

Student motivation in supplemental science programs

La motivación del estudiante en los programas complementarios de ciencia
A motivação do estudante nos programas complementares de ciência

Reception date: OCTOBER 30, 2008 / Acceptance date: MARCH 22, 2009
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Abstract

Two studies examined students' science motivation at two supplemental science programs, After School Science (N = 22) and Summer Science Camp (N = 33). We surveyed students at each program and interviewed staff members to understand each program's goals and activities. Findings suggest that the two programs differentially influence interest and motivation, and the staff's goals for students differed by program. Results have implications for the design of supplemental science education programs.

Key words author

Science Education, supplemental education, middle school, after school programs, achievement motivation.

Key words plus

Science education.

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Transference to practice

When matching student to program, school administrators and counselors might best place students with little interest in science into shorter, intensive programs like the two week structure of Summer Science Camp to provide time for sustained examination of complex concepts that encourage their interests. Students with a pre-existing interest in science may be better placed in a less structured program similar to the After School Science program that provides more freedom to pursue personal interests.

To cite this article | Para citar este artículo | Para citar este artigo

Hudley, C., Chhuon, V., Carranza, F. & González, A. (2009). Student motivation in supplemental science programs. *magis, Revista Internacional de Investigación en Educación*, 2, 383-396.

Palabras clave autor

Enseñanza de ciencias, enseñanza complementaria, escuela media, programas de después de clase, motivación de logros.

Palabras clave descriptor

Enseñanza de las ciencias.

Palavras-chave

Ensino de ciências, ensino complementar, escola média, programas depois da escola, motivação de logros.

Palavras-chave descritor

Ensino das ciências.

Resumen

Dos estudios examinaron la motivación de los estudiantes en dos programas complementarios de ciencias, el After School Science (N = 22) (Ciencias después de clase (N = 22)) y el Summer Science Camp (N = 33) (Campamento de verano de ciencias (N = 33)). Encuestamos a estudiantes de cada programa y entrevistamos al personal de ambos, para entender los objetivos y las actividades de cada uno. Las conclusiones sugieren que ambos programas influyen el interés y la motivación de manera diferencial y que los objetivos del personal en cuanto a los estudiantes difieren por programa. Los resultados tendrán implicaciones en el diseño de programas complementarios de enseñanza de las ciencias.

Resumo

Dois estudos examinaram a motivação dos estudantes em dois programas complementares de ciências, o After School Science (N = 22) (Ciências depois da Escola (N = 22)) e o Summer Science Camp (N = 33) (Acampamento de verão de ciências (N = 33)). Entrevistamos a estudantes de cada programa e ao pessoal de ambos, para entender os objetivos e as atividades de cada um. As conclusões sugerem que ambos os programas influenciam o interesse e a motivação de maneira diferencial e que os objetivos do pessoal quanto aos estudantes diferem em cada programa. Os resultados terão implicações no design de programas complementares de ensino de ciências.

Transferencia a la práctica

Al momento de elegir los estudiantes correspondientes para cada programa, los administradores de las escuelas y los consejeros podrían ubicar mejor a los estudiantes con poco interés en ciencias en programas más cortos e intensivos como el campamento de verano de dos semanas, Summer Science Camp, el cual les proporciona el tiempo necesario para revisar de manera continua conceptos complejos que motiven su interés. Los estudiantes que ya tienen interés en ciencias pueden estar mejor ubicados en un programa menos estructurado, más parecido al programa de después de clases, the After School Science, el cual les brinda mayor libertad para ir en busca de sus intereses.

Transferência à prática

No momento de escolher os estudantes correspondentes para cada programa, os administradores das escolas e os conselheiros poderiam distribuir melhor os estudantes com pouco interesse em ciências em programas mais curtos e intensivos como o acampamento de verão de duas semanas, Summer Science Camp, que lhes proporciona o tempo necessário para rever de maneira continua conceitos complexos que motivem seu interesse. Os estudantes que já tem interesse pelas ciências podem estar melhor em um programa menos estruturado, mais parecido ao programa de depois da escola, the After School Science, que oferecer maior liberdade para procurar seus interesses.

