Science Enrichment Programs for Gifted High School Girls and Boys: Predictors of Program Impact on Science Confidence and Motivation

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Abstract: The impact of two science enrichment programs on the science attitudes of 330 gifted high school students was evaluated using a multimethod, multiperspective approach that provided a more comprehensive evaluation of program impact on science attitudes than did previous assessments of science programs. Although pre–post comparisons did not indicate positive impact on science attitudes, other measures provided strong evidence of program effectiveness. Program benefits were greater among girls, those who had more supportive families and teachers, and those who entered the programs with greater general confidence in their abilities. Implications for science enrichment programs and their evaluation are discussed. © 2001 John Wiley & Sons, Inc. J Res Sci Teach 38: 1065–1088, 2001

Students in the United States lag behind in science achievement relative to their counterparts in many developed countries, particularly those along the Pacific Rim (Gallagher, 1993). Some U.S. students lose enthusiasm for science in grade school or middle school (Simpson & Oliver, 1990; Greenfield, 1996; Jovanovic & King, 1998), and the number of students who continue to pursue science drops still further in high school and again in college (Simpson & Oliver, 1990; Bazler, Spokane, Ballard, & Fugate, 1993). The lack of involvement in science among U.S. students has led to a shortage of native-born scientists and engineers and the concern that the United States may lose its competitive edge in science and technology (Gallagher, 1993).

The problem of low science interest and achievement is particularly serious for girls and women. By middle school girls in the United States tend to have slightly lower science

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achievement scores than do boys, and this gender gap widens as students proceed through high school and college (Catsambis, 1995; Burkam, Lee, & Smerdon, 1997; Steele, 1997). Similar gender differences in science achievement have been reported in the majority of other countries for which information is available (Halpern, 1997). Still larger gender differences have been reported for science interest and participation (Catsambis, 1995). A meta-analysis of 18 studies representing 6,753 students revealed that girls have less positive attitudes than boys across all science areas (Weinburgh, 1995). Even girls and women who have performed well in science and mathematics classes have been less apt to pursue science careers (Wellesley College Center for Research on Women [WCCRW], 1992; Steele, 1997) and are underrepresented in those fields (Rayman & Brett, 1995; Steele, 1997). Researchers have continued to report gender differences in science participation despite efforts to improve educational equity for girls (Weinburgh, 1995; American Institutes for Research, 1998).

Many theorists and researchers have attempted to understand the causes of the persistent science gender gap. Most agree that subtle forms of sexism still exist in science education even though overt forms of discrimination have been significantly reduced. Science texts, although using gender neutral language, continue to depict a greater number of males in active science roles and little attention is paid to issues of particular importance to women, such as pregnancy and menses (Potter & Rosser, 1992; Guzzetti & Williams, 1996). Boys tend to receive more encouragement from science teachers (Guzzetti & Williams, 1996; WCCRW, 1992) and are more likely to have a network of friends who support and encourage their interests in science (Kelly, 1988). Because science is stereotyped as a male domain, girls continue to feel that science is not "their space" and that they are not entitled to be equal participants in science (Bartholomew & Schnorr, 1994; Koch, 1998; Meyer, 1998). In addition, some girls believe that a science career is incompatible with having a family and balanced personal life (Ware & Lee, 1988).

A variety of enrichment programs and curricular initiatives have been developed to enhance the science achievement and attitudes of both girls and boys. These programs have emphasized the importance of inquiry-based learning, in which students participate in the process of scientific discovery (Bazler et al., 1993; Burkam et al., 1997; Freedman, 1997; Jovanovic & King, 1998). A large longitudinal study revealed that students who actively performed their own science experiments learned more than those who did not (Burkam et al., 1997). Other comparisons of hands-on versus more passive learning paradigms also support the value of active learning for enhancing science achievement (Houtz, 1995; Freedman, 1997). Girls may benefit in particular from opportunities to use science tools and equipment because they have less experience than boys do with science-related activities outside the classroom (Rand & Gibb, 1989; Potter & Rosser, 1992; Jovanovic & King, 1998). Educators have stressed that girls learn best through an "engaged pedagogy" that promotes student participation in a supportive environment (Koch, 1998; Meyer, 1998). Science role models, close mentoring, and detailed science career information have also been identified as important for the promotion of science interest and achievement. Educators have suggested that these advantages are especially important for girls because girls are less likely to have them in traditional educational settings (Rand & Gibb, 1989; Rea-Poteat & Martin, 1991; Bartholomew, 1995).

Some science educators have focused on the needs of high-ability boys and girls because these students have the most potential to achieve in science. Interestingly, the same pedagogic themes espoused for general students are considered important for gifted students (Tassel-Baska & Kulieke, 1987; Pyryt, Masharov, & Feng, 1993; Harwood & McMahon, 1997). Harwood and McMahan noted that gifted students are often expected to learn in the abstract, but in reality they, too, learn best with more active, engaged approaches to learning. In discussing the needs of gifted science students, Tassel-Baska and Kulieke stressed the value of direct interactions with practicing scientists as mentors and role models.

Science enrichment programs generally have been effective in increasing science knowledge and mastery in groups of general students (Bazler et al., 1993; Houtz, 1995; Burkam et al., 1997; Freedman, 1997), female students (Bazler et al., 1993; Houtz, 1995), and gifted students (Tassel-Baska & Kulieke, 1987; Lynch, 1992; Gallagher, 1993; Pyryt et al., 1993). However, the effectiveness of these programs for improving science attitudes and increasing aspirations for science careers is much less certain. Programs that have brought about gains in science achievement have generally not shown evidence of positive impact in the affective realm (Houtz, 1995; Dechsri, Jones, & Heikkinen, 1997; Freedman, 1997), and other programs designed to improve attitudes toward science have yielded disappointing results (Kelly, 1988; Bazler et al., 1993; Harwood & McMahon, 1997). Because science attitudes are strongly related to long-term science achievement (Weinburgh, 1995), the promotion of positive science attitudes is critically important.

Despite the lack of positive evidence of attitude change, science intervention programs may have a positive influence on science attitudes and aspirations that has gone undetected. The traditional pre–post design used in most studies may be insufficient for measuring the impact of intervention programs for two reasons. First, when students have been selected for science programs based on their science interest or have elected to enroll in science programs, their ratings of science interest have usually been high at pretesting, placing a ceiling on possible change scores. Second, the experience of participating in a science intervention program may affect students' frame of reference for evaluating their science interests and abilities. There is evidence that treatments influence how participants interpret and respond to questions that require self-evaluation and that, therefore, the pre–post design may sometimes fail to detect change that is experienced and recognized by the participants (Spiro, Shalev, Solomon, & Kotler, 1989). For example, contact with highly motivated science students in an enrichment program may shift students' frame of reference for rating their own level of motivation, leading to lower ratings at posttesting, even when they have experienced positive change during the program.

