______________________________

BIRTH DATE ______________________________

FATHER'S OCCUPATION ______________________________

Does your Mother work?

Fulltime   Partime   Occasionally   No

MOTHER'S OCCUPATION ______________________________

FATHER'S YEARS OF SCHOOLING

Doctor's Degree   Masters Degree   AB or BS   Some College

High School Graduate   10th Grade   8th Grade

MOTHER'S YEARS OF SCHOOLING

Doctor's Degree   Masters Degree   AB or BS   Some College

High School Graduate   10th Grade   8th Grade

Career Interests

Please rate each of the following occupations in terms of your own interest as a possible career, using the following scale:

5 - Very much interested
4 - Moderately interested
3 - Mildly interested
2 - Probably not interested
1 - Definitely not interested

______	Actress	______	Journalist
______	Anthropologist	______	Kindergarten Teacher
______	Artist	______	Mathematics Teacher
______	Author	______	Physical Education Teacher
______	Accountant	______	Psychologist
______	Biologist	______	Psychiatrist
______	Biology Teacher	______	Physician
______	Chemist	______	Airline Pilot
______	Chemistry Teacher	______	Executive Secretary
______	Business Executive	______	Sales Manager
______	Dancer	______	Social Worker
______	Engineer	______	Sociologist
______	English Teacher	______	Life Insurance Salesman
______	Airline Stewardess	______	Professional Athlete
______	Guidance Counselor	______	Registered Nurse

Purpose: The purpose of this test is to assess how you feel about certain occupations in terms of these adjective rating scales.

Directions: For each occupation such as "Novelist" there will be 6 scales (pairs of adjectives) which follow. Place an X on one of the seven spaces of the scale for each of the 6 scales (pairs of adjectives) as follows:

1) If you feel that your perception of a novelist is <u>very closely related</u> to one end of the scale (for example, valuable), place your check mark as follows:

valuable _X_ __ __ __ __ __ __ worthless
or
worthless __ __ __ __ __ __ _X_ valuable

2) If you feel that the occupation is quite closely related to one end of the scale (say boring) place your check-mark as follows:

interesting __ __ __ __ __ _X_ __ boring
or
boring __ _X_ __ __ __ __ __ interesting

3) If you feel that the occupation is only slightly related to one side (say successful) as opposed to the other (say unsuccessful), but is not really neutral, then check as follows:

unsuccessful __ __ __ __ _X_ __ __ successful
or
successful __ __ _X_ __ __ __ __ unsuccessful

4) If you consider the occupation to be neutral on the scale, both sides of the scale equally associated with the occupation or if the scale is completely irrelevant, unrelated to the occupation for you, then you should place your check-mark in the middle space:

honest __ __ __ _X_ __ __ __ dishonest
or
dishonest __ __ __ _X_ __ __ __ honest

Note: It is important that you complete each scale for each occupation. Place one check (and only one) on one of the seven spaces for each adjective scale.

NOVELIST

Valuable	____	____	____	____	____	____	____	Worthless
Foolish	____	____	____	____	____	____	____	Wise
Successful	____	____	____	____	____	____	____	Unsuccessful
Boring	____	____	____	____	____	____	____	Interesting
Honest	____	____	____	____	____	____	____	Dishonest
Pessimistic	____	____	____	____	____	____	____	Optimistic

Note: Other occupations rated were Psychologist, Dramatist, Biologist, Poet, Chemist, Dancer, Economist, Artist, Sociologist.

In a few sentences describe your own career plans, giving reasons for your choices.

Appendix F. Syllabi of Course Sections

Research Introduction to Science (Project RISE)

Section: Biology I (Lacy)

Syllabus

1. Reading Assignments.

Beadle, G.W., 1948, The genes of men and molds, Sci. Amer., 78-87

Beadle, G.W. and E.L. Tatum, 1941, Genetic control of biochemical reactions in Neuropsora. P.N.A.S. 27: 499-506

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Project RISE Biology Syllabus - 2

II. Experimental Projects: two to be carried on by all students concurrently

A. Attempt to develop a replica-plating technique that would be effective in isolating amitrol resistant mutants of <u>N. crassa</u> - a necessary preliminary to a projected study by AML of the regulation of tryptophan biosynthesis in such mutants. A number of tricky technical problems are involved.