Introduction

Over the past several decades, there has been a steady concern in the United States about students' lack of participation in and preparation for science and technology related careers (Simpkins, Davis-Kean & Eccles, 2006). The decline in U.S. student enrollment in high school and college science courses, entrance into math and science career fields, and overall science achievement since the 1960's has been well documented (Lee & Anderson, 1993; Lee & Luykx, 2006; Linn, Lewis, Tsuchida, & Songer, 2000; Schmidt, McKnight & Raizen, 1997; Tai, Qi Liu, Maltese & Fan, 2006). National and international reports such as the 2005 National Assessment of Educational Progress (NAEP) and the Third International Mathematics and Science Study (TIMMS) demonstrate that academic gains in elementary schools students' science knowledge are often lost during middle and high school (NAEP, 2006; Schmidt et al., 1997). For example, the TIMMS data show that, relative to other industrial nations, U.S. students experience a greater decline in science achievement between 4th and 8th grade (Schmidt et al., 1997). Other cross-national data reveal that U.S. and Japanese students demonstrate similar levels of science achievement in 4th grade, but by 8th grade Japanese students' science achievement is a full year ahead of their U.S. peers (Linn et al., 2000).

As the U.S. and global economies become increasingly reliant upon a scientifically competent labor force (Lee & Luykx, 2006; Simpkins et al., 2006), improving student rates of participation in science at the K-12 level is an important national goal. As well, current national education policy in the U.S. (i.e., the No Child Left Behind Act, NCLB) requires annual high stakes testing for public school students. Public schools that do not reach mandated student achievement levels are required to provide free, supplemental educational services to students. As a result of these twin forces, supplemental education programs have become increasingly common for the promotion of achievement in science and other core subjects, particularly in lower-performing schools (Sunderman & Kim, 2004; Sunderman, Kim & Orfield, 2005).

Students' attitudes toward science

Although much of the literature on science motivation focuses on cognitive aspects of learning (Anderman & Young, 1994), other research has emphasized the importance of attitudinal variables (Hofstein, Maoz, & Rishpon, 1990; Tuan, Chin & Shieh, 2005). For example, students who hold positive attitudes toward science are more likely to engage and persist in science (Lee & Anderson, 1993). Data from the National Education Longitudinal Study of 1988 (NELS) reveals that students' positive expectations concerning science careers in 8th grade were more powerful predictors of actual careers in science than their levels of 8th grade science achievement (Tai et al., 2006). However, interest and motivation toward science tend to decrease as students move through middle school (Anderman & Young, 1994; Lee & Anderson, 1993; Zacharia & Barton, 2004). Thus, persistence and eventual career participation in science may depend upon students' attitudes about science content and science classroom activities during the late elementary and middle school years (Haladyna & Shaughnessy, 1982; Speering & Rennie, 1996).

Student interest as a motivational variable. Recent theory that defines the role of interest in student learning suggests that interest in a given topic influences positive attitudes toward that topic, positive attitudes lead

Article description | Descripción del artículo | Artigo Descrição

This article is the product of an empirical study. The project title was the same as the article title. Research was conducted under the responsibility of the first author, Dr. Cynthia Hudley, a professor at the University of California, Santa Barbara and with the approval of the Institutional Review Board at the University. The 3 co-authors are my doctoral students and comprised the research team that assisted in the research and writing. Financing was provided by the first author's institution, and the project was conducted over the period November, 2005-July, 2006.

The authors would like to thank the participating school and summer program, including the faculty at the community college, for their kind cooperation.

to motivation to persist in learning, and persistence is related to achievement (Hidi & Renninger, 2006). Research to date has defined three types of interest - individual, situational, and topic. Individual interest is a student's preference for a particular content area. Situational interest is created by activities in the environment, including the ways in which tasks are organized and presented. Topic interest, created when a specific topic is presented, seems to have both individual and situational aspects. Students with a previously developed individual interest are likely to be motivated by a topic that falls within that domain, and this is especially true for science topics (Ainley, Hidi & Berndorff, 2002). As well, a person's interest in a given topic can be triggered by the situation or activity in which it is presented (Hidi, 2001), suggesting that highly engaging activities may create an individual interest in science topics.

Consistent with the potential of situational interest, some research has found that teachers and the classroom environment are important variables for understanding students' attitudes toward science (Haladyna & Shaughnessy, 1982; Tobin, 1984). In general, students are likely to remain on task in their science classes if they are actively engaged in a variety of activities during a lesson. Students' off-task behavior in science classes has been associated with lessons involving only one or two kinds of activities (Tobin, 1984). Wendy Speering and Léonie Rennie (1996) found that students' declining interest and motivation in science were related to their general disenchantment with how science was being taught in middle school classes. Students expected their science classes to be hands-on and entertaining, but the data revealed a discrepancy between these expectations and actual experiences in science classes.