With these issues in mind, we used an expanded methodology in the present study to obtain a more complete assessment of the impact of science enrichment programs on science attitudes. In addition to pre- and post measures, we included the following indices of change: (a) student subjective ratings of program-related change, (b) student written descriptions of change, (c) parent ratings of student change, (d) parent written descriptions of change, and (e) a third administration of the repeated measures at a 6-month follow-up. The programs evaluated were designed to incorporate the science education elements identified by earlier researchers: active, inquiry-based learning; individual mentoring; female and male science role models; and information about a wide variety of science-related careers. The science programs were aimed at the high school level because high school is a critical stage in science education when many students, especially girls, are apt to drop out of science (Ethington & Wolfle, 1988; Manis, Thomas, Sloat, & Davis, 1989). Only students with high academic aptitude were included because high aptitude has been shown to be a very strong predictor of science achievement (Fleming & Malone, 1983; Napier & Riley, 1985), and high-ability students have the best potential for successful science careers. Two related science enrichment programs were evaluated. The programs were designed so that students could participate in Program I only, Program II only, or Programs I and II sequentially. This arrangement allowed for a comparison between first-time science program participants and participants returning for a second science enrichment experience.

A key issue in the evaluation of science intervention programs is the possible differential effect of programs on student participants. Determining who benefits most from these programs has important policy implications for the distribution of limited educational resources and the development of successful, effective science programming. Thus, an additional goal of the present study was to assess student factors associated with program impact. Few researchers have considered individual differences when evaluating the impact of science programs, so there was little previous research to help us anticipate which student variables might be associated with positive program impact. In the absence of this information, we identified possible impact factors on the basis of research on individual differences associated with science interest and participation. Previous research has found that students who have stronger and more persistent science interest and involvement have had (a) parents with more education (Kremer & Walberg, 1981; Baker & Leary, 1995; Mau, Domnick, & Ellsworth, 1995); (b) confidence in their abilities (Talton & Simpson, 1986; Ethington & Wolfle, 1988; Simpson & Oliver, 1990; Fouad & Smith, 1996); (c) strong family encouragement and family members interested and involved in science (Talton & Simpson, 1986; Manis et al., 1989; Simpson & Oliver, 1990; Mau et al., 1995; Rayman & Brett, 1995; George & Kaplan, 1998); (d) a network of friends interested in science (Talton & Simpson, 1986; Simpson & Oliver, 1990); (e) support and positive advice from teachers (Napier & Riley, 1985; Kelly, 1988; Rayman & Brett, 1995; Simpson & Oliver, 1990); (f) positive attitudes toward their science teachers (Stake & Granger, 1978; Atwater, Wiggins, & Gardner, 1995); and (g) same-sex teacher models (Stake & Granger). In addition, as discussed earlier, by the high school years it has been found that boys show more interest in science than do girls. Thus, for the development of high science interest and confidence, it appears advantageous to be a boy who has well-educated parents; general self-confidence; encouragement from family, peers, and teachers; and teachers who are positive role models.

In considering the question of differential benefit, there were three possibilities. First, it was plausible that students with the least advantages (e.g., less encouragement from others) would benefit more because the science programs would function as a welcome compensation for the lack of science advantages elsewhere. A compensatory model may be particularly relevant to gender differences in program impact. Girls may benefit more than boys because enrichment programs may help to compensate for the widespread social stereotype of science as a male domain. A second possibility was that students who had had advantages in science would benefit more because they would be better prepared to meet the challenges of the program. In support of this preparedness model, Merton (1968) noted that the most outstanding scientists have enjoyed many early advantages in science and that the benefits of these advantages accrue over time. He termed this tendency for scientists to profit from previous advantages, the Matthew effect. A third possibility was that the programs would help students equally regardless of previous science-related advantages. These alternatives were evaluated by examining the relation between science advantages and program impact.

Method

Participants

Participants were selected from 76 high schools in a large metropolitan area in the Midwest. All participants had high aptitude scores, a strong academic record, an expressed interest in science, and a recommendation from a high school teacher or counselor. Participants were senior high school students, including 165 girls and 165 boys. The ethnic composition of the sample was 8.5% African American, 13.0% Asian American, 74.8% European American, and 3.6% other ethnic groups.

Programs Evaluated

The two science enrichment programs evaluated were administered at a midsize Midwestern university (Table 1). Program I was designed as an initial science enrichment experience. Students attended this intensive full-time summer program over a 4-week period. The program provided instruction on the elements of the scientific process, including library research, laboratory procedures, and technical writing. Students received close mentoring as they developed proposals for scientific experiments. Detailed information on science career opportunities was presented by a variety of female and male scientists. In the programming and selection of instructors and mentors, a balance of the life sciences, physical sciences, engineering, mathematics, and medicine was represented. In addition, social activities were planned for the purpose of helping students to develop strong interpersonal ties and a sense of community with one another. In each program group of 40–50 students, a wide variety of high schools was represented, and most students were previously unacquainted with one another. The building of new peer relationships was facilitated by this arrangement. Sixty-eight boys and 90 girls participated in Program I.

Program II was a 6-week intensive, full-time summer program that contained all the elements of Program I plus provided time for students to carry out their research proposals and present their findings. Program II was open to both graduates of Program I and to students who had not attended Program I but had attended a nonscience academic enrichment program for gifted students. Ninety-six boys and 76 girls in the study attended Program II.

Measures

In those cases in which measures needed for the current study had been previously developed and had adequate psychometric properties, they were used in their original form or adapted as appropriate for the present study. When no suitable instruments had yet been developed, measures were constructed for this study. All newly constructed measures are included in the Appendix. For each new measure, a pool of items was rationally derived to sample the targeted content domain. The items were then independently evaluated by three

Table 1
Description of participant groups

Participant Group	Program Length	Program Requirements	Program Activities
Program I	4 weeks	Demonstrated science interest and potential	Instruction in library and lab research and technical writing; research proposal; science career lectures; social activities
Program II — returning	6 weeks	Graduation from Program I	Same as Program I plus completion of research study
Program II — new	6 weeks	Graduation from non-science enrichment program for gifted students	Same as Program I plus completion of research study

experts in high school science education and three high-ability students at the same level as program participants for clarity, suitability of language, and relevance to intended constructs. Changes in item wording were made in response to the evaluators' feedback. To simplify the wording of items, the word *science* was used to encompass all fields in science, mathematics, engineering, and medicine; this use of the word *science* was explained in the instructions to participants. Items on all measures were worded in the positive direction, unless otherwise noted in the description of the measures to follow. Scores for all multi-item measures were derived by first reversing ratings on any negative items and then averaging ratings across all items on the scale. All measures were tested for internal reliability and met accepted standards (coefficient $\alpha \geq .70$).

