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Evaluating the Impact of Science-Enrichment Programs on Adolescents' Science Motivation and Confidence: The Splashdown Effect

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Abstract: The impact of summer science-enrichment programs on high-school students' science motivation and confidence was evaluated in a 7-month period following program completion. The programs took place on a college campus. The splashdown effect was defined as program-related changes the program graduates recognized in themselves that became apparent to them after reentry to their home high school. The effect was studied in a group of 88 gifted girls and boys from 38 high schools. On qualitative and quantitative measures obtained during private interviews, students reported a strong splashdown effect after returning to their high school. Results supported the validity of the splashdown concept. Splashdown motivation and splashdown confidence (i.e., recognition of program-related gains in motivation and confidence that occurred after high-school reentry) predicted change in corresponding science attitudes during the follow-up period. As predicted by social comparison theory, the intensity of the splashdown effect was associated with average school achievement in the student's home high school. Students from academically weaker schools reported stronger splashdown effects. Implications for enhancing and evaluating the effect of science-enrichment programs on students' science attitudes are discussed.

Significant concerns have been raised over the previous 4 decades about lack of science interest and poor science achievement among students in the United States (Collins, 1997; Gallagher, 1993; George & Kaplan, 1998). Students in the United States have performed poorly relative to students in many developed countries, particularly those along the Pacific Rim, and this science-achievement gap becomes wider at higher grade levels (Gallagher, 1993; Linn, Lewis, Tsuchida, & Songer, 2000). For example, Linn et al. (2000) reported that the science performance of fourth-grade U.S. students is equivalent to that of corresponding Japanese students, but is lower by almost a full U.S. grade level by seventh grade. Along with a decrease in achievement, students in the United States tend to lose interest in science as they progress from middle school through

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high school (Bazler, Spokane, Ballard, & Fugate, 1993; Jovanovic & King, 1998; Simpson & Oliver, 1990). Girls are particularly likely to express decreasing interest in science as they move from lower to higher educational levels (Catsambis, 1995; Farenga & Joyce, 1999; Kahle & Meece, 1994; Manis, Thomas, Sloat, & Davis, 1989). A recent survey indicated that women now represent 40% of the U.S. workforce, but only 23% of the science and engineering labor force (Phillips, Barrow, & Chandrasekhar, 2002).

It is critical that we come to understand better how science attitudes are developed and maintained over time because science-related interest and confidence are highly predictive of students' persistence in science (Fouad & Smith, 1996; Lent, Brown, & Larkin, 1986) and science achievement (Lent et al., 1986; Mattern & Schau, 2002; Steinkamp & Maehr, 1983). In fact, Houtz (1995) found that science achievement was linked more closely to science attitudes than to aptitude among junior-high-school students, and Marsh and Yeung (1997) reported more generally that domain-specific measures of academic self-confidence predict choice of coursework better than domain-specific performance. Thus, for students to persist and succeed in science, science aptitude and the acquisition of science knowledge are not enough. Instead, students must sustain high motivation and confidence in their abilities to achieve in science.

In response to declining science interest and achievement among U.S. students, many innovative programs have been developed across the country to provide science-enrichment experiences to promising science students. Consistent with national standards for science education (National Research Council, 1996), these programs have emphasized inquiry-based, participatory learning and "hands-on" laboratory activities. Evaluations of such programs have been focused primarily on changes in science knowledge and achievement. Pyryt, Masharov, and Feng (1993) reviewed meta-analyses representing hundreds of evaluations of science-enrichment programs and concluded that overall, they are successful in raising science achievement substantially. More recent studies continue to demonstrate significant positive results for a wide range of science-enrichment programs when success is measured by science achievement (Freedman, 1997; Harwood & McMahon, 1997; Romance & Vitale, 2001). Inquiry-based, participatory educational strategies appear to be effective for gifted as well as mainstream students (Gallagher, 1993; Harwood & McMahon, 1997; Pyryt et al., 1993).

Despite these positive findings for gains in science knowledge, the value of science-enrichment programs for improving science motivation and confidence is far less clear. Some researchers have reported no difference in science attitudes following enrichment programs even when changes in science achievement were observed (Dechsri, Jones, & Heikkinen, 1997; Freedman, 1997; Houtz, 1995), and a number of programs have resulted in mixed or equivocal findings for attitude measures (Bazler et al., 1993; Harwood & McMahon, 1997; Tassel-Baska & Kulieke, 1987). Moreover, Tassel-Baska and Kulieke (1987) reported large individual differences in program responsiveness among participants. When students were given the opportunity to experience science firsthand, some increased their fascination for the scientific process whereas others were disappointed, finding it less creative and rewarding than they had expected (Tassel-Baska & Kulieke, 1987).