Supplemental science education

Recall that supplemental educational services, a major aspect of NCLB, are intended to enhance achievement for students attending underperforming schools. As we have described, student persistence and motivation are important determinants of achievement and are influenced by student interest in a given topic or subject matter. Research on extra-curricular enrichment programs reveals increased engagement and motivation in reading, mathematics and science (Eylon, Hofstein, Maoz, & Rishpon, 1985; Gunn, Smolkowski, Biglan, Black & Blair, 2005). For example, junior high school students exposed to extracurricular science activities tend to be more interested in science and confident of their science abilities (Hofstein et al., 1990). However, the role of specific program charac-

teristics in supporting situational interest in science is still unclear.

The current studies

We report two studies that examine two separate programs designed to enhance students' situational interest in science curricula -After School Science and Summer Science Camp. To assess the impact of these different types of programming for stimulating students' interest in science, data were collected on students' attitudes and on staff perceptions of each program. We surveyed students' interest in science, aspirations, future expectations, and perceptions of their science classroom environment. Additionally, we interviewed program staff members to gain an in-depth understanding of each supplemental science program's goals and practices and how those impacted students' science interest, aspirations, and expectations. This initial, exploratory analysis was guided by two very general research hypotheses. We expected perceptions of the classroom environment in each program type to be related students' interest in science. We also expected participants to vary in their future aspirations about science and their expectations for science careers as a function of both the science program environments and their individual interest in science.

Study 1: After school science

Method

Program Description and Participants. Our first study focused on middle school students (Grades 7-8) in an After School science program held Monday through Thursday in a science classroom on campus. The program is designed to expose students to science topics by engaging them in activity projects that produce tangible items such as radios, telescopes, and robots. Two middle school science teachers and a college student volunteer staff the after school program, and up to 25 students work in small teams to create a product that is the topic of a particular unit. Program participation is voluntary, but students are typically nominated by teachers as showing promise but not achieving to their full potential.

Student participants ($N = 22$) in our study ranged from 12 to 13 years old ($M = 12.3$, $SD = .48$), and the majority (64%) were in the 7th grade. Only 4 students (19%) were female, and ethnicity was fairly evenly divided between white (29%), Latino (33%), and biracial (33%). One Asian student participated in the program, and two students declined to state an ethnicity. The sample is roughly similar to the school's ethnic compo-

sition. All 3 after school teachers participated in the qualitative interviews, including the two full-time junior high school science teachers (one white male and one Latina) and one Latino college undergraduate student volunteer.

Survey and Analysis. The complete student survey consisted of 28 items, each rated on a 4-point scale (1 = Never/Not at all to 4 = Always/Really Well). The survey was designed specifically for this project, and items were drawn from a review of reliable and valid instruments used in the published literature concerning students' attitudes and motivation about academic subjects, with a specific focus on science (e.g., the *Children's Academic Intrinsic Motivation Inventory*, Gottfried, 1985; the *School Attitude Measure*, Wick, 1990; the *Classroom Environment Scale*, Trickett & Moos, 1973). To answer the hypothesis of student interest, we analyzed the 8 items that tapped our variables of interest. Four items, two with negative phrasing and two with positive phrasing, measured the two theoretical dimensions of student interest as described above - individual interest ("I would like to learn more about science" and "I think it is boring to do work in science") and situational interest (e.g., "I give up when I don't understand something in science" and "We learn about interesting new ideas in this class"). Two items measured student perceptions of the classroom environment, including the teacher ("The science teacher explains new things so that I can really understand") and the curriculum ("we do lots of different activities in this class"). One item each measured aspirations ("If you could be anything you wanted when you grow up, would you hope to be a scientist?"), and expectations for the future ("When you grow up, how possible is it that you will become a scientist?").

To be certain that our instrument was reliable, we computed both a Guttman split half coefficient and an Alpha coefficient for the responses. Because of our small sample size, we analyzed our responses at the item level (8 items total) and confined our quantitative analyses to correlation and chi-square. As well, we employed a more generous Alpha level ($\alpha = .10$) for significance in this study, due to the limited power of our design. Students were surveyed at the start of the spring semester, when they had been participating in the program for at least 3 months.

Interviews and Analyses. Our interview guide consisted of 10 open-ended questions designed to understand teachers' perceptions of program goals, ideas for program effectiveness, and perceptions of students' experiences. Sample questions include "What are the goals of the program?" "What activities are you providing that meet the program goals?" and "What is the specific benefit of this program for these participants?" Individual interviews ranged from 20 to 45 minutes. Our qualitative analyses of the interviews followed an inductive method consistent with grounded theory (Miles & Huberman, 1994; Strauss, 1987). After each interview was transcribed verbatim, the research team applied an open-coding scheme that allowed concepts to emerge from the data. Two members of the research team coded each interview transcript; a third member was brought in to resolve disagreements about code designations. Inter-coder reliability ranged from .89 to .92 for the three transcripts. The team next used a constant comparative approach to develop larger categories and themes for discussion (Strauss, 1987).