Measures of science attitudes were administered at pretesting, posttesting, and follow-up to evaluate changes in attitudes over time. Measures of science advantages were gathered at pretesting. Subjective measures of program impact were given at posttesting and follow-up to assess participants' immediate and more long-range perceptions of program impact.

Science advantages. As explained earlier, variables identified as science advantages were selected on the basis of previous research evidence on factors associated with science interest. These measures were obtained as follows:

1. The highest educational level of each parent was reported by the students; these values were averaged to form the parent education variable.
2. Aptitude was defined by scores on standardized tests provided by the home high school. Each student had completed either the ACT or SAT prior to entering the program. The verbal and quantitative percentile scores from the particular standardized test taken were averaged to derive a measure of aptitude.
3. Students' confidence in their abilities was measured by the 15-item short form of the Performance Self-Esteem Scale (PSES; Stake & Noonan, 1985). This measure has been found to correlate with a range of achievement variables including: career commitment (Stake, 1979), dominance behavior in task-oriented interactions (Stake & Stake, 1979), reactions to success and failure feedback on experimental tasks (Stake, 1982), and reactions to everyday achievement events (Stake, 1985). Reliability estimates have been consistently high in these studies. Internal reliability in the present study was .82. Participants rated the extent to which a set of attributes was true of them on a 7-point scale that ranged from 1 (*never or almost never true*) to 7 (*always or almost always true*). A sample positive item is "Headed for success," and a sample negative item is "Makes mistakes when flustered."
4. A 4-item measure of family encouragement was developed for this study (see Appendix). The items tapped student perceptions of encouragement from family members for science pursuits. Students responded to this and the other encouragement measures on a 7-point scale that ranged from 1 (*not at all true*) to 7 (*very true*). The internal reliability of the measure was .85.
5. Perceived peer encouragement was measured with a five-item scale adapted from the Friends' Attitudes Toward Science subscale developed by Simpson and Troost (1982). Using factor analysis and cross-validation procedures in a large sample of junior high school students, Simpson and Troost (1982) found the subscale to be distinct from 14 other school, home, and self variables relevant to science. The scale has had adequate internal reliability (.71) and has related to positive science attitudes (Talton & Simpson, 1986). A sample item is "My best friend likes science." Internal reliability in this study was .70.

6. Teacher encouragement was measured with a five-item scale adapted from the Science Teacher subscale developed by the same procedures described above for the Friends subscale (Simpson & Troost, 1982). This scale measured student perceptions of encouragement received from science teachers. The subscale was found to be distinct from 14 other school, home, and self variables relevant to science (Simpson & Troost, 1982) and has related significantly to positive science attitudes (Talton & Simpson, 1986). The original scale had low internal reliability (.44), but the adaptation used in the present study had adequate internal reliability (.79). A sample question is "My science teachers have encouraged me to learn more about science."
7. To determine the gender of students' science teacher models, students were asked, "When you think of science, which of the science teachers you have had comes to mind most often?" To measure attitudes toward the teacher model (teacher attractiveness), students were asked, "To what extent would you like to become like the teacher you named above?" Responses were made on a 7-point scale that ranged from 1 (*not at all*) to 7 (*very much*).

Repeated measures of science attitudes and goals. Students completed these measures at pretesting, posttesting, and follow-up:

1. Motivation for a science career was measured with a four-item scale that was developed for this study (see Appendix). The rating scale ranged from 1 (*not at all true*) to 7 (*very true*). Internal reliability was .93 at pretesting and .95 at posttesting and follow-up.
2. Science confidence was measured by the Science Self-Concept Scale (Campbell, 1991). The scale was developed with a large sample of gifted students and cross-validated in a broad national sample of high school students. It has been shown to be distinct from general self-concept measures, to be associated as expected with criterion groups, and to have good internal reliability (Campbell, 1991). Internal reliability in the present study was .76 at pretesting, .80 at posttesting, and .78 at follow-up. The scale includes five positive items (e.g., "I have a lot of confidence in my abilities in science") and three negative items (e.g., "Science is hard for me"). The 7-point rating scale had the anchors, 1 (*disagree strongly*) and 7 (*agree strongly*).
3. Two additional measures of science-related confidence were based on self-schema theory (Markus & Nurius, 1986; Cross & Markus, 1994). Markus and her colleagues have defined the "possible self" as an aspect of the self-schema that represents what the self may become at a future time. The possible self serves to organize the individual's task-relevant thoughts and behaviors, linking current specific plans and actions to future desired goals. The measures of the possible self developed for this study were the self as a developing scientist (future career self) and the personal life of the self as scientist (future personal self; see Appendix). Instructions for the measures were as follows:

> We all think about the future to some extent. When doing so, we often think about the kinds of experiences that are in store for us. Some of these experiences you may be quite confident will happen and some you may be more unsure of. Let's say you decide you would like to have a career in science, math, engineering, or medicine. Think about what is likely or possible to happen to you in the future if you decide you want this type of career. For each of the experiences listed below, mark how confident you are that each would actually happen to you.

Items for both scales were rated on a 7-point scale with the anchors, 1 (*not at all confident*) and 7 (*very confident*). The measure of the future career self includes eight items that describe successive steps toward a science career. Internal reliability of the career-self scale was .89 at pretesting, .88 at posttesting, and .89 at follow-up. The measure of the future personal self includes four positive and four negative items describing the personal life of the self as scientist. Internal reliability was .73 at pretesting, .79 at posttesting, and .81 at follow-up.

4. Current occupational goals were obtained at each testing. Occupational goals were coded into four categories: scientist (nonphysician), physician, nonscientist, and don't know. Physician was included as a separate category because of the large proportion of participants who aspired to a medical career.

Student subjective science-attitude change measures. Four scales were developed to measure participants' assessment of the extent to which the program brought about positive changes in their science motivation, confidence, knowledge, and relationships with other science students (see Appendix). For all items on these scales, students were asked to rate "How much (if at all) the program changed you and your attitudes toward science" on a 7-point scale anchored by 1 (*not at all*) and 7 (*a great deal*).