B. The genetic and physiological characterization of "unknown" tryptophan synthetase mutants of <u>N. crassa</u>.- Each student will be given two "unknowns". They will characterize them genetically by determining whether or not they are linked to "fluffy" on linkage group II. They will also characterize them functionally by measuring their growth at different temperatures on differently supplemented media, by identifying and measuring accumulation products after growth in tryp. supplemented medium, and by the ability of the mutants to complement other mutants in heterocaryons.

III. Quizes: there will be three quizes based on reading assignments and laboratory reports.

The grade will be determined on the average of the three quizes, final written report, and general quality of laboratory work.

cc: Dean Billet
Mrs. Horn

BIOLOGY SECTION: Study of the Effects of Reserpine on the white Chromatophore System of the Fiddler Crab (Uca pugilator)

INSTRUCTOR: Dr. H. Marguerite Webb

TEXTS AND COURSE MATERIALS: The Biological Clock; Brown, Hastings, Palmer; other related readings; lectures; laboratory equipment and chemicals; fiddler crabs

ASSIGNMENTS AND ACTIVITIES: One test; written report on experiments and results; performance in laboratory; lectures and discussions.

COURSE DESCRIPTION: After reading related materials, background information, and attending lectures, the students carried out experiments on reserpine-treated and untreated crabs. They learned to inject the crabs with reserpine, to observe the stage of the chromatophores, and to analyse their data. They attempted to identify the nature of the blocked synapses.

CHEMISTRY SE(Chemical Studies and Research

INSTRUCTOR: is A. Walker

TEXTS AND FIUltimate Speed," "Time Dilation" (films); guest peaker; various readings related to laboratory ork; laboratory equipment and chemicals

ASSIGNMENTS IVITIES: One test, two oral progress reports; one final written report; performance in laboratory; lectures and discussions

COURSE DESCR Readings were assigned on laboratory techniques, and class lectures and discussions were held on pertinant reactions and structures of compounds. Experimental (laboratory) work was carried on with close supervision of instructor and student supervisor. The following three chemical problems were studied:

1) The synthesis, separation, characterization and identification of an organic compound (the reaction product of rhodonine and isobutraldehyde); weighing, refluxing, filtration, recrystallization, determination of melting point, and infra-red absorption spectrum techniques were used.

2) chemical studies of allagechrome, a water soluble plant pigment; main technique used was polarography to attain an estimated molecular weight.

3) spectrophotometric (U-V visible) studies of the complexation of copper by chloride ions in tertiary butanol; preparation of several solutions, analysis of U-V spectra were involved.

In addition, two films and a guest lecturer supplemented the class work.

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ECONOMICS SECTION: The Ghetto

INTSRUCTOR: Robert Pearson

TEXTS AND MATERIALS: Daniel R. Fusf eld, <u>The Basic Economics of the Urban Racial Crisis</u>; simulation game, GHETTO

ASSIGNMENTS AND ACTIVITIES: readings from text, class discussions and lectures, films, simulation game, GHETTO; two exams (one two-hours long, one one-hour long), final report (analytical biography)

COURSE DESCRIPTION: Students were introduced to some basic economic principles of efficient and inefficient allocation of resources in the market system. The major project consisted of writing an analytical biography of two ghetto characters (data was generated by the GHETTO game). A two hour exam on economic principles and a one hour exam on the ghetto readings were given in addition to the project. The grade was determined by the exam grades and the final project (analytical biographies).