Results

Quantitative Data. Preliminary reliability analyses for our instrument yielded a split half coefficient of .78 and an α of .73. We first inspected correlations among students' perceptions of classroom environment, indi-

vidual interest, aspirations, and expectations. As hypothesized, students' individual interest in science ("I would like to learn more about science") was positively related to expectations to enter a science career. Our negatively worded individual interest item ("I think it is boring to do work in science") was negatively related to perceptions that the classroom provided a variety of activities. As well, similar to previous research in regular school science classrooms, classroom characteristics were related to students' situational interest. Student ratings of the quality of teacher explanation were inversely related to student tendencies to give up quickly if they did not understand the activity (see Table 1 above the diagonal for after school values).

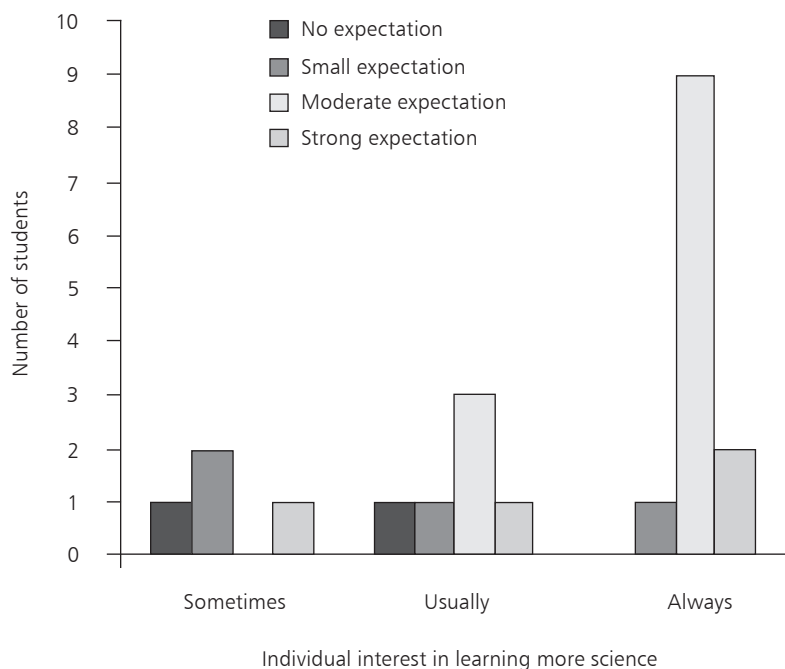
Table 1
Correlations for student interest, aspirations, and expectations in after school and summer programs

	1	2	3	4	5	6	7	8
1. Hope to be a scientist	---	-.03	-.01	.17	-.02	-.21	-.08	.80**
2. Boring	-.61***	---	.30	.23	.14	-.07	-.44*	.22
3. Give up when I don't understand	-.36*	.59***	---	.08	-.40 ⁺	.01	.22	.01
4. Learn science	.58***	-.64***	-.47**	---	.08	-.21	.24	.39 ⁺
5. Teacher explains	.33 ⁺	-.45**	.28	.49**	---	.42*	.36 ⁺	.13
6. New ideas	.45**	-.46**	-.45**	.41*	.59**	---	.33	.14
7. Different activities	.66***	-.66***	.37*	.47**	.41*	.31	---	.14
8. Expect to be a scientist	.77***	-.53**	.39	.53**	.19	.32	.53**	---

NOTE. After School Science above the diagonal; Summer Science Camp below the diagonal. Rows and columns represent the same variable. #1 = "I hope to be a scientist". #2 = "I think it is boring to do work in science". #3 = "I give up when I don't understand something in science". #4 = "I would like to learn more about science". #5 = "The science teacher explains new things so that I can really understand". #6 = "We learn about interesting new ideas in this class". #7 = "We do lots of different activities in this class". #8 = "I expect to become a scientist".
⁺ $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

Our subsequent chi-square analyses supported hypothesis one. Students who perceived the science instructor to "always" explain new ideas clearly also more often reported that they never gave up when they did not understand something, while those who perceived that teacher explanations were only "sometimes" clear more often reported that they usually gave up when they did not understand ($\chi^2 [2, n = 22] = 5.70, p < .06$). Similarly, students who found that the teacher was "sometimes" clear more often felt that the class only "usually" presented "interesting new ideas", while those who felt that the teacher was "always" clear felt that the ideas were "always" interesting and new ($\chi^2 [2, n = 22] = 4.79, p < .09$). Hypothesis two was partially supported, in that students with individual interest were "pretty" confident that they expected to be a scientist ($\chi^2 [6, n = 22] = 10.87, p < .10$), as depicted in Figure 1. Expectations went up as individual interest increased, with a sharp increase in expectations evident at the highest levels of individual interest.