1. Student perceptions of program impact on their motivation for science were measured by a six-item scale. Internal reliability for the motivation scale was .89 at posttesting and .93 at follow-up.
2. Student perceptions of program impact on their science confidence were assessed with a six-item scale. Internal reliability for the confidence scale was .92 at posttesting and .93 at follow-up.
3. Student perceptions of the extent to which the program increased their science knowledge were assessed with a six-item scale. The measure was administered at posttesting only (internal reliability = .79).
4. Student perceptions of the extent to which the program helped them to develop a network of friendships with other science students (a new social niche) were assessed with a five-item scale. The internal consistency was .85 at posttesting and .83 at follow-up.

In addition, students were asked at posttesting to write a brief description of any changes they had seen in themselves as a result of the science programs.

Parent perspectives on student change. Parent views of the programs' impact on their children's science motivation and confidence were assessed with two 6-item scales designed for this study (see Appendix). Parents were asked to make ratings on the basis of what they had observed in their son or daughter. The rating scale ranged from 1 (*not at all affected*) to 7 (*affected a great deal*). Internal reliabilities were .90 for the motivation scale and .92 for the confidence scale. In addition, parents were asked to write a brief description of any changes they observed in their child as a result of the programs.

Coding of Qualitative Responses

Content analysis of the student and parent descriptions followed the procedure outlined by Weber (1990). Coding units were identified, and coding categories were derived from the content of the coding units based on the single guiding construct of program-related student change. The original content categories were tested with a small sample of student and parent responses, which lead to revisions of the classification scheme to clarify category meanings and distinctions between categories. Eight positive categories of change were identified through this procedure: Increases in (a) motivation for a science career, (b) motivation for science education, (c) self-confidence in academic/science abilities and potential, (d) general self-confidence, (e) social self-confidence, (f) development of a new social niche, (g) knowledge of science facts and procedures, and (h) knowledge of science careers. Fewer negative than positive categories were defined because few statements of negative change were found in the texts of student and parent responses. The negative categories were: (a) decreased motivation for science and scientific research and (b) decreased confidence in academic/science abilities and potential. A no-change category was also included. Once the final coding scheme was established, two independent raters coded the student and parent written descriptions. The interjudge agreement between the coders was 82.4% for student responses and 83.3% for parent responses. When differences between coders occurred, differences were resolved through discussion with a third coder familiar with the coding system.

Procedures

The study included 158 students who participated in Program I only, 111 who participated in Program II only, and 61 who participated in both programs. The programs took place during the summers of 1995–1998. For students who participated in both programs, only data from Program II was included in the data analysis so that each set of student responses would be independent. Students completed all pretest measures in a group administration during the morning of the first day of their program. The pretest included all measures of science advantages and all repeated measures of change. The study was explained as an effort to understand how programs can best meet the needs of gifted students. The confidentiality of all responses was stressed. Students were told that their responses would not be reported to their teachers, parents, or others and were strongly encouraged to give honest, open responses to all questions. Posttests were completed in a group administration toward the end of the last week of the programs. The posttest included a second administration of the repeated measures of change and the student subjective-change questions.

At the close of the programs, a copy of the parent questionnaire addressed to the parent(s) was mailed to the home of each student. The accompanying cover letter explained to parents that information they provided about their child would be helpful for better understanding how students are affected by the programs and would be used in future program planning. The questionnaire could be completed by either parent. The confidentiality of individual responses was assured. If neither parent responded, a second questionnaire was sent and, if needed, a third with a reminder letter. Questionnaires were received from the parents of 75.2% of the participants. Parents of boys and girls were equally litely to return the questionnaires (76.0% vs. 74.4%, respectively). Parents of White students were somewhat more likely to respond than parents of minority students (80.0% vs. 67.5%).

Students received the follow-up questionnaire 6 months following the end of the programs. The follow-up questionnaire included a third administration of the repeated-change measures and the quantitative subjective-change measures. Students received second and third reminders if needed. Follow-up questionnaires were returned by 84.5% ($n = 278$) of the total sample.

Results

The distributions of all variables were examined prior to the analyses. Several distributions were negatively skewed. These were reversed and logarithmic transformations made to normalize the distributions. For clarity of presentation, the means of all variables are reported in the text and in the tables in their original scale. Effect sizes were in the small to medium range (Cohen, 1977) and are reported for all significant findings.

Repeated Measures of Science Attitudes

Changes in science attitudes over time (pretest, posttest, and follow-up) were assessed in a 3×3 (time by participant group) repeated-measures analysis of variance (ANOVA) design. The repeated science attitude measures were: motivation for a science career, science confidence, future career self, and future personal self. The three participant groups were Program I students, Program II students who had completed Program I (returning Program II students), and Program II students who had not completed Program I (new Program II students; see Table 1). Program II students were divided in this way to assess the impact of Program II with and without experience with Program I. Linear and quadratic effects were tested. The Greenhouse–Geisser correction was applied to adjust degrees of freedom downward to avoid an inflated Type I error rate in tests involving repeated measures.

Three of the four repeated attitude variables yielded significant findings; means for these variables and results of post hoc comparisons between means are presented in Table 2. Differences over time showed a main quadratic effect for science career motivation, $F(1.8, 481.6) = 8.23$, $p < .01$, $\eta^2 = .03$; and a main linear effect for science confidence, $F(1.9, 513.0) = 9.96$, $p < .01$, $\eta^2 = .04$; and for future personal self, $F(1.8, 492.0) = 5.77$, $p < .05$, $\eta^2 = .02$. Simple pairwise comparisons between time periods for the full sample revealed that differences between pre- and posttesting were not significant for any variables but that follow-up

Table 2
Means for repeated measures of science attitudes at pretesting, posttesting, and follow-up

Science Attitude	Program I	Program II Returning	Program II New	All Programs
Science career motivation				
Pre	6.23_a	6.22	5.94_{cd}	6.13
Post	6.03_a	6.33	5.75_{ac}	6.04_a
Follow-Up	6.10	6.30	6.12_{ad}	6.17_a
Science confidence				
Pre	5.50_a	5.38_{cd}	5.34	5.41_a
Post	5.43_b	5.50_c	5.39	5.44_b
Follow-Up	5.65_{ab}	5.53_d	5.45	5.54_{ab}
Future personal self				
Pre	5.11_{ab}	5.36	4.95_c	5.14_b
Post	5.31_a	5.34	4.91_a	5.19_c
Follow-up	5.31_b	5.40	5.09_{ac}	5.26_{bc}

Note. Scores represent mean ratings on a 1- to 7-point scale. For each variable, means in the same column with the same subscript (either a or b) are significantly different from each other ($p < .05$); means with the same subscript (either c or d) are marginally significantly different ($p < .10$) The N varies across variables, ranging from 269 to 270, because of missing values.

scores were significantly higher than posttest scores for science career motivation and science confidence, $p < .01$, and marginally higher for future personal self, $p < .07$. The main effect of participant group was significant for future personal self, $F(2, 267) = 5.33$, $p < .01$, $\eta^2 = .04$. New Program II students had lower future personal self scores ($M = 4.98$) than did Program I students ($M = 5.24$) or returning Program II students ($M = 5.37$), $p < .05$.