HISTORY SECTION: Historical Research - Political Elections

INSTRUCTOR: Dr. Jeanne Baker

TEXTS AND MATERIALS: Ray Nichols, The Stakes of Power, pp. 47-89
J. G. Randall, Lincoln the President, pp. 75-153
E. D. Fite, The Presidential Election of 1860, pp. 1-
Allan Nevins, The Emergence of Lincoln, pp. 1-88
J. Baker, The Politics of Continuity, pp. 1-45
Leonard Freedman and Cornelius Cotler, Issues of the Sixties, pp. 169-194
Barton Bernstein and Allen Madison, Twentieth Century America: Recent Interpretations, pp. 47
Theodore White, The Making of the President, 1972, passim.

ASSIGNMENTS AND ACTIVITIES: readings, library research, introduction to statistical methods, final written report given as oral report to class

COURSE DESCRIPTION: Students did background reading on political elections of 1860 & 1972 and were introduced to library research techniques and statistical research methods. Each student researched a question on either or both elections, using new quantitative procedures, and wrote a final paper on the results of their research. The paper was presented in class at the end of the course.

Among the topics investigated were an analysis of the Republican platform of 1860, its "rationality" and the ability of the party to translate promises into legislative reality; comparison of the Democratic platforms in 1860 and 1972; comparison of the Republican platforms in 1860 and 1972; microscopic examination of Irish and German voting patterns in 1860 in Baltimore.

MATHEMATICS SECTION: Computers in Number Theory

INSTRUCTOR: Dr. Geraldine Coon

TEXTS: Richard Mann, An IBM 1130 Primer, Intext Educational Publishers, 1974

John E. Maxfield and Margaret W. Maxfield, Discovering Number Theory, W. B. Saunders Co., 1972

ASSIGNMENTS AND ACTIVITIES: Reading text and collateral material, homework problems, class discussion, class lectures, two tests during course, final written report

COURSE DESCRIPTION: Students learned the basic elements of FORTRAN programming for the IBM 1130. This included an introduction to flow-charting, learning how to keypunch, and writing programs to solve such problems as finding the average of a set of numbers, evaluation of factorials and polynomials, factoring numbers, determining whether or not a given number is prime, finding the greatest common divisor of two numbers, etc. All of the programs were run on the computer and corrections were made by the students.

Students acquired a knowledge of number theory by assigned readings in the text, collateral reading, class discussions, and lectures.

The independent project was determined by the student's ability and interests insofar as possible. Detailed written reports were required, including a statement of the problem, mathematical background, solution, conclusions, and bibliography. All reports included a flow chart, listing and discussion of a computer program developed for that project and computer output.

PSYCHOLOGY SECTION: Psychology Projects

INSTRUCTOR: Dr. John Finn

TEXTS AND FILMS: "The Kind of Man" (film), BBC series on psychobiology, readings relevant to projects

ASSIGNMENTS AND ACTIVITIES: readings, design of project, work on project, final written report, no quizzes or tests

COURSE DESCRIPTION: Students designed and carried out experiments in psychology, consulting with the instructor and reading relevant literature. Their grades were based on attendance, conscientiousness, the design of their project, and the final written report.

The projects were:

Emotionality and Perceptual Defense - replication of 1949 study by Elliot McGinnies (published in Psychological Review, 1949, 56, 244-251); a more up-to-date list of "taboo" and neutral words was used and presented to six subjects tachistoscopically for recognition while at the same time the Galvanic Skin Response was used as a measure of "arousal". The trend of the results was similar to those reported by McGinnies.

The Menstrual Syndrome: Fact or Fiction - a questionnaire consisting of 14 items dealing with the "mood" variations, physical discomforts, and sexual feelings was administered to 24 females (16 to 17 years old) over an eight-week period; results showed no systematic variation specifically related tosthe subjects' menstrual cycles.

The Effects of Weather on the Moods of People - this study was an attempt to correlate climatic variations with "mood" shifts in 20 students of high-school age; a [illegible] item questionnaire was administered at the same time each day over a five week period and weather conditions were recorded for each day; no systematic variation in mood caused by weather was noted.