The difference in measured program results for science knowledge versus science attitudes may be explained by inherent differences between the processes of knowledge acquisition and attitudinal change. Any knowledge gained in a science program should be remembered best at the end of the program and should be evident at that time. In contrast, the impact of a science-enrichment program on science attitudes may not be fully or accurately recognized by participants at the close of the program, particularly when the program has taken place away from the student's familiar academic environment, as is the case in many summer enrichment programs. Measures of science attitudes, such as self-ratings of science motivation and confidence, represent aspects of the self-concept, and the self-concept is formed and changed in large part by comparing oneself to others in the immediate social environment (Marsh & Hau, 2003; Sax, 1994). That is, the science abilities and interests of nearby others provide a basis for students to evaluate their own science ability and interest and therefore affect students' self-ratings of science confidence and motivation. At the close of a science-enrichment program, students will compare themselves, at least in part, to fellow program participants. This means that in programs for gifted and motivated science students that are separate from students' home high-school settings, the point of reference for making self-judgments will tend to be higher than in the students' high school. For example, in the case of confidence, contact with highly capable science students should result in a higher reference point for students' evaluations of their own science ability and may therefore dampen their confidence in science.

This negative effect of academically challenging environments has been referred to by Sax (1994) as an example of relative deprivation theory and by Marsh and Hau (2003) as the big-fish-little-pond effect. Extensive evidence of this effect has been reported. Pascarella and Terenzini (1991) found that the transition from high school (a smaller pond) to college (a larger pond) resulted in a temporary decrease in the academic self-concept, and Sax (1994) reported that attendance at more selective schools (larger ponds) negatively affected students' self-concept. Similarly, in a very large cross-cultural study, Marsh and Hau (2003) found a consistent negative relation between average student achievement in a school and academic self-concept across 26 countries.

Given that students' self-evaluations are affected by other students available for comparison, one would expect that any effect of fellow science-program participants on the student's frame of reference for making self-judgments would lessen after students have completed the program and returned to their familiar academic setting. They should then be better able to recognize and incorporate program-related gains into their self-concept. In other words, participants may more accurately and fully evaluate how they have changed as a result of their program when they have had the opportunity to experience themselves as science students back in their normal high-school setting. We will refer to this delayed recognition of program impact on science attitudes after reentry to the home high school as the *splashdown effect*.

To evaluate this effect, follow-up evaluations of students who have completed enrichment programs separate from their regular high-school learning environment are needed. Of the few evaluations of the long-term impact of separate science programs on student science attitudes, most have not found positive differences in attitudes between posttesting and follow-up (e.g., Gibson, 1998; Phillips et al., 2002); however, some positive effects on later course taking have been observed (Redmond, 2000), and Stake and Mares (2001) reported that groups of students new to a summer science program for gifted students reported higher science confidence and motivation at a 6-month follow-up than at posttesting. These latter findings are consistent with the expectation that some program-related changes in science attitudes may become evident to program graduates in the period following the completion of science-enrichment programs. Further, analyses of change at the level of the individual participant have revealed large decreases as well as increases in science attitudes among some program participants in the months following enrichment programs (Phillips et al., 2002; Stake & Mares, 2001). These findings suggest that some, but not all, program participants may experience a splashdown effect after returning to their home high school.

Given that some students experience enhanced confidence and motivation for science after their program ends that is attributable to their science-enrichment program, it is important that this effect be investigated and documented so that the full impact and value of these programs can be understood by educators and policy makers. The first goal of the present study was to assess the extent to which students recognize positive effects of a science-enrichment experience in the months following their program. To test the splashdown effect, the programs studied were selective and separate from participants' high schools, and splashdown measures were taken after students had had ample time to be back, as program graduates, in their usual high school setting. In addition, two tests of the validity of the splashdown effect were undertaken. First, we tested the relation between measures of the splashdown effect and change in science attitudes during the postprogram period. If students on returning to their high school come to recognize that their enrichment program increased their competence and interest in science, they should report higher science confidence and motivation at follow-up than at the close of the program. At the same time, we know that development and maintenance of science attitudes may be strongly influenced by encouragement from important social agents including family, teachers, and peers (e.g., Simpson & Oliver, 1990; Stake & Mares, 2001). Thus, it was expected that changes in science attitudes in the follow-up period would be affected by encouragement for science provided by these social agents during this time. The influence of social encouragement was therefore controlled when testing the extent to which measures of the splashdown effect predicted changes in attitudes.

As a second means of testing the validity of the splashdown concept, the relation between student achievement in the participant's high school (school achievement level) and the splashdown effect was assessed. On the basis of the social comparison and self-concept theory and research discussed earlier, students who returned to schools with less academically capable students (smaller ponds) were expected to experience a stronger splashdown effect than those from schools of higher academic achievement (larger ponds). The former schools would provide opportunities for more favorable social comparisons than would the latter schools. It also was expected that students who had a stronger tendency to regard themselves positively as science students before they began their science program would more readily recognize, once back in their high schools, positive changes in themselves as science students gained from their program. Therefore, the relation between school achievement level and the splashdown effect was tested after controlling for participant self-ratings prior to the program.

