

constructivist minded students rated the subject less favorably if they had been in a student-centered learning situation. Accordingly, expository-oriented students seemed to develop better attitudes to the subject if they were in a teacher-centered learning environment, and non-expository-oriented students judged the subject less positively if they had been in a teacher-centered learning situation. The findings suggest that classroom instruction should pay more attention to the interaction between students and learning environments, and teachers should also be aware that the mere introduction of constructivist-oriented software/instruction does not necessarily guarantee that all students will benefit affectively from it; and vice versa, this holds true for traditional instruction.

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The Splashdown Effect: Measuring the Effect of Science Enrichment Programs on Science Attitudes of Gifted High School Girls and Boys

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Abstract

The benefits of enrichment programs for the enhancement of students' science achievement are well established. However, little evidence is available on the value of these programs for increasing students' confidence and motivation for science. One problem in measuring changes in students' science attitudes is that students may suffer from a temporary "big pond, little fish" phenomenon when they are with academically strong students in their enrichment program rather than with students in their usual school settings. To study the influence of science enrichment programs for improving student science attitudes, it is therefore important to assess the program effect that students experience as they return to ("splashdown" in) their home high school after completing their enrichment program. It may be only then that students can fully recognize how they have benefited from their program. We found that gifted high school students experienced strong splashdown effects following an intensive summer science program, and these effects were especially strong for students who returned to academically weaker schools (smaller "ponds"). Our findings provide strong support for the importance of evaluating splashdown effects following enrichment programs so as to measure the full impact of science enrichment on students' motivation and confidence to achieve in science. (This paper is a summary of Stake & Mares, 2005)

Introduction

Educators have expressed concern that students in the United States perform poorly in science relative to students in many developed countries (e.g., Collins, 1997; George & Kaplan, 1998). Partly as a response to these concerns, science enrichment programs for gifted students have been developed across the country. Many of these programs take place on college campuses away from the students' home high schools. Studies that have evaluated the effectiveness of these enrichment programs have consistently shown that, by and large, these programs are successful in providing students with a better understanding of science methods and content (e.g., Pyryt, Masharov & Feng, 1993). In particular, inquiry-based, participatory educational approaches have been effective with gifted as well as mainstream high school students.

Although students' science achievement appears to improve with science enrichment, the value of science enrichment programs for increasing confidence and motivation to achieve in science has not been established. Changes in confidence and motivation for science have been positive for some students and negative for others (Stake & Mares, 2005). It is important that we better understand how enrichment programs influence science attitudes because science-related interest and confidence lead to long-term persistence and achievement in science. In fact, Houtz (1995) reported that science achievement was more closely related to science attitudes than to aptitude for junior high school students, and Marsh and Yeung (1997) found that topic-specific self-confidence predicted choice of coursework better than topic-specific academic performance. It is clear, therefore, that if students are to persist and succeed in science, it is not enough that they acquire more science knowledge and display a talent for science. They must develop and maintain a high level of motivation and confidence in their ability to have a successful science career.

Measuring Change in Science Attitudes

Despite the importance of science attitudes, the measurement of change in science motivation and confidence presents special challenges for evaluators. To measure changes in these science attitudes, one must ask students to describe how they subjectively feel about themselves as science students as they enter their program and as they complete it. In making their self-ratings, students necessarily compare themselves to fellow students, and their "yard stick" for comparison tends to shift when they are in an enrichment program for gifted students. At the beginning of their program, they likely compare themselves to students in their home high schools, whereas when they make their post-program self-ratings, their comparison group is likely to be the gifted and motivated science students in their enrichment program. Thus, students may see themselves as highly gifted and motivated for science at the beginning of their program but may evaluate themselves less positively once they have spent a significant amount of time with their science peers in their enrichment program. This change in self-ratings is known as the "big pond-little fish" phenomenon.

The Splashdown Effect

If students' self-ratings of science confidence and motivation are attenuated by their big-pond experience, then once back in their home high school, this effect should lessen, and students should be better able to recognize and incorporate what they learned from their program into their views of themselves. We refer to this delayed recognition of program impact on science attitudes after re-entry to the home high school as the *splashdown effect*. This effect should predict positive change in confidence and motivation during the months following the program. In addition, if students are affected by their current science peer group, then the splashdown effect should be stronger when

students return to schools with less academically capable students (smaller ponds) than to schools with more academically capable students (larger ponds).

Study Methods

We tested the splashdown effect with a group of participants who completed summer science enrichment programs at the University of Missouri-St. Louis. The participant group comprised 47 girls and 41 boys who were drawn from 38 high schools in the St. Louis area. Students were selected competitively on the basis of their academic performance, teacher recommendations, and test scores. The science enrichment programs were 6 weeks in length and comprised a broad and intensive science enrichment experience designed in accordance with the National Science Education Standards (National Research Council, 1996). Students were engaged in original research in an inquiry-based learning environment under the supervision of a university research mentor. For more information about this program, see Stake and Mares (2001, 2005).