Relationship between Astrological and Personality Characteristics - sixty subjects were given a 48 item semantic differential scale dealing with "personality" characteristics of people born under the 12 astrological signs; no large correlation between astrological sign and birthdate was noted for all subjects, although some individuals did show reasonably high correlations.

<u>The Oddity Concept in Rats</u> - this study was an attempt to demonstrate whether a rat could learn the concept of oddness; rats were trained and tested over a six week period and water-deprived rat reached a criterion of 80% correct choices; in transfer phase of experiment, a new pattern of oddness was used and the rat took significantly fewer trials to reach criterion.

PSYCHOLOGY SECTION: Experimental Work in Psychology

INSTRUCTOR: Ms. Sally Wall

TEXTS AND FILMS: Introduction to Descriptive Statistics and Correlation, McCollough, C. and Van Atta, L. (1965)
"The Mind of Man" (film)

ASSIGNMENTS AND ACTIVITIES: library assignment; 3 quizzes; oral report; written project; design and implementation of experimental project

COURSE DESCRIPTION: Students were expected to become familiar with library research technique using the library assignment and to become familiar with statistical concepts by studying from the text listed above. Then in pairs, the students researched (in the library), designed and conducted one of the following experiments:

1) determining leadership in a small group

2) the effect of birth order on social interaction

3) an analysis of sex differences in children's figure drawings

4) the presence of birth order stereotyping in characterizations constructed from adjective lists

5) changing attitudes of women.

Three quizzes were administered, and each student gave an oral progress report on her project to the instructor. A final written report of the project and its results was required.

Appendix G

Student responses to "What did you like best about the RISE course?"

I. Those graded A.

1. "I liked the college credit, I liked working with something new - computers and advanced math."
2. "I liked the fact that we got to work pretty independantly of the teacher, but the help was avalible at any and all times."
3. "The individual attention I recieved."
4. "I liked the research [illegible]ect the best because it was worthwhile. The final solution wasn't known to the instructor. We were really contributing something, not just doing 'busy work'."
5. "I liked using the advanced science equipment most. I also liked the informality of the class. I think I had a chance to do more and learn more in this informal arangement. And I feel I did learn a lot."
6. "The opportunity to work at a college, and to meet some of the students and teachers."
7. "I like the chance to take a college level course without a lot of pressure, and being able to take a course in something I had never thought about before."
8. "The subject matter of my particular course (genetics, Lacy), and the challenge it presented.
9. "The actual college-situation learning experience as opposed to the traditional high school situation was a wonderful switch for me. I loved the Goucher campus, and my instructor, Sally Wall, was a great help to me during my project."
10. "I liked the close contact between the instructors and the students."

II. Those graded B.

11. "I thoroughly enjoyed the course and one of the major reasons was that I had the opportunity to choose the field I entered, therefore being more willing to learn and be taught."
12. "The class size and the independence work involved. I worked with a questionnaire and enjoyed working with computers to analyse data."
13. "I enjoyed the relationship between student and teacher. I could use Mrs. Baker as a resource center rather than a computer who feeds out information that I must digest. I realized that I will only learn something if I do it myself and do it to the best of my ability."