In summary, the aims of the present study were to (a) investigate the extent to which students report the splashdown effect following completion of science-enrichment programs for academically able and motivated students, and (b) test the validity of the splashdown concept. Relations between splashdown measures and change in student attitudes during a follow-up period and between school achievement level and splashdown measures were assessed. It was expected that program participants who reported stronger splashdown effects would show greater postprogram changes in attitudes during a follow-up period independently of science encouragement from significant others. In addition, students from academically weaker schools were expected to report a stronger splashdown effect independently of their tendency to evaluate themselves positively as science students.

Method

Participants

All participants completed a summer science-enrichment program for academically able students during the summer of 1999, 2000, or 2001. Students were drawn from 38 high schools in a large Midwestern metropolitan area. For information on the level of achievement in the schools, see the description of the school achievement measure. Students applied for the program and were selected on the basis of academic performance, teacher recommendations, and test scores. The total sample at pretesting comprised 41 boys and 47 girls. The sample included 49 European Americans, 21 Asians, 11 African Americans, 2 American Indians, 2 Hispanics, and 3 students of other ethnic identities. All but 2 of this beginning group completed the program and the posttest measures. Of students who completed the posttesting, 90.7% participated in a splashdown interview, 82.6% in later follow-up testing, and 75.6% in both the splashdown and follow-up testing. The proportion of girls and boys was highly similar between the pretest sample (53.4 vs. 46.6%) and the sample that participated in all parts of the study (52.3 vs. 47.7%). Further, the mean scores on the pretest measures for the sample who completed all parts of the study were close to the mean scores for the entire pretest sample. Averaged across the four measures, this difference was .08 of 1 *SD* of the pretest measures. Thus, the students who completed all parts of the study were highly similar to the pretest sample.

Program Description

The science programs were 6 weeks in length and were offered on a college campus during the summers of 1999 to 2001. The programs comprised a broad and intensive science-enrichment experience developed in accordance with the National Science Education Standards (National Research Council, 1996). Students actively designed and carried out original research studies in an inquiry-based learning environment. Students received guidance in library research, laboratory procedures, technical writing, and research presentation. They worked closely with science mentors who were members of the faculty at local research universities. The experience culminated in a research presentation to the program staff, participants, and invited guests.

Measures

Most measures comprised multiple items. For items that were worded negatively, participants' ratings were reversed so that higher values indicated more positive ratings for all items. Responses to individual items were averaged to derive participants' scores on each measure. Students responded to the items on scales that ranged from 1 to 7. Thus, the possible range of scores on each of the measures was 1 to 7.

Motivation. Motivation for a science career was assessed with a four-item scale developed by Stake and Mares (2001). This scale has correlated significantly with other science-related variables, including science ability and encouragement from others to pursue science (Stake, 2004; Stake & Mares, 2001). A sample item is: "I would like to have a career in science." Participants responded to each question on a rating scale with anchors ranging from *not at all true* to *very true*. The internal consistency of the measure (coefficient alpha) has ranged from .88 to .93 in previous research (Stake, 2004; Stake & Mares, 2001). In the present study, the alpha was between .93 and .95 at pretesting, posttesting, and follow-up.

Confidence. Three indices of confidence were included.

1. The eight-item Science Self-Concept Scale (Campbell, 1991) measured students' confidence in their science abilities. This scale was developed with a large sample of gifted students and cross validated in a broad national sample of high-school students. 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"). Participants were asked to rate the extent to which they agreed with each statement on a scale with anchors ranging from *disagree strongly* to *agree strongly*. The internal consistency of the scale has been acceptable in previous administrations (.76–.80, Stake & Mares, 2001) as well as the present study (.76–.83 at pretesting, posttesting, and follow-up).

2. The second measure of science confidence, *the possible self in science*, was developed by Stake and Mares (2001) based on self-schema theory (Cross & Markus, 1994; Markus & Nurius, 1986). Markus and colleagues (Cross & Markus, 1994; Markus & Nurius, 1986) defined the possible self as an aspect of the self-schema that represents the individual's vision of what the self has the potential to become. The possible self may include both hoped for and feared imagined outcomes and therefore serves as a motivator and organizer of the individual's task-relevant thoughts and behaviors, linking current specific plans and actions to future desired goals. Measures of the possible self have been linked to performance on schema-relevant tests (Cross & Markus, 1994), and self-images associated with future career goals have affected student academic choices (Eccles, 1994; Lips, 1995). The possible self measured in the present study was the possible self in science—the imagined self as a developing scientist should the student choose to pursue science as a career. This scale has related in previous studies to a more general measure of confidence, teacher ratings of ability, and science encouragement from family and teachers (Stake, 2004; Stake & Mares, 2001). Instructions to participants 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 below, mark how confident you are that each would actually happen to you.