Figure 1
 After school program student expectations for science career by individual interest



Qualitative Data. All 3 staff members in After School Science emphasized that the program’s goal should center upon encouraging students to become “excited” and “interested” in science. They believed that After School Science’s aim is to motivate and engage students so that they can view science as “fun”. For example, one After School Science staff member, the male middle-school science teacher, shared that although he understood the importance of helping students aspire to college, he viewed After School Science as his opportunity to get students “riled up” about learning science. He explained:

During the day [schools] have a lot of academic expectations, these high standards, and a lot of times the kids don’t just get to have fun with science. And that to me is what I like about science. I find the academic part interesting, but a lot of the kids don’t. So for me it’s the idea that these kids get to just have fun learning science, and they don’t have to worry about the homework. They don’t have to worry about the grades, and it’s just getting them excited about science like I am.

Another After School Science staff member, the undergraduate engineering major, similarly viewed his job as “motivating students to like science” and helping students to “realize that science is in their lives everyday.” When asked about what he felt the purpose of After School Science was, he discussed focusing on the “fun” aspects of science because that is how he became a science major. The third staff noted that “too many kids get turned off” by science during the regular school day. Therefore, she interpreted the program roles as helping to “keep kids interested in science”.

In particular, teachers emphasized the importance of activity-based learning for student engagement. One of the middle school science teachers shared, "I think it's critical to do activities. We try to get to at least one if not two labs a week where the kids spend the entire time doing activities". He explained that "if you want kids to remember something, they've got to do it!" A recurring theme from these interviews was participants' focus on "keeping kids moving" as way to make science enjoyable. This included doing science hands on, "playing" while learning science, and working on projects as a member of a group while having individual tasks within the group. The goal of making science fun was evident in the playful activities that comprised the After School Science program. Students created volcanoes from baking soda, rudimentary robots from scrap metal, and self-propelled model cars. All teachers also discussed the importance of training and experience for science instructors in this program. They believed that having a science background serves as an advantage for helping students develop an interest and appreciation for the science that is the foundation of these playful activities. One of the teachers felt that because her "specialty is science", she knew "there is lots of stuff that they don't get to do in the classroom".

Each After School Science instructor also observed that fluctuating attendance was a problem in the program. They described how the After School program must compete with other activities that students enjoy (e.g. sports, television, hanging out with peers). However, they perceive attendance as one hurdle they can address by helping students develop an interest in many science topics. One of the teachers believed that After School Science, while enriching, should be "low stress". He explained that if students viewed science as fun they would spread the word among their friends and "encourage each other to do well in school and come to the after school program."

Discussion

These data suggest that program characteristics were related to situational interest; clear teacher presentations of fun and enjoyable topics supported student engagement in science tasks. Our qualitative data suggest that the science instructors in the after school program were focused on stimulating students' enjoyment of science activities, which may explain students' engagement and distinguish the program from the science instruction they receive in their normal school day. The program instructors clearly intended that the program should make science lessons interesting and different from students' regular science classes. Instructors generally felt that the purpose of the program was to encourage students' interests and moti-

vation for science through a variety of activities rather than traditional science teaching methods centered upon lecture and textbooks. However, this program only indirectly influenced students' expectations for science careers through their own individual interests.

The after school science program seems to stimulate situational interest for students with careful and clear pedagogy that presents new information using a variety of activities. However, an initial individual interest, no matter how mild, may not only encourage students to join the after school program but also initiate or strengthen an interest in a science career. The important question of whether initial situational interest is sufficient for students to develop an individual interest in science cannot be answered by these data.

Study 2: Summer science camp

Method

Program Description and Participants. The Summer Science Camp was a collaborative partnership with a local community college, a non-profit organization, and the city recreation department and was also aimed at middle school students. Participation was voluntary and available at no cost as a part of the city recreation program. The program comprised 2 sessions, each lasting two weeks during the summer, and each session lasted 4 hours a day.