Significant quadratic interaction effects qualified the main effects found for science career motivation, $F(3.6, 481.6) = 6.27$, $p < .01$, $\eta^2 = .05$; science confidence, $F(3.8, 513.0) = 3.57$, $p < .05$, $\eta^2 = .03$; and future personal self, $F(3.7, 492.0) = 4.30$, $p < .05$, $\eta^2 = .03$. The significant interaction effects indicated that patterns of change over time differed by program type. An examination of the means within participant groups revealed that the first-time students (i.e., Program I students and new Program II students) in some cases had lower scores at posttesting than pretesting. These differences were significant or approached significance for science career motivation (Table 2). In addition, some significant increases between posttesting and follow-up were found for first-time students but not for returning Program II students. Thus, first-time participants tended to show decreases between pre- and posttesting and increases between posttesting and follow-up, whereas returning Program II students had gradual, nonsignificant increases over time.

Changes in Career Goals

The distribution of career goals is displayed in Table 3 by participant group and time period. The distributions of goals at pretesting and posttesting shown in the table are for all students who participated at pretesting and posttesting. These percentages are highly similar to the distribution of pretesting and posttesting goals for the follow-up sample (84.5% of the full sample). Chi square comparisons between pretest and posttest goals included all subjects who participated at posttesting; comparisons between posttest and follow-up goals were made with the follow-up sample.

Comparisons were made within each participant group. The distributions of goals were significantly different between pre- and posttesting, $X^2(9) > 65$, $p < .0001$, and between posttesting and follow-up, $X^2(9) > 53$, $p < .0001$, for all program groups. Thus, considerable shifting of occupational goals took place during the program and follow-up periods. As shown in Table 3, Program I students were less likely to state a science career goal and more likely to express uncertainty about their future occupation following their program. Both groups of Program II students tended to move away from the goal of physician and toward other science career goals.

Subjective Measures of Change

Student subjective ratings of science attitude change. The means of student ratings of positive change are given in Table 4. All means were between the rating scale points *somewhat* (4) and *a great deal* (7). Thus, despite the lack of significant positive change in the pre–post measures, students reported substantial change in each area assessed. To evaluate the relation between the repeated- and subjective-change measures, differences between pre- and posttest scores were calculated for the science motivation and confidence measures. These difference scores were then correlated with the corresponding subjective measures at posttesting. Pre–post difference scores for motivation were significantly correlated with subjective ratings of motivation change ($r = .36$, $p < .0001$), and pre–post difference scores for confidence were

Table 3
Percentage of students with career goals by participant group at pretesting, posttesting, and follow-up

Participant Group	n	Physician	Scientist	Nonscientist	Don't Know
Program I					
Pretesting	148	30.4	50.0	11.5	8.1
Posttesting	148	29.7	38.5	12.2	19.6
Follow-up	119	34.5	35.3	10.9	19.3
Program II (returning)					
Pretesting	60	43.3	35.0	6.7	15.0
Posttesting	60	40.0	38.3	10.0	11.7
Follow-up	51	31.4	45.1	5.9	17.6
Program II (new)					
Pretesting	101	23.8	43.6	11.9	20.8
Posttesting	101	22.8	46.5	12.9	17.8
Follow-up	90	15.6	53.3	11.1	20.0

Note. Comparisons within each program group indicated that distributions of goals were significantly different between pre- and posttesting ($p < .0001$) and between posttesting and follow-up ($p < .0001$).

significantly correlated with subjective ratings of confidence change ($r = .28$, $p < .0001$). These correlations indicate that the pre–post difference scores reflected only a small part of the gains reported by the students.

Student perceptions of their gains in science motivation and confidence were assessed at posttesting and follow-up. These ratings were analyzed in a 2×3 (time by program group) repeated-measures ANOVA. Ratings were significantly higher at follow-up than at pretesting for science motivation, $F(1, 269) = 4.53$, $p < .05$, $\eta^2 = .02$; and for science confidence, $F(1, 269) = 10.54$, $p < .001$, $\eta^2 = .04$. Thus, students reported strong gains in science motivation

Table 4
Mean student subjective ratings of science attitude change by participant group

Science Attitude	Program I	Program II (Returning)	Program II (New)	All Programs
Increased motivation				
Post	4.73_a	5.46_a	4.31_a	4.83_a
Follow-up	4.94_a	5.55_a	4.31_a	4.93_a
Increased confidence				
Post	4.80_a	5.45_{ab}	4.55_b	4.93_a
Follow-up	5.04_a	5.64_{ab}	4.76_b	5.15_a
Increased knowledge				
Post	5.57_a	6.07_{ab}	5.53_b	5.65
New social niche				
Post	5.61_a	5.23_b	4.62_{ab}	5.22

Note. Scores represent mean ratings of amount of change on a scale from 1 (*not at all*) to 7 (*a great deal*). For each variable, means in the same row with the same subscript are significantly different from one another ($p < .05$). $N = 322$ at posttesting and 272 at follow-up.

and confidence at posttesting, and these gains were reassessed in a still more positive way at follow-up.

Main effects of the participant group were found for ratings of increased motivation, $F(2, 269) = 14.79$, $p < .0001$, $\eta^2 = .10$; and for confidence, $F(2, 269) = 9.86$, $p < .0001$, $\eta^2 = .07$. Tukey comparisons revealed that returning Program II students rated their motivation and confidence gains significantly higher than either of the first-time groups for all comparisons ($p < .01$). In addition, the new Program II students gave significantly lower motivation change ratings than did the Program I students ($p < .05$). The interactions between time and participant group were not significant.

Students also reported increases in their science knowledge and the development of a new social niche at posttesting. Their ratings indicated that students perceived substantial benefits from the program in these areas (see Table 4). Differences by participant group were analyzed by a one-way ANOVA. Participant group was significantly related to ratings of increased science knowledge, $F(2, 319) = 8.90$, $p < .0001$, $\eta^2 = .05$, and new social niche, $F(2, 319) = 18.95$, $p < .0001$, $\eta^2 = .11$. Returning Program II students rated increases in their science knowledge higher than the other groups ($p < .0001$), and new Program II students gave lower ratings for new social niche than the other groups ($p < .01$).