Listed below these instructions were eight items that described steps in a science career. The list began with the item ''You will make it into a good college and major in the area needed for this career'' and ended with the item ''You will become tops in your field—one of the best in the country.'' Items were rated on a scale with anchors ranging from *not at all confident* to *very confident*. In previous studies, the alpha was between .89 and .92 (Stake, 2004; Stake & Mares, 2001). In the present study, alpha ranged from .84 to .88 in the three administrations.

3. As a more general measure of students' confidence in their abilities, the 15-item short form of the Performance Self-Esteem Scale (PSES) was included at pretesting, posttesting, and follow-up (Stake, 1979; Stake & Noonan, 1985). PSES scores have related to a variety of achievement variables, including self-ratings of competence and performance following daily achievement events (Stake, 1985); and career salience, educational aspirations, and women's nontraditional career choices (Hackett, Esposito, & O'Halloran, 1989). The short form of the PSES correlates highly with the original long form ($r = .95$; Stake & Noonan, 1985). The short form of the PSES comprises nine positive self-descriptors (e.g., ''enjoys a challenge,'' ''headed for success'') and six negative descriptors (e.g., ''indecisive,'' ''lacks confidence''). The anchors on the rating scale range from *never or almost never true of me* to *always or almost always true of me*. Alpha for the scale has been acceptable in previous research and was between .82 and .84 in the present study.

Social Encouragement. Three measures of social encouragement in the follow-up period were included:

1. Family encouragement was measured by a four-item scale developed by Stake and Mares (2001). The items pertained to student perceptions of encouragement from family members for science pursuits. The scale has predicted science attitudes and openness to

the influence of science-enrichment programs (Stake, 2004; Stake & Mares, 2001). A sample item is: ‘‘My family has encouraged me to study science.’’ Students responded to this and the other encouragement measures on a scale with anchors that ranged from *not at all true* to *very true*. Alpha was .85 in previous studies (Stake, 2004; Stake & Mares, 2001) and .81 in the present sample.

2. A measure of peer encouragement was adapted from the four-item Friends’ Attitudes Toward Science Scale (Talton & Simpson, 1985) by Stake and Mares (2001). Based on factor analysis, Simpson and Troost (1982) found the scale to be distinct from 14 other school, home, and self variables relevant to science attitudes in a large sample of junior-high-school students. This scale related to students’ attitudes toward science in a large adolescent sample (Talton & Simpson, 1985). The revised scale has related to science confidence and motivation (Stake, 2004). A sample item is: ‘‘I have felt supported by friends for my interests in science.’’ Alpha for the revised scale was .70 in the Stake and Mares (2001) sample and .65 in the present study.
3. Teacher encouragement was measured with a five-item scale adapted from the Science Teacher subscale (Simpson & Troost, 1982) by Stake and Mares (2001). This scale measured student perceptions of encouragement received from science teachers. The original 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 revised scale also has related to positive science attitudes (Stake, 2004). A sample item is: ‘‘My science teachers have encouraged me to learn more about science.’’ The adapted scale has yielded adequate alpha values (Stake, 2004: .80; Stake & Mares, 2001: .79; present sample: .87).

Splashdown Variables. Program effects recognized by students after returning to their high schools were assessed with qualitative and quantitative measures. To obtain qualitative information on the splashdown effect, students were asked to participate in a structured interview approximately 3 months after returning to their high school (see Procedure section for additional details). Interviewers were trained to perform a standardized interview and audiotaped all interviews. At the beginning of the interview, students’ thoughts and feelings about their program were primed by means of introductory questions about their science activities in the program. Students were then asked:

> Now that you are back in your school, we are interested to learn how it has been for you, now that you have successfully completed the science program. Does your school seem any different now, having been in the program and having been on a university campus? Do you see yourself differently at school, having been in the program?

The interviewers were trained to provide encouragement to students to elaborate on their responses as needed so that all students gave their current perspectives on themselves as program graduates and science students in their high schools. Following the structured interview, participants completed two quantitative measures developed for this study to assess students’ awareness of program impact on their science confidence and motivation after returning to their high school. The measures were rationally derived based on the splashdown construct. The six-item confidence measure and four-item motivation measure allowed students to rate the impact of their summer program as experienced within the context of their high school. Examples of confidence items are: ‘‘Once back in high school this fall, I realized how much I had learned last summer in the program,’’ and ‘‘My experiences in the program made what we do in high school seem simpler than it use to because of the comparison to what we did in the program.’’ Examples of motivation items are: ‘‘My experiences in the program made me realize how much more motivated

I am in science compared to many students in my high school,'' and ''Once back in high school this fall, I could see that I am especially focused on science—more than a lot of students in my high school.'' Students responded to the items on a scale with anchors ranging from *disagree strongly* to *agree strongly*. Alpha was .75 for the confidence items and .74 for the motivation items in the present sample.