14. "It gave a good taste of a college course plus what we studied there supplemented high school science."
15. "In my particular course I found the way the teacher taught the information interesting. By using a game called the Ghetto we were able to place ourselves in place of the people we were studying and therefore acquire a broader range of knowledge in this area."
16. "working with the computer".
17. "It gave me an early chance to experience a college course in the area of my interests."
18. "I had a lot of independence in deciding what kind of studies I wished to pursue and plenty of time to meet course requirements."
19. "the experience of working on a college level"
20. "I liked how we got to do an original project and make discoveries that were new, sometimes."
21. "I liked the fact that we were left to do our own work, even make up what it was we were to research; then we were allowed to use the ditto machine if necessary etc....We were basically on our own, with guidance from our teacher when necessary."
22. "the association with girls from other schools, and the exposure to college equipment and techniques."
23. "I liked meeting all the people from different school and working with Miss Webb and her assistant and the labatory atmosphere"
24. "The opportunity to take it was best to me. I enjoyed psychology because we got to choose our course of study. Also the 4 credits!"
25. "I liked the exposure that I got to computers because now I have an idea what they involve. I may have never had this opportunity otherwise."
26. "That courses were offered that students may contine on with. The experience offered to see how college courses can be puts a student a jump ahead of freshman in college. We were treated as college students, hopefully and thus introduce how hard or easy college can be. To show us what's in store. Thanks for the experience. The student-teacher relations were good."
27. "One of the best results of the Rise course for me was that it gave an insight into college courses of this type that I have yet to find in high school. I also found the results of the testings interesting and somewhat helpful."

28. "The preparation it gave for taking future college courses"
29. "The movies about the monkeys and my experiment"
30. "I was able to learn a great deal, not only about our history but the expectations of college professors and the type of work expected."
31. "the size (individualized attention)
    all women and somewhat homogeneous intellect"
32. "It was interesting."
33. "It taught me what college will be like for me in the future and taught me a course that will help me in college and the field I want to go into."

III. Those graded C.

34. "We only had it once a week."
35. "working for credits. Being able to work on equipment I never used before".
36. "experiments"
37. "the equipment we worked with really fascinated me. I enjoyed doing the experiments."
38. no comment
39. "Dr. Baker, the history instructor
    working with the computer
    to experience what college will be like"
40. "The experience of being on a college campus doing college level work and research."
41. "The beginning when we got to hear from every teacher. I really would have liked to have gotten to work on the computer more."
42. "Being able to work without any hassle I mean - limitations were set but you could ask questions about what interested you and experiment on what you had questions about
    I also liked having different schools being able to work together"
43. "I liked the fact that the class was only 7 people. It made it much easier to learn and communicate with the people and teacher."
44. "I liked the fact that we could pick the course I wanted."
45. "You were given some incite on each one of the courses and were able to chose which one you wanted."

Appendix H

Student response to "What suggestions do you have for change if we ever should have the course again?"

I. Those graded A.

1. "I enjoyed the course as it was and can't think of anything I would have done different."
2. "I think the teachers were more than cooperative with the students. They didn't give too much homework because of regular school and they tried to have classes when everyone could attend. I completely enjoyed the class (course) the way it was."
3. "Simplify the courses a little more. At first I was lost in all the chemistry we had to know, but I caught on after Dr. Walker showed us what we were doing."
4. "I have found from taking other college courses that there is a big difference between a course with full-time college students and a college-level course with high school juniors. I feel it would be more stimulating to place the juniors in regular classes. I also feel the biology course would have been more complete if the class schedule had been more flexible. The instructor and assistant were forced to do much of our work because many of the steps in certain experiments had to be done after certain time spans, not each week."
5. "I feel we, as the students, lacked some of the necessary knowledge to fully understand and appreciate what we were doing. The students should be taught the chemistry needed to understand the purpose of the experimentation. At times I knew what to do, but not what the results meant. Even when I did understand the results, I wasn't sure what happened in the spectrometer to get them."
6. "I took the math course, and I think you should have a good background in math because I found that the girls who didn't slowed down the rest of the class."
7. No comment.
8. "Obtain a more reasonable, less sexually biased test of interests. The one given prior to and after the course was, quite frankly, insulting to me. I believe Ms. Horn received a letter from me with regard to this. One of the best parts of the course was the caliber of instruction, at least in my case. Lacy was magnificent! (say hello to her for me.)

9. "No changeI think that the program should be continued as it did much as far as enlightening me to a college situation. I hope thir capable students have the chance in the future."

10. "I think twould be better if the students could have more time to see courses offered before they had to make a decision."