Parent ratings of positive change. Parent average ratings of student gains were also between the rating scale points *somewhat* (4) and *a great deal* (7). Ratings of increased science motivation averaged 5.11, and ratings of increased science confidence averaged 5.35. Parents' ratings of increased motivation and confidence were significantly correlated with their children's corresponding ratings of motivation (.52, $p < .0001$) and confidence (.43, $p < .0001$). Thus, parent and student ratings of change showed substantial agreement. Parent ratings of change also correlated significantly with student pre–post difference scores, but the coefficients were lower (motivation: $r = .15$, $p < .05$; confidence: $r = .17$, $p < .01$).

Written descriptions. The 11 categories of change derived from the content analysis are listed in Table 5 with the percentage of students and parents who reported the changes. The pattern for parent descriptions was generally similar to that for student descriptions, although students were more likely than parents to mention gains in science knowledge and decreases in motivation. Most student and parent comments indicated positive change. Far less prevalent were descriptions of negative change and statements of no change. Thus, the positive nature of the student and parent ratings of change was reflected in the student and parent written descriptions.

Predictors of Change

Predictors of change were assessed by a series of hierarchical regression analyses. Variables were assessed for multicollinearity by the variable inflation factor and for influential outliers by the Cook's distance statistic. No problems were detected. Student ethnic identity was not related to change as measured by the repeated or subjective variables and was not included in the analysis.

Repeated measures of science attitudes. Predictors of change from pre- to posttesting were examined through four hierarchical regression analyses, one for each repeated-change variable. The dependent variables were the science attitudes at posttesting. The corresponding measure at

Table 5
Percentage of students and parents writing descriptions of change

Change	Students	Parents
Increased motivation		
For science career	17.6	17.2
For science education	7.6	8.6
Increased confidence		
Academic/science	20.6	12.6
General	12.0	22.4
Social	7.3	8.2
New social niche	12.3	10.8
Increased knowledge		
Of science	36.0	8.2
Of science careers	15.9	6.0
Negative change		
Decreased science motivation	9.6	1.3
Decreased science confidence	3.0	0.4
No change	3.3	4.3

Note. Percentages sum to more than 100% because some students and parents described more than one type of change. Percentages are based on the 302 students and 232 parents who provided written descriptions of change.

pretesting was entered first in the regression model to control for initial differences in attitudes. The other predictor variables were then arranged in sets and entered in the order they had occurred in time: (a) demographic variables (gender, parents' education, and aptitude); (b) history of science support variables (family encouragement, peer encouragement, teacher encouragement, attraction of science teacher model, same- vs. opposite sex science teacher model); and (c) PSES score (confidence in abilities) at pretesting. To control for Type I error, only when a set of variables predicted a significant proportion of the variance were variables within the set tested for significance.

The set of demographic variables did not predict any of the pre–post science attitude measures at posttesting. The set of science support variables contributed significantly to the prediction of posttest science career motivation, $F(5, 259) = 3.51$, $p < .01$, $R^2_{chg} = .03$; science confidence, $F(5, 260) = 2.99$, $p < .05$, $R^2_{chg} = .03$; and future career self, $F(5, 262) = 2.36$, $p < .05$, $R^2_{chg} = .03$. Significant variables are displayed in the top section of Table 6. Teacher and family influences were positively related to changes in science attitudes from pre- to posttesting. Also, the PSES score was significantly related to changes in ratings on the future self measures.

Student subjective ratings of change. The same three sets of predictors used in the analysis of the pre–post measures were used for the analysis of student subjective ratings of positive change at posttesting. These analyses revealed that the set of demographic variables was significantly related to subjective ratings of change in motivation, $F(3, 268) = 4.74$, $p < .01$, $R^2_{chg} = .05$; science knowledge, $F(3, 268) = 2.80$, $p < .05$, $R^2_{chg} = .03$; and new social niche, $F(3, 268) = 13.50$, $p < .0001$, $R^2_{chg} = .13$. Gender was the only significant demographic variable (see lower section of Table 6). Girls reported greater gains than boys in motivation (M's $= 4.72$ vs. 4.30), science knowledge (M's $= 5.76$ vs. 5.56), and new social niche (M's $= 5.59$ vs. 4.80).

Table 6
Predictors of change in science attitudes

Change Variable	Significant Predictors	Beta Weight[a]
Pre to post change		
Science career motivation	Family encouragement	.10*
	Teacher attraction	.13**
Science confidence	Teacher encouragement	.13**
Future career self	Family encouragement	.11*
	PSES	.27****
Future personal self	PSES	.11*
Subjective change at posttesting		
Motivation	Gender	.18**
	Family encouragement	.25****
	Teacher attraction	.21****
	PSES	.12*
Confidence	Teacher encouragement	.16*
	Family encouragement	.20**
	Teacher attraction	.13*
	PSES	.19***
Science knowledge	Gender	.14*
	Family encouragement	.19**
	Teacher attraction	.13*
	PSES	.15*
New social niche	Gender	.35****
	Family encouragement	.21***

Note. N varies across variables from 269 to 273 because of missing values.
[a]All beta weights indicated a positive relation between predictors and change variables.
*$p < .05$.
**$p < .01$.
***$p < .001$.
****$p < .0001$.

It was possible that the gender differences in self-ratings of science gains were due to a gender difference in positive response sets. To explore this possibility, gender differences in ratings at pretesting were examined. Girls and boys did not differ in any of their self-ratings of science attitudes at pretesting. Thus, girls did not show a greater predisposition to respond positively on self-rating scales than boys.

The set of science support variables was significant for each subjective change measure: motivation, $F(5, 263) = 8.38$, $p < .0001$, $R^2_{chg} = .13$; confidence, $F(5, 263) = 6.16$, $p < .0001$, $R^2_{chg} = .10$; science knowledge, $F(5, 263) = 3.84$, $p < .01$, $R^2_{chg} = .07$; and new social niche, $F(5, 263) = 4.26$, $p < .001$, $R^2_{chg} = .07$. As in the pre–post change analyses, family and teacher influences were positively related to subjective measures of change (see lower section of Table 6). In addition, the PSES score was positively related to reports of increases in science motivation, confidence, and knowledge.

Discussion

A major goal of the present study was to apply an expanded methodology for assessing the effectiveness of science enhancement programs for improving science attitudes. Similar to much previous research, no significant positive changes in attitudes were found when attitudes were compared between pre- and posttesting. Hence, a traditional pre–post evaluation would have failed to detect any positive impact of the programs on science attitudes. The use of multiple measures and perspectives allowed for a more comprehensive assessment of program effectiveness, and these measures provided strong evidence that the programs had a positive effect on science attitudes. The program participants themselves reported substantial change in their science attitudes at posttesting, and their evaluations of program impact were even higher at the follow-up. It could be argued that the students' ratings were inflated by the their wish to please the program staff or by a more general positive response set, but there is much corroborating evidence that the program brought about meaningful change. First, parents independently reported high levels of change in their children, and there was a strong correlation between parent and student ratings. Also, written descriptions of change from both parents and students indicated many more positive than negative program-related changes. The validity of the student subjective change ratings was supported also by the finding that they correlated significantly with the pre–post difference scores.