School Achievement Level. School achievement level was defined by the American College Test (ACT) performance (ACT, Inc., 2004) of students in the participant's school in the year the student participated in the program. This information was obtained for public schools from published records of school performance and for private schools from school officials. Schools were categorized as low in achievement if less than 35% of students were at or above the national average in ACT performance, average in achievement if between 35 and 70% of students were at or above the national average, and high in achievement if more than 70% of students were at or above the national average. In the participant sample, 21.0% of students were from low-achievement schools, 44.4% from average-achievement schools, and 34.6% from high-achievement schools.

Procedure

On the morning of the first day of the program, the following attitude measures were administered to the students in a group setting: science motivation, science confidence, the possible self in science, and PSES. Students were told that the purpose of the study was to understand how science programs can best meet the needs of gifted students. The confidentiality of all responses was emphasized to the students. They were informed that their individual responses at each point in the testing would not be reported to their teacher, parents, program staff, or others and were strongly encouraged to give honest, open responses to all questions. At the end of the program, students again completed the four attitude measures in a group setting, and students' confidentiality was again emphasized to the participants.

Approximately 4 months following the program and 3 months after students had returned to their high school, they were contacted by telephone by one of five research assistants who served as interviewers for the project. The assistants requested a 20- to 30-min interview to discuss students' experiences in the science program. All students who could be contacted and whose schedules allowed agreed to the interview. The interview took place in a private setting at the student's high school. Interviewers first conducted the structured splashdown interviews and then administered the quantitative splashdown measures.

Students received a follow-up questionnaire at their home mailing address approximately 7 months after the end of the program and 3 months after the splashdown interview. This questionnaire included the four attitude measures and three social-encouragement measures. Students received up to three reminders to return the follow-up questionnaire if necessary. At each testing period, other measures were included that are not a part of the present study.

Coding of Structured Splashdown Interviews

Interviewers transcribed students' responses in the structured splashdown interview from the audiotaped recordings. A content analysis of student responses was undertaken using the procedure outlined by Weber (1990). Coding units were identified, and coding categories were defined from the content of the coding units based on the specific guiding construct, *change in self* *attributed to science program recognized in high-school setting*. The set of identified categories was tested by two independent coders using a small sample of coding units. This test led to revisions and clarifications of the category meanings and distinctions between categories. The final set of categories comprised seven types of change: (a) confidence to achieve in science, (b) confidence to interact with others, (c) general confidence, (d) science motivation, (e) science knowledge, (f) feeling smarter/better prepared relative to others in high school, and (g) feeling esteemed as a scholar at school. No negative or neutral responses pertaining to this construct of change were found. After the final coding categories were identified, two independent raters assigned a coding category to each coding unit. Interjudge agreement was 88.7%. Where coders differed, the final coding was decided by discussion with a third coder familiar with the coding system.

Results

Preliminary Analyses

All distributions were tested for normality. The distributions of science-motivation scores at each time period and of peer-encouragement scores were negatively skewed. They were therefore reversed and logarithmically transformed to normalize those distributions. The transformed scores were used in all analyses. For clarity of presentation, the direction of results and means reported are those prior to the transformations.

The encouragement variables were moderately correlated with one another (M intercorrelations $= +.36$). Thus, students reporting encouragement from one source tended to report encouragement from other sources as well, but students did distinguish in their ratings among the three sources of encouragement. It was therefore appropriate to treat the encouragement measures as separate variables in the analysis. The measures of confidence also were moderately related, but sufficiently distinct to require separate analyses for each measure (M intercorrelations $= +.42$ at pretesting, $+.45$ at posttesting, and $+.44$ at follow-up).

Attitude Change

Change scores during the follow-up period for each attitude measure were computed by subtracting posttest scores from corresponding follow-up scores. Although mean change scores were very small, change scores of individual participants varied substantially across the sample, with some participants showing large positive or large negative changes during the follow-up period (see Table 1).

Changes in the confidence variables over time were tested in a 3 (time: pretesting, posttesting, follow-up) $\times$ 2 (gender) multivariate analysis of variance (MANOVA) in which the three

Table 1
Attitude change scores in 7-month follow-up period

	Mean Change Score	*SD*	Range
Science confidence	+.02	.68	−1.75 to +1.75
Possible self in science	+.06	.69	−1.88 to +1.75
PSES	+.07	.56	−1.07 to +2.20
Science motivation	.00	.72	−2.00 to +1.75

Note. Possible range of scores: 1 to 7. PSES = Performance Self-Esteem Scale.