Summer Science Camp was held at the community college campus, and the program director was a community college physics professor. Each session employed the instructor and an assistant, and the local university engineering society provided interns every summer to help in the program. The staff for the sessions from which these data were drawn included an elementary school teacher and a university intern; both were supervised by the community college instructor who developed and produced all of the lab demonstrations. Summer Science Camp students watched demonstrations, engaged in experiential science learning through activity based group and individual projects (e.g., building a rocket, creating electric light boards, researching ocean water quality), and participated in three science-related field trips per session. Students visited a science museum, a wetlands area, and a marine biology lab at the local university.

We collected data for this study during two separate sessions, on the next to last day of each session; everyone present on the day of data collection participated in the survey. Participants ($N = 33$) ranged from 11 to 13 years in age with a sample mean of 12.3, very similar to participants in study 1. Only 2 of the participants were girls; both attended a single session

together. The ethnic composition of the students was 38% White, 29% Latino, 20% biracial, 10% African American, and 3% Asian. Additionally, all 5 staff members participated in qualitative interviews.

Data and procedures

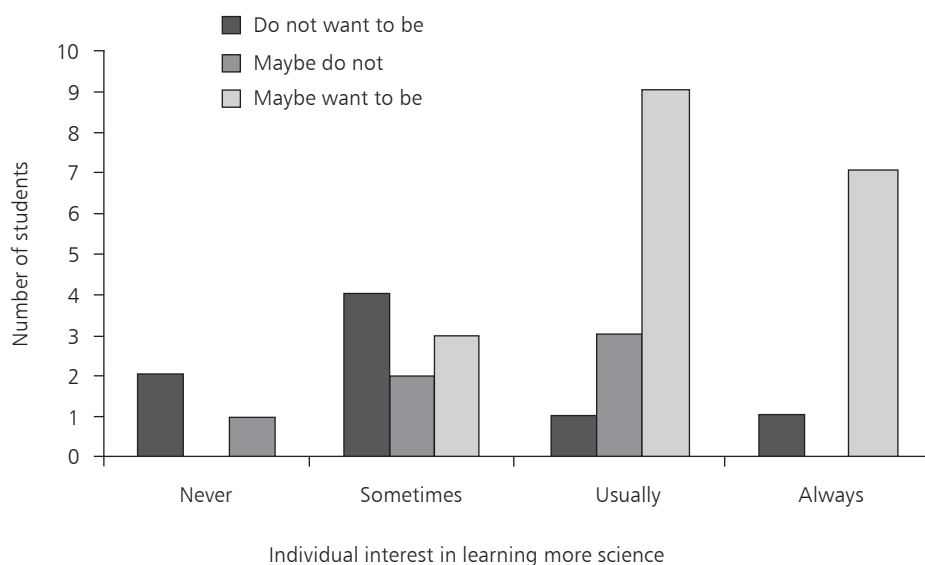
The student survey, staff interview questions, and all data analyses replicated those used for Study #1.

Results

Quantitative Data. In our Summer Science sample, preliminary reliability analyses for our instrument yielded a Guttman split half coefficient of .90 and an α of .88. Our examination of correlations among students' perceptions of classroom environment, individual interest, aspirations, and expectations (see Table 1, below the diagonal for summer science values) revealed that expectations for a science career were related to both measures of individual interest and one measure of classroom environment ("We do lots of different activities in this class"). Students' aspirations to be a scientist were correlated with all measures - individual interest, situational interest, and classroom environment. However, we were surprised to find that students who rated the program as providing a variety of activities also rated their situational interest lower ("I give up when I don't understand something in science" $r = .37, p < .05$).

Our chi square analyses again revealed that students who had an individual interest in science were "pretty" confident that they expected to be a scientist ($\chi^2 [6, n=32] = 18.95, p < .05$) (see Figure 2) and aspired to science careers ("I hope to be a scientist"; $\chi^2 [6, n=33] = 14.68, p < .05$). Similarly, students with greater situational interest in science more strongly aspired to be a scientist ($\chi^2 [6, n = 33] = 10.76, p < .10$) (See Figure 3).