If participants experienced positive change in their science attitudes between pre- and posttesting, why was that change not reflected in higher posttest scores? The results suggest two reasons that the posttest scores may have been depressed. First, pretest scores were fairly high, so there may have been some ceiling effects. Second, it is likely that some participants temporarily shifted their frame of reference for making self-ratings while in the program. They were exposed to a new and gifted peer reference group, and Sax (1994) has reported that under these conditions students may raise their reference point for making self-ratings. Two aspects of the data support this interpretation. First, where ratings dropped between pre- and posttesting, an increase was seen at follow-up. This pattern would be expected if students had shifted their frame of reference because the effects of the program on response sets should tend to wear off after participants are back in their familiar academic environments. Also, the curvilinear pattern from pretesting to follow-up, which suggests a temporary shift in set, was found only for students new to the programs and not for returning Program II students. The latter students should have been less vulnerable to shifts in self-rating sets because they had previous Program I experience. Regarding the follow-up testing note also that participants came to evaluate their program gains on the subjective measures even more highly during the follow-up period than they did at posttesting. Taken together, information gained in the follow-up evaluation lends support to the other evidence of the positive value of the program for enhancing science attitudes.

Comparisons of career goals at pretesting, posttesting, and follow-up showed significant changes during and following the programs. Program II students tended to shift away from the goal of physician, and Program I students shifted away from other science goals. It was evident from students' written descriptions that some had lost interest in the particular field they had thought they wanted to pursue as they developed a better understanding of the realities of their chosen field through the information and activities provided in the program. Tassel-Baska and Kulieke (1987) also reported that some students become disillusioned with their science career goals when they become better informed about them. Despite the shifts away from some science goals, there was no loss of students to nonscience career fields. Thus, it appears that when students are exposed to extensive information about science careers, they may reevaluate their goals and possibly entertain alternative directions in science without losing interest in pursuing a science career.

The career goal of physician is usually associated with a biology premed major, and the career goal of science is associated primarily with the fields of engineering, the physical sciences, and mathematics. It is in these latter fields that recruitment has been a more serious problem in the United States. The results for those in this study indicate a drop in interest in these latter fields after Program I and an increase following Program II. Program II differed from Program I in giving students the time and opportunity to carry out an original research proposal of their own. That Program II students tended to become more, rather than less, interested in nonmedical science careers suggests that the experience of completing a research study can provide an impetus for setting science career goals. Thus, the excitement and satisfaction that may come from an original independent research project may be important in "hooking" students to those science fields in which recruitment has been most difficult.

The second major goal of this study was to evaluate differences in program impact among participants. Several factors were associated with relatively greater program gains. First, returning Program II students reported more positive changes than first-time students in either program. These findings suggest that the experience of the first science enrichment program helped to prepare students to take full advantage of the opportunities offered in the second. It is likely that the returning Program II students fared especially well in their second experience partly because they were members of a self-selected group that had appreciated their first science program enough to choose to continue in the second program. Even so, the findings provide evidence of the value of providing a sequence of science enrichment experiences for continuing to foster a positive science orientation.

Family encouragement was a strong predictor of program impact. Family encouragement predicted pre–post gains in science career motivation and expectations for a successful science career and was related to all self-ratings of change. These results fit with previous findings that highlight the strong influence of the family on student attitudes toward science (Talton & Simpson, 1986; Kelly, 1988; Baker & Leary, 1995). Our results suggest that students who went home to interested, supportive families were able to benefit more from the programs. Interestingly, the social status of the family, as measured by the parents' education, was not related to change. Similarly, the meta-analysis by Fleming and Malone (1983) indicated no relation between social status and science attitudes. Thus, it was not the general advantages associated with well-educated parents but positive family attitudes about the value of science and science careers that seems to have helped students to maximize what they took from their program experience.

The influence of science teachers was also associated with greater program benefits, just as teachers have been found to have a strong influence on science involvement generally (Kelly, 1988; Baker & Leary, 1995). Those who felt more encouraged and supported by previous science teachers gained more in science confidence during the program period, as measured by both the pre–post and subjective-change measures. A history of positive support from science teachers seems to have readied students to take in the additional program supports offered in the programs to further advance their beliefs in their ability to succeed in science. In addition, students who had a science teacher model whom they wanted to emulate had greater pre–post gains in science career motivation and reported greater gains in motivation, confidence, and knowledge. Having had the opportunity to work with a teacher who presented a positive image of a science professional appears to have prepared students to be more open to enrichment experiences designed to guide them toward involvement in science.

Performance self-esteem was associated with pre–post gains and self-ratings of change. Thus, students who came into the program with strong general beliefs in their abilities appeared to profit more. The strongest association between PSES scores and change was for the future career self. Those with a strong sense of their capabilities prior to the programs showed greater increases in their expectations for a successful science career. It seems to have been easier for students to expand the horizons of their possible selves while in the program if they were more confident in their abilities at the outset of the program. In contrast, academic aptitude was not related to any change variable. The small range of aptitude scores in this sample reduced the possibility of detecting any aptitude effects, but previous studies had similar results, finding little or no correlation between academic aptitude and science interest (Fleming & Malone, 1983; Steinkamp & Maehr, 1983). Thus, although high aptitude is required for a successful science career, high aptitude does not guarantee interest in science or a capacity to gain from a science enrichment program. Instead, belief in one's ability to perform challenging tasks effectively was a more important predictor of the value of science enrichment for the student.

These findings provide strong support for the preparedness model of program impact. Clearly, students who entered the program with more science advantages — a previous science enrichment experience, strong support from family and teachers, a positive teacher model, and confidence in their abilities — appeared to profit more from the science programs. Our results provide evidence of the value of a history of positive science-related experiences for continued growth in commitment and confidence to achieve in the challenging world of science.

One set of findings did not support the preparedness model. Girls, who generally have less science advantages than boys, reported more program gains. The gender difference in reported change appears to be valid even though girls did not have greater pre–post differences than boys. It is unlikely that the higher ratings of girls are attributable to a more positive response set because girls did not show a predisposition to make higher ratings at pretesting. Also, as discussed earlier, there is substantial support for the validity of the subjective change measures. We can conclude, therefore, that the programs did have a particularly positive impact on the girls who participated.