Table 2
Mean attitudes at pretesting, posttesting, and follow-up

	Pretest	Posttest	Follow-Up
Science confidence	5.54	5.59	5.61
	(.83)	(.82)	(.75)
Possible self in science	5.85	5.96	6.03
	(.75)	(.84)	(.74)
PSES	5.24	5.24	5.30
	(.66)	(.75)	(.77)
Science motivation	6.34	6.31	6.31
	(.81)	(.78)	(.91)

Note. Possible range of scores: 1 to 7. *SDs* appear in parentheses. PSES = Performance Self-Esteem Scale.

confidence measures (science confidence, possible self in science, and PSES) were the dependent variables. Neither gender nor the Time × Gender interaction was significant. The main linear effect of time was significant, $F(1, 69) = 4.58, p < .05, \eta^2 = .06$. The means at each time period for each dependent variable are given in Table 2. Small amounts of change were seen from pretesting to posttesting and from posttesting to follow-up. A post hoc comparison for change between pretesting and posttesting was not significant. Thus, significant change was found only when the follow-up period was included in the assessment of change. Univariate analyses of the individual confidence variables revealed a significant linear effect of time for the possible self in science variable, $F(1, 68) = 4.39, p < .05, \eta^2 = .06$. Students were more confident that they could achieve a successful career in science at follow-up than at pretesting. The univariate analysis of PSES and science confidence did not yield a significant time effect, although the means for these variables were higher at follow-up than at pretesting. A 3 (time) × 2 (gender) analysis of variance for the science-motivation variable yielded no significant main nor interaction effects.

Extent of the Splashdown Effect

Qualitative Measures. The percentage of students who gave responses in each coding category and examples of student responses in each category are listed next. The percentages sum to greater than 100% because the interview responses of many participants contained more than one codable splashdown unit.

1. Confidence to achieve in science (61.5%): "I feel more comfortable in science class, just knowing that I spent six weeks (in the program)," and "I feel better about my science classes because I am more confident."
2. Confidence to interact with others (7.7%): "(Before the program) I was more like a shy person. I would never talk in class, nothing, and then I went through this summer and I am like a whole new person. . .. It turned me around."
3. General confidence (44.9%): I feel now that I can do anything if I put my mind to it. "I can go to college and do whatever I want," and "I realize I am more prepared for college than I probably thought I was."
4. Science motivation (48.7%): "I am more involved in science activities. Last year I couldn't get involved but this year I am more involved," and "When I first came back I did notice I am more inquisitive, especially in the sciences."

5. Knowledge of science (69.2%): "I think I know a lot more about science in general and have a better idea what it's about," and "I am able to understand my science classes better because of the program experience."
6. Feeling smarter/better prepared relative to others in high school (38.5%): "Upon returning. . .. I feel kind of better than everyone else," and "I feel more confident because I know that most of the kids around here haven't had the chance to do everything I have."
7. Feeling esteemed as a scholar at school (7.7%): "Teachers when they found out I've done it, they want me to do certain things—like my teacher wants me to do the science fair. They look upon me better now," and "I've been congratulated by a lot of different teachers and my principal announced it over the intercom. I really liked that."

Quantitative Measures. The mean scores on the splashdown measures were 5.58 ($SD = .76$) for confidence and 5.62 ($SD = .93$) for motivation. These values were between the anchors 5 (*agree slightly*) and 6 (*agree*). The range of splashdown confidence scores was 3.83 (just below the anchor *neither agree nor disagree*) to 6.83 (just below the anchor *agree strongly*). The range of motivation splashdown scores was 3 (*disagree slightly*) to 7 (*agree strongly*).

Thus, students as a group tended to agree that, being back in their home high schools, they recognized that they were more confident and motivated for science as a result of the program; however, the range of scores indicates substantial differences across participants in their endorsement of the splashdown effect.

Testing the Validity of the Splashdown Concept

As one test of the validity of the splashdown concept, relations between the splashdown measures and change in corresponding attitudes in the follow-up period were assessed. Because social encouragement has been found to influence the development and maintenance of science attitudes, the measures of social encouragement in the follow-up period were entered in these analyses prior to the splashdown measures. The four attitude measures at follow-up served as the dependent variables in separate hierarchical regression analyses. Variables were entered in the analyses in the following order: (a) attitude measure at posttesting, (b) the set of social-encouragement variables, and (c) the splashdown measure corresponding to the attitude being tested. The splashdown confidence variable was used in the analyses of the three confidence measures, and the splashdown motivation variable was used in the analysis of science motivation. Because attitude scores at posttesting were entered first, the findings for the other independent variables (encouragement and splashdown) represent the relation between them and the residual (change) in attitudes from posttesting to follow-up.

Results of the regression analyses are provided in Table 3. As a set, the social-encouragement variables added a significant amount of predicted variance in the analyses of science confidence, $F_{chg}(3, 59) = 2.84$, $p < .05$, adjusted $R^2_{chg} = .05$, and the possible self, $F_{chg}(3, 59) = 3.74$, $p < .05$, adjusted $R^2_{chg} = .07$. Students who reported more social encouragement for science during the follow-up period were more likely to show positive change on these measures from posttesting to follow-up; however, no single source of encouragement was significant when tested individually. Relations between encouragement and change in PSES and science motivation were positive, but not significant.