Students' science attitudes were assessed at four points in time:

- *Pre-testing*: Self-rating scales of science confidence and motivation were administered on the first morning of the program.
- *Post-testing*: The self-rating scales were administered for a second time at the close of the program.
- *Splashdown assessment*: Approximately 3 months after returning to their home high schools, students were interviewed privately and individually about how they viewed themselves and their high school since they had returned following the program. Students also completed questionnaires to measure changes in science confidence and motivation that they recognized in themselves since returning from their program. The items on these measures are included in Appendix A.
- *Follow-up*: Approximately 7 months following the program, students were mailed the self-rating scales of confidence and motivation, completed them for the third time, and returned them to us by mail.

Splashdown Findings

The statements made by students during the interviews were audio-recorded, transcribed, and coded into categories. The splashdown effect was highly evident in the students' comments during the interviews. Virtually all students indicated during their interview that they had observed some positive differences in themselves after returning from their enrichment experience and none described negative changes. The major categories of splashdown changes described by the students, the percentage of students who described the changes, and examples of student comments are as follows:

1. Enhanced confidence to achieve in science (61.5%): "I feel more comfortable in science class, just knowing that I spent 6 weeks [in the program]."
2. Enhanced confidence in general (44.9%): "I realize I am more prepared for college than I probably thought I was."
3. Greater motivation and interest in science (48.7%): "When I first came back I did notice I am more inquisitive, especially in the sciences."
4. Increased science knowledge and understanding (69.2%): "I am able to understand my science classes better because of the program experience."

5. New sense of feeling smart and better prepared relative to other students in the home high school (38.5%): “I feel more confident because I know that most of the kids around here haven’t had the chance to do everything I have.”

In addition to these qualitative findings, students described themselves on the self-rating questions (Appendix A) as having experienced a strong splashdown effect. On a scale from 1 to 7, the average splashdown confidence rating was 5.58, and the average splashdown motivation rating was 5.62. However, students’ splashdown ratings varied a great deal from 3 (slight disagreement that a splashdown effect was felt) to 7 (strong agreement that a splashdown effect was felt). In support of the splashdown theory, students who reported a stronger confidence splashdown effect during the splashdown assessment changed more in confidence from post-testing to follow-up, and those who reported a stronger motivation splashdown effect changed more in motivation from post-testing to follow-up. Moreover, all students in the United States take the standardized American College Test (ACT) prior to entering college, and students who returned to schools in which students had lower average test scores on the ACT (smaller ponds) reported stronger splashdown confidence than students who returned to schools in which students averaged higher ACT scores (larger ponds). Thus, when the high school peer comparison group had lower standardized academic test scores, and were therefore demonstrating less academic ability and achievement, students experienced a stronger splashdown effect, as expected.

Conclusions and Implications for Measuring the Effectiveness of Science Enrichment Programs for Gifted Students

Our results strongly support the concept of the splashdown effect. Most students were better able to recognize the value of their science enrichment program once they had returned to their home high schools. Even those students who described themselves as less confident and motivated at post-testing than at pre-testing and, therefore, seemingly discouraged by the big pond of the enrichment program, reported high levels of splashdown confidence and motivation once back in their high schools. Further, splashdown measures predicted increases in confidence and motivation in the 7-month follow-up period and were linked to the size of the pond of the home high school. Students who returned to schools in which students had lower ACT scores were especially able to identify positive changes in themselves as science students once they were back in those schools.

Our findings indicate the importance of conducting follow-up assessments of the effectiveness of science enrichment programs. We did not find significant change in confidence and motivation when only the period from pre-testing to post-testing was included, but we did find significant changes when the entire period from pre-testing to follow-up was assessed. Our findings suggest that, unless follow-up testing is included as a part of program evaluation, the full effect of science enrichment programs on student science attitudes will be underestimated. To determine the impact of enrichment programs on student attitudes, program evaluators should assess program effects that become evident after students have returned to their own schools. 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 enhancing students’ science interest and confidence to achieve in science.

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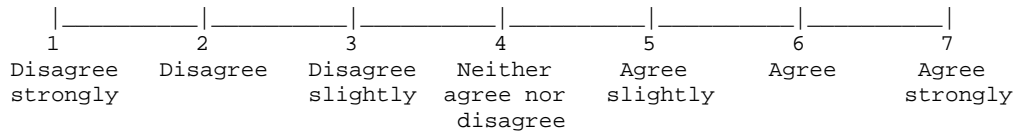
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Appendix A

Quantitative Splashdown Measures

Each of the statements below describe how you may (or may not) feel as a science student in your school, now that you have successfully completed the program. Use the 1 to 7 scale to show the extent to which you agree or disagree with each of the statements. Mark your answers in the space provided to the left of each statement.



My Experiences in the Program

- _____ 1. Made me feel more confident of myself in my high school classes. [C]
- _____ 2. Made high school science seem easier to me. [C]
- _____ 3. Made me realize how much more motivated I am in science compared to many students in my high school. [M]
- _____ 4. Made what we do in high school seem simpler than it used to because of the comparison to what we did in the program. [C]
- _____ 5. Made me even more interested in doing extra science projects and activities. [M]

Once Back in High School This Fall

- _____ 6. I realized how much I had learned last summer in the program. [C]
- _____ 7. I saw I was ahead in science compared to students who weren't in the program. [C]
- _____ 8. I could see that I am especially focused on science--more than a lot of students in my high school. [M]
- _____ 9. I became sure that of all subjects I take in high school, science is my favorite. [M]
- _____ 10. I saw that I am especially capable as a science student. [C]

[C] = splashdown confidence item; [M] = splashdown motivation item.