II. Those graded E

11. "The only sun that I have is that you get them started into the course of choice earlier. You should split them up immediately and have anwith each teacher explaining what their course will offer and wwo weeks you could have them started."

12. "I would tryre the course two days a week so it doesn't drag from Oct to."

13. "1. have itdifferent time of day because after school is out I tend to falp if I begin to read.

2. bring these down to a level in between college and high-school. It took me a while to realize that must actually do some work (in high sche doesn't ever have to work). I ended up in wasting most of my thing time. This was not the fault of the teacher but that ofits from high-school. There should be more information on how dy."

14. "Make it availfor more students"

15. "To have a grvariety of fields to choose from on Saturday as well as Thursday.

16. "shorter sess

17. "possibly 2 t week per class because once a week was not enouff time to condperiments and such."

18. "perhaps diffareas of study could be added: dance art music, drama"

19. "psychology -t that I would've like to have learned more about the field - lec group experiments etc. instead of a full course individual sexperiment) The course in general was a good idea and I feel tirls will be able to benefit from it."

20. "maybe 2 courstead of 1 to get diversity and more of a taste for science, abilo compare is advantageous, but also expensive"

21. "I can only st changes in the psycholog aspect of the course. If the course wbe continued I'd suggest that people choose the courses they were inted in first then be chosen for the specific day the majority of tchoices were given or taught.

For psychology I feel that if groups are going to do a day to day study as I did they should make it more compact so that the subjects wouldn't grow tired of filling out questionnaires."

22. "I found the course well organized, and well conducted."

23. "To have a little more background information on the course."

24. "I think it should be kept so other girls can have the new experience. Since I wasn't in all the groups I can only speak for the group I was a part of. The only complaint I had was that I wished a little more classroom teaching had been done. Ours was an independent project and Mrs. Walls gave us the help we need if we asked, but we had a booklet to work in and I think it might of been more effective if she had gone over the material."

25. "I think that some way, if possible, the course should not be dragged out so much. Between all the vacations and school days off, it was a little difficult to remember everything that was done a couple times before."

26. "Offer more courses. Its a good idea. I think you should continue with the project."

27. "I really can't think of anything that could use adjustment in the course. I found it helpful in its educational value and the staff of the RISE course also helpful towards the RISE students."

28. "open the course to as many as possible; it was a great experience that others should have the benefit of."

29. "Have more of a classroom atmosphere"

30. "try not to make the girls feel like such freaks-"

31. "For the psychology course, I would have more formal instruction before allowing the student to start on their own project."

32. "I feel that the teacher will have to teach more background about computers before she sends us out to do a project on our own. I did not have enough background so that I could do the project by myself without the teacher's constant help.

I really enjoyed the course and have recommended it to many people if they are offered it."

III. Those graded C.

33. "Try to offer some <u>interesting</u> and <u>useful</u> courses. How about some in Pre-Med or in arts or music? <u>We</u> didn't get offered any in History or

Mathematics, how come? You ought to have it later in the morning or afternoon so we don't have to break our backs getting up. Having it after school is a bad idea."

34. "Make sessions 1 hour long instead of 2 hours."
35. "To pick the teachers so as to be able to have the students understand and comprehend what is being taught.
36. "Breaking the work down some. We spent most of our time experimenting, some classroom instruction would have been useful. Because I was only in chemistry at school a lot of things weren't clear."
37. "have a different aspect if any for economics"
38. "-not to rent such an expensive large bus to pick us up in.
-make it on another day, it made the day too long coming after school."
39. "more assistants to help explain."
40. "Don't offer history."
41. "I don't think the participants for the project should have been picked so much entirely by random. I think more people who really wanted to take the course should be able to.
Otherwise it was great!"
42. "If you have the course again I feel you should have the grading be based on at least 2 projects or papers. As in my case our grade was on one paper, but in a way I might not change this because you do get a lot more out of working on one paper thoroughly. All in all I really wouldn't make any changes as I found the Project a most worthwhile experience and think it should be continued."
43. "it was o.k."
44. "Give more choice of days and hours if possible and maybe a more wider variety of subjects to choose from."