That the programs were especially meaningful for girls is understandable in light of the gender-related problems in science described earlier. Whereas science is stereotyped as a male domain (Bartholomew & Schnorr, 1994), and boys often dominate in science classes (Guzzetti & Williams, 1996), the enrichment programs were structured to avoid this male- dominated atmosphere. Girls had as much opportunity as boys for hands-on learning and close mentoring from advisers, and all students attended talks by female scientists who described science career alternatives from their own personal experience. Furthermore, a substantial proportion of participants in each program were girls. Social activities were held throughout the program, and girls had ample opportunity to develop relationships with other girls and boys who were interested in science. Although all students felt that the programs had provided an opportunity to develop new social ties with other students similar to themselves, girls endorsed this benefit more strongly than boys. Given that girls are less likely to have a network of friends interested in science (Kelly, 1988), it follows that they would be especially likely to use the enrichment program to develop a science social niche.

Even though a substantial proportion of students in each program were girls, more girls participated in Program I than in Program II. As discussed earlier, Program II took place over a longer time period and required the completion of a research study. The girls appeared to be somewhat less willing to make this greater commitment to their science training. The difference in girls' participation from Program I to Program II is consistent with the drop in girls' science involvement reported by other researchers (Catsambis, 1995; Burkam, Lee, & Smerdon, 1997; Steele, 1997). Clearly, to retain girls in the science track, particular efforts must be made as they progress to higher educational levels.

The results of this study have implications for science enrichment programs and their evaluation. First, evaluation of program impact should not be limited to pre–post difference scores because this approach may not be adequate for detecting program-related change. The use of extended time periods for measuring program impact and multimethod, multiperspective assessment approaches will allow for a more comprehensive picture of program effectiveness. Second, because family and teacher support was found to enhance benefits derived from the programs, program effectiveness may be improved by actively enlisting the support of parents and teachers for students' involvement in science programs. In particular, parents could be helped to recognize the key role they play in affecting their children's attitudes toward science and the importance of their support while their children are attending science programs. The results of comparisons between new and returning students also suggest that when students enroll in a second enrichment program, benefits may be even more positive than for initial enrichment experiences. Thus, sequences of enrichment programs appear to be especially effective in promoting and sustaining positive science attitudes. Finally, the results suggest that science enrichment programs can be of particular benefit to high school girls interested in science. These students tend to feel isolated with their science interests in their home high schools, and programs that bring them together can help them to develop a network of friends to provide continuing support for their science interests.

Some limitations of the present research should be noted. First, the programs were general and broad in scope, including some attention to a range of topics in the physical sciences, life sciences, mathematics, engineering, and medicine. The evaluation measures were necessarily general as well, with the term *science* used in the questionnaires to refer to all of these areas. Future programming and evaluation research should be directed at developing and assessing programs specific to particular fields, such as engineering, in which recruitment has been particularly problematic. In addition, although minority students appeared to fare well in Programs I and II, showing no differences on any change variables, recruitment of non-Asian minority students into the programs has been difficult, and some minority groups have been underrepresented in the programs. More efforts are needed to determine how best to attract minority students to science enrichment programs, where they may develop the knowledge and commitment to science that can help to sustain them in the science track.

Appendix: Questionnaire Measures Constructed for the Present Study

Family Encouragement

1. My family is interested in the science courses I take.
2. My family has encouraged me to study science.
3. People in my family are interested in science.
4. My family is enthusiastic about a science career for me.

Motivation for a Science Career

1. I would enjoy a career in science.
2. I have good feelings about a career in science.
3. Having a science career would be interesting.
4. I would like to have a career in science.

Future Career Self

1. You will make it into a good college and major in the area needed for this career.
2. You will graduate with a college degree in the major needed for this career.
3. You will get into graduate or medical school and continue your education toward this career.
4. You will graduate from your graduate or medical school program.
5. You will get a job in the field.
6. You will stay in the field and do acceptable work in your job.
7. You will have a strong professional career and make substantial contributions.
8. You will become tops in your field — one of the best in the country.

Future Personal Self

1. When you introduce yourself to people, they will admire you for being a scientist.
2. You will have enough time to enjoy personal relationships with people you care about.
3. The people close to you will never fully accept that you have a demanding career.
4. Your career will interfere with keeping up important personal relationships.
5. You will be able to balance your roles at home and work — keeping up with your career and a full personal life, including a family if you want one.
6. The people close to you will support you in your work.
7. It will be difficult to keep up with your career and still have time for a full and enjoyable personal life, including having a family if you want one.
8. When introduced to others, some people will think it's a little odd or strange that you are a scientist.

Student Subjective Science Attitude Change Measures

Increased science motivation. My experiences in the program:

1. Made science seem more interesting to me.
2. Stimulated my enthusiasm for science.
3. Increased my interest in a science career.
4. Made science seem more fun.
5. Clarified for me what I want to do in a science career.
6. Made me feel more sure that I want a career in science.

Increased science confidence. My experiences in the program:

1. Made me feel more relaxed about learning science.
2. Increased my confidence in my ability to do science.
3. Increased my confidence that I can succeed in science as a career.
4. Made me feel more self-assured as a student of science.
5. Made the idea of a science career for me seem more possible.
6. Increased my confidence that I could handle science courses at the college level.

Increased science knowledge. My experiences in the program:

1. Enhanced my knowledge of science.
2. Allowed me to learn science techniques I didn't know before.
3. Gave me "hands-on" experience that will help me in the future with science projects and activities.

4. Gave me a better understanding of what science is all about.
5. Gave me a better grasp of how to write a research paper.
6. Helped me learn problem-solving skills needed in science.

New social niche. My experiences in the program:

1. Helped me see that many other students like science, just as I do.
2. Made me realize that some other people my age really respect and appreciate other students who are good at science.
3. Gave me an opportunity to meet students from other schools who were more enjoyable to be with than many of the students at my high school.
4. Gave me an opportunity to make friends with people who are a lot like me.
5. Made me realize it is okay to be smart and like science, even if some students in my high school don't think so.

Parent Perspectives on Student Change

Increased science motivation. The science program experience:

1. Made science seem more interesting to him/her.
2. Stimulated her/his enthusiasm for science.
3. Increased his/her interest in a science career.
4. Made science seem more fun to her/him.
5. Clarified for her/him what s/he wanted to do in a science career.
6. Made him/her more sure that s/he wants a career in science.

Increased science confidence. The science program experience:

1. Made her/him feel more relaxed about learning science.
2. Increased his/her confidence in his/her ability to do science.
3. Increased her/his confidence that s/he can succeed in science as a career.
4. Made him/her feel more self-assured as a student of science.
5. Made the idea of a science career for her/him seem more possible.
6. Gave his/her confidence that s/he could handle science courses at the college level.

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