The splashdown confidence measure added a significant amount of additional, predicted variance in the analysis of possible self scores, $F_{chg}(1, 58) = 10.65$, $p < .01$, adjusted $R^2_{chg} = .08$, $\beta = +.31$, and PSES scores, $F_{chg}(1, 58) = 6.04$, $p < .05$, adjusted $R^2_{chg} = .04$, $\beta = +.23$. Students who reported higher splashdown confidence showed more positive change on the possible self and

Table 3
Regression analyses of change in attitudes during the follow-up period

	Social Encouragement			Corresponding Splashdown variable
	Family	Teacher	Peers	
Science confidence[a]	.07	.13	.18	.09
Possible self in science[a]	.08	.28	.06	.31**
PSES	.08	.05	.09	.23*
Science motivation	.07	.08	.14	.32**

Note. Tabled values are standardized regression weights. PSES = Performance Self-Esteem Scale.
[a]Set of encouragement variables was significant at $p < .05$.
*$p < .05$.
**$p < .01$.

PSES measures in the follow-up period. The splashdown confidence measure also was positively related to change in science-confidence scores ($\beta = +.09$), but the effect was not significant. In addition, the splashdown motivation measure predicted positive change in science motivation during follow-up, $F_{chg}(1, 58) = 7.34, p < .01$, adjusted $R^2_{chg} = .06$, $\beta = +.32$. Thus, the splashdown variables were significantly related to corresponding attitude change in three of the four attitude variables from posttesting to follow-up independently of social encouragement.

The relation between the splashdown variables and change *during* the program also was tested. No significant or near-significant relationships were found. The extent to which students experienced positive or negative change during the program did not predict the amount of splashdown effect they later reported. Students whose attitudes dropped during the program therefore experienced splashdown effects similar to those of students whose attitudes improved.

The second test of the validity of the splashdown concept was the assessment of the relation between school achievement level and the splashdown measures. Because students' tendency to rate themselves highly prior to the program was expected to relate to their tendency to see program-related change in themselves on returning to high school, students' attitude self-ratings at pretesting were controlled while testing the relation between school achievement level and the splashdown measures. The effects of pretest attitudes and school achievement level on the splashdown variables were tested in two hierarchical regression analyses, one for each splashdown measure. Step 1 in the analysis of the splashdown confidence variable included the three pretest confidence measures: science confidence, possible self in science, and PSES. Step 1 in the analysis of the splashdown motivation variable included science motivation at pretesting. The three pretest confidence measures as a set predicted splashdown confidence, $F(3, 74) = 4.59, p < .01$, adjusted $R^2 = .12$. The effect of PSES was significant ($\beta = +.39$, $p < .01$); the individual effects of the science confidence and possible self variables were not. Pretest science motivation predicted the motivation splashdown measure, $F(1, 76) = 30.53$, $p < .0001$, adjusted $R^2 = .28$, $\beta = +.54$. As expected, students who evaluated themselves more highly prior to the program reported stronger corresponding splashdown effects.

School achievement level was added at Step 2 in each regression analysis. School achievement level predicted splashdown confidence, $F_{chg}(1, 73) = 12.31$, $p < .001$, adjusted $R^2_{chg} = .12$, $\beta = -.35$. As predicted, students from schools with lower academic achievement reported stronger splashdown confidence independently of their preprogram confidence. School achievement also was negatively related to splashdown motivation ($\beta = -.11$), but this effect was not significant.

Discussion

This study provides strong support for the splashdown effect in our sample of gifted science students. On both qualitative and quantitative measures, these graduates of a science-enrichment program indicated that they experienced changes in themselves as science students when back in their home high school that they attributed to the science program. On the quantitative splashdown measures, student ratings of their splashdown confidence and motivation were equally high. Students as a group agreed that the program led to positive change. Even students who described themselves as less confident and motivated at the end of the program than at the beginning, and therefore appeared to be discouraged by the program experience, reported levels of splashdown confidence and motivation similar to those of other participants. Qualitative information from the postprogram interview provides a description of the nature of the changes students recognized in themselves. The majority of the sample saw themselves as more knowledgeable about science processes and content and were confident that they could do well in their remaining science classes in high school. Many saw themselves as more motivated for science activities and compared themselves favorably to others at their school who had not attended the program. The quantitative and qualitative information was consistent in showing that virtually all program participants recognized at least some positive program-related change in their science attitudes when back in their familiar school setting.

Our results were generally supportive of the validity of the splashdown concept. We expected that measures of the splashdown effect would predict changes in science attitudes from posttesting to follow-up. This expectation was partially confirmed in that splashdown motivation predicted positive change in science motivation, and splashdown confidence predicted positive change in general confidence and confidence to achieve in a future career in science. These relationships were found independently of science encouragement received from teachers, family, and peers; however, the splashdown confidence measure was not significantly related to change in science confidence. It is not clear why the effect was not found for this measure. The science confidence scale has strong psychometric properties and yielded a normal distribution with slightly more variable scores than the other attitude measures. One might think that the sample size was not sufficient to detect this relationship; however, the effect size in the present sample for the science confidence/splashdown relationship was very small and would be considered trivial even if significant.