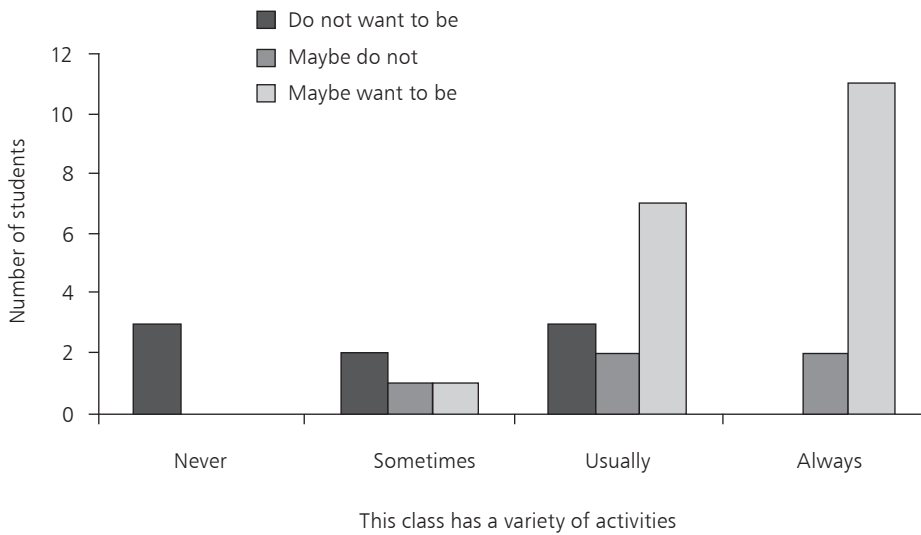
Figure 2
 Summer school student expectations for science career by individual interest



Qualitative Data. Summer Science Camp staff generally discussed their program goals as encouraging students to learn more science in the hope that they will find it interesting. When asked about program activities, all discussed hands-on learning activities, including the building of

rockets, studying “organisms at the beach”, and taking advantage of the college facilities. For example, one staff member shared that students’ interest was especially high after “look[ing] at bacteria and fungi at the marine biology lab” on campus. However, all 5 of the Summer Science Camp staff mentioned explicitly that student discipline was sometimes a challenge in the program. Staff members stated their belief that the program seemed to be a place parents sent their children to keep busy during the summer. For example, one staff member, a college intern, remarked that the program had a dual purpose for some families:

Figure 3
Summer school student aspirations for science career by situational interest



“They are in summer right now and they are not going to school so it’s just something to do for the vacation.”

Four of the five staff members that we interviewed believed that program goals included increasing student achievement. The community college physics professor and director was especially concerned “that the goals are not well defined.” He worried that the content was not sufficiently rigorous and lacked “actual science” such as lab demonstrations and structured learning activities aligned with students’ regular academic curricula. While also acknowledging that one goal for the program was helping students gain interest in science, he “would like the program to be more educational” and has tried to include “more substantial science content” in the Summer Science Camp.

An undergraduate chemistry major who taught in one of the sessions also emphasized science achievement as an important program goal. He perceived Summer Science Camp as an opportunity for “kids to develop an interest in science” but also for them to gain an advantage in their regular science classes. For instance, he suggested that the objective of Summer Science camp is “to help kids get a step ahead in their science education” and advance “farther than their fellow students.” At the same time, he wanted students to share his enthusiasm for learning science. Similarly, an elementary school teacher expressed that Summer Science Camp students should “leave knowing more about the ocean and the

organisms that live in the ocean". This staff member believed that the program should emphasize that "science is fun" but also teach basic science skills. In general, the staff in Summer Science Camp preferred that program goals involve both science achievement and fun, although the lead instructor did not feel that the content always met this goal.

Discussion

Overall, these data suggest that students' interest, both individual and situational, in Summer Science Camp was significantly related to both expectations and aspirations for a science career. However, when students strongly felt program activities were varied, they rated themselves more likely to give up when they could not understand something. This finding is perhaps a function of the summer environment. Students who come to a summer program without an individual interest in science may "tune out" if the environment exceeds their capacities in science skills or knowledge. Perhaps students who perceive this program to be simply "something to do" in the summer (a belief that some staff hold) find that the variety of activities are overwhelming. On the other hand, our data suggest that for many of the students, having a broad variety of program activities is related to individual interest as well as future aspirations and expectations for science careers.

General discussion

A primary goal of this study was to identify specific practices in middle-school supplementary science programs that were related to student interest in science and the desire to pursue science careers. Research on out of school and enrichment science programs typically examines learning outcome variables such as grades and cognitive development. However, our data point to the importance of addressing affective variables, i.e., students' interest and attitudes toward science, as well as their perceptions of the science classroom, when the goals are understanding how to sustain science interest, counter the typical decline in motivation to persist in science, and promote science careers as a viable occupational goal.