Appendix I. Students' Comments on Course one year later

Positive responses to question, "Has the RISE course that you took last year influenced your plans for college and career in any way? If so, please briefly describe how."

1. "Yes, the program gave me the desire to continue my education through college."
2. "Yes, I was able to see psychology in more of its true, scientific character. It was good for me to get a more intense idea of what the study of psychology is. Also, I was able to realize that it is more the philosophical aspect of human behavior that I am and have been interested in studying.

   Because of the nature of my own research project--dealing with the psychology of child development--I became interested in a whole new area: teaching and researching child-development and education."
3. "Interested more in science."
4. "I took economics at Goucher and although it was interesting, it was not something I would like to go into. Therefore, it influenced me by stirring me away from something I really would not be happy going into."
5. "The course of study stimulated my interest in a field involving biology that was not a pre-med curriculum and influenced me to pursue a career in Environmental Studies."
6. "Through RISE, found that I liked Goucher, that I didn't particularly like psychology."
7. "A little, it gave me college experience and taught me how to be organized and to conduct a research project. It also got me interested in psychology, so that I took it in high school and will probably take it in college."
8. "Yes, I realised that I enjoy the atmosphere of a biology lab and won't mind the courses required of a pre-med."
9. "Yes, it aroused my curiousity about the sciences."
10. "Yes, it has let me know that I am not ready just yet for college."
11. "Yes, I took the biology part and found that I enjoyed the labs and technique. I knew Gettysburg had a good biology department so decided I would apply there."

12. "The biology course I took convinced me even more that a career in the biology field is where I belong. It was also a good experience in that I saw some of what I can expect this fall in college. I am very glad that I had this experience in RISE."
13. "Yes. It did help to show me that I liked working with computers."
14. "It has opened my eyes to the computer field."
15. "I'd like to say yes--but I can't say how."
16. "The RISE course stimulated my interest in Marine Biology."
17. "Yes. I've decided to attend a college geared to independent study as that is what most of my Goucher experience was, and I enjoyed it. Mrs. Baker left it up to us to choose a pertinent topic, research it, and present it. I found that I was interested in doing independent work through my Project RISE course."
18. "Yes. I was thinking of majoring in phychology, but once I took the course in phychology I decided I didn't want to."
19. "Yes, it let me see what my interests were and how many fields were open in different areas."
20. "Because of the RISE course I possibly will take a more advanced economics course."
21. "Reinforced my suspicion that I want to concentrate on microbiology, genetics."
22. "In a way--I feel a desire to attack and pursue a career which has been traditionally male-oriented rather than female oriented."
23. "Project RISE showed me that I could perform well on a college level and made me want to major in sciences and become a doctor."
24. "Yes it has. Now I realize that my field I desire to work in can be helpful by the use of a computer."

Negative responses to question, "Has the RISE course that you took last year influenced your plans for college and career in any way? If so, please briefly describe how."

1. "It more or less reinforced my knowledge that I was weaker in science and math areas. While I pulled through ok, it was not particularly easy. I was glad to be able to have the experience, but I don't believe that it influenced my future plans."
2. "No not really. I was interested in psychology before RISE and now have decided to go into s/h [speech/hearing] which involves psychology."

3. "No--gave me a better idea of what college life would be like."
4. "No, because my career influenced the class I took in Project RISE."
5. "Not really. It's allowed me to observe more of what happens in a lab, but hasn't affected my career choice. The chemistry course has helped me more in 12th grade then it will in college."
6. "No but it certainly made high school a lot easier to take that year. Thank you for the opportunity."
7. "Because of my computer math course, I might possibly take a college computer math course. However, my career choice has not changed because of the program."
8. "No, it has not."
9. "Only affirmed my previous career choice."