When interpreting the significant relationships between the splashdown measures and attitude change, it is important to keep in mind that the mean attitude changes for the sample were near zero. Individual change scores varied widely, and a substantial number of students indicated negative rather than positive change. To gain an accurate understanding of program impact, therefore, it is important to consider individual differences in change rather than change at the group level only. Considered within this context, the relation between splashdown and attitude changes meant that students with lower splashdown scores tended to decrease in motivation and confidence during the follow-up period, just as students with higher scores tended to increase. Thus, whether science attitudes were improved, maintained, or decreased was associated with how students assessed the impact of the program when back in high school.

In the second test of the validity of the splashdown concept, school achievement level was predictive of the splashdown confidence measure. Students who returned to schools in which students were less academically capable tended to rate their splashdown confidence higher, and this effect was found regardless of the participants' tendency to rate themselves highly on confidence measures. This relation between school achievement level and splashdown confidence is consistent with the theory of social comparison and self-concept discussed earlier (Marsh

& Hau, 2003; Sax, 1994). Our results support the prediction that the frame of reference for making self-evaluations will be affected by the performance of peers in the immediate social context.

Although splashdown confidence was predicted by school achievement level, splashdown motivation was not. These results can be explained in terms of the meaning of peer academic performance for program participants in relation to the splashdown measures. The school achievement variable is particularly relevant to the question, ‘‘*Can* I succeed in science?’’ If program graduates return to a high school with a large proportion of academically strong students, the comparison group for answering this question will continue to be highly competent. Graduates will be less likely, then, to view themselves as especially advantaged to achieve in science from having completed the enrichment program. If, instead, students come back to a school in which many students are performing poorly, the benefits the program has provided to enhance their science abilities should be more salient to them. In contrast, splashdown motivation refers to the extent to which the student *wants* to continue in science. High-achieving schools are likely to have more students interested in science because it is a demanding field; however, level of school achievement is less relevant to students’ evaluations of their desire to continue in science than their ability to do so and should therefore be less closely related to splashdown motivation than to splashdown confidence.

Encouragement from significant others for science activities in the follow-up period was associated with change in students’ confidence to achieve in science and to have a successful science career. Students who enjoyed support and encouragement from important others for their science interests after completing the program continued to develop more confidence in their science abilities in the months thereafter whereas those who did not became less confident. Similarly, encouragement from these sources has been found to relate to change in science attitudes among gifted high-school students during a science-enrichment program (Stake & Mares, 2001), and science-related encouragement from family, teachers, and peers has been strongly related to science confidence and motivation among mainstream high-school science students (Stake, 2004). In fact, social encouragement in this latter sample accounted for a large percentage of the association between student ability and science attitudes (Stake, 2004). Taken together, these findings provide strong evidence for the importance of social encouragement for the development and maintenance of science attitudes. It is important that science programs recognize the role of social support from significant others in the development of positive science attitudes while students are attending the program and in the period thereafter. Program effectiveness may be increased by encouraging important others in the student’s life to become actively involved in the students’ science related activities, or at least passively supportive of the student’s participation in science. The findings from this study indicate that without social support, students may lose confidence in their science abilities after they leave their science program.

A related implication of this study’s findings pertains to the link between students’ initial science attitudes and the splashdown effect. Students who had been evaluating themselves positively on entering the program and, hence, had seen themselves positively in the context of their familiar high-school setting later experienced a stronger splashdown effect. The tendency to assess oneself favorably relative to one’s high-school peers, therefore, appears to have helped students to recognize when back in their high school that they had benefited from the program. From the reverse perspective, this result means that students who tended to see themselves more negatively as science students prior to the program were less likely to recognize program-related changes in themselves. To enhance program impact for these students, it may be helpful to have program staff directly articulate and reinforce to them how their participation in the program can benefit them as science students.

Conclusions

Results of the present study highlight the importance of including follow-up measures in any evaluation of science-program impact on student attitudes. Change from pretesting to posttesting was not significant when measured alone, but significant change was found when the follow-up period was included in the evaluation. Moreover, most program participants came to recognize at least some program benefits once they were back with their high-school peers, and this splashdown effect was associated with more positive attitudinal change in the follow-up period. Consistent with social comparison theory, students who came back to a high school with low-achieving peers reported stronger splashdown effects. These students had an opportunity to reevaluate the value of their program experience within an academic context in which they could compare themselves favorably to others.

These findings suggest that the full impact of science-enhancement programs on science attitudes has been underestimated in previous research when follow-up measures were not included. To document the impact of science-enrichment programs on student attitudes, program evaluators should assess program effects that become evident after students have returned to their familiar academic settings. Further, these findings have implications for the allocation of resources for science education. When considering the value of science-enhancement programs, administrators should consider not only the benefits of these programs for increasing students' knowledge but their value for sustaining and enhancing students' science interest and confidence in their ability to achievement in science.

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