While findings from these two studies are not causal, the data are consistent with prior research on the importance of classroom variables for students' engagement in the regular school science curriculum (Haladyna & Shaughnessy, 1982; Speering & Rennie, 1996) and aspirations for science careers (Tai et al., 2006). Further, we discovered that the After School Science participants with a greater individual interest

in science expected more strongly to go into science careers as adults. Summer Science Camp participants' aspirations and expectations for science careers related to both individual interest and situational interest. The goals of After School Science centered upon psychoeducational pedagogy by encouraging students' interest and motivation for science to enhance science learning, while Summer Science Camp staff seemed to emphasize increasing students' science knowledge to develop motivation and interest in science. This may help to explain the difference in students' responses toward the two program environments.

The After School Science program's explicit emphasis on enjoyment and individual interest may provide students a place to enjoy science without the academic standards and achievement pressures that permeate the regular school day. Attendance in the After School Science Program was irregular, and the program competed with a variety of other recreation programs at the school. Students who attend the program due to an existing individual interest in science may unsurprisingly have already developed expectations to pursue science careers. However, students without an individual interest may perceive the program as another recreation activity, and they may not see this recreational activity as relevant to their perceptions about science careers.

The Summer Science Camp may have provided an array of activities that sparked situational interest in science among some students who did not initially have an individual interest. The format was more intense—2 weeks of full day activities that students attended regularly—and more focused on twin goals of learning and enjoyment. As well, participants in the Summer Science Camp may have been enrolled by an adult, rather than self selecting the activity due to an existing interest in science. Thus, based on our measures of student attitudes and the statements of program goals from staff, one possible conclusion is that situational interest promoted in the Summer Science Camp may have had a greater influence on career expectations because students were not necessarily drawn to the program due to preexisting individual interest and career expectations. However, as we stated earlier, our data are unable to explore reciprocal relationships between the development of situational and individual interests in science. That knowledge awaits a longitudinal examination of supplemental science programs.

Although interest and motivation are significant influences on students' science achievement (Anderman & Young, 1994; Tobin, 1984), research has well documented that many students lose interest in science as they move through school. This decline in interest is particularly strong when students reach middle school

(Anderman & Young, 1994; Lee & Anderson, 1993; Simpson & Oliver, 1990), just at a time when they begin to think about future career goals. Fortunately, interest in science among elementary and middle school students can be sustained with curriculum that is appropriately challenging (Mant, Wilson & Coates, 2007) and provides students extended time to develop confidence in their own understanding of complex science concepts (Mistler-Jackson & Songer, 2000).

Limitations and conclusions

We must acknowledge several limitations of these studies. Our small sample size severely limited our analyses strategies, and the opportunity to examine ongoing programs precluded random assignment. Thus we were confined at the outset to a descriptive study. A larger sample that afforded power for more sophisticated analyses and a randomized longitudinal design would have allowed us to develop a more complete understanding of the causal links and interactions among students' interest, aspirations, expectations, and program characteristics. As well, our samples limit generalizability of our findings. Consistent with prevailing gender stereotypes, our participants were almost entirely boys, and the overwhelming gender imbalance rendered our design unable to detect reliable differences between boys and girls. Moreover, our participants were drawn from a single, medium sized city, albeit students attended a broad range of public schools in the area.

Longitudinal data are sorely needed to untangle the direction of effects between student interest and program characteristics. The extent to which student interest drives program attendance and features of a program initiate and support student interest can only be assessed with data that track students from the transition to middle school to at least the transition to high school to determine how early interest and exposure reciprocally influence one another and together influence the preparation that is necessary to enter science career fields. Finally, the sole source of qualitative data is individual interviews. The addition of ethnographic data drawn from programs with varying characteristics should provide even richer data for increased understanding of these relationships. Nonetheless, the results of this research provide empirical guidance for the design of supplementary science enrichment programs.

Our study adds to a scant literature on supplemental educational programs, a topic that is increasingly relevant in the U.S., as such programs are now prescribed by national educational policy. These services are an untested element of school reform aimed

at increasing student achievement (Sunderman & Kim, 2004). Research has demonstrated that participants in extracurricular science activities hold more science related interests and read more books on science topics (Hofstein et al., 1990; Zacharia & Barton, 2004). Thus it seems reasonable to surmise that supplemental educational programs in low performing schools have the potential to enhance interest in science careers for students who may not otherwise have access to such services. As well, students in low performing schools are more often low income and ethnic minority students, populations critically underrepresented in science careers (Zacharia & Barton, 2004). However, our data make clear that supplemental services must attend carefully to the match between characteristics of the science programs and students' interest and attitudes toward science, or programs may not lead to sustained interest in science or science careers.

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