

Effects of a High School Summer Internship Program on Students' Science Attitudes, Science Self-efficacy, and Locus of Control

This study measures the effects of a summer internship on high school students' attitudes towards science, science self-efficacy, and locus of control. The internship was conducted at a large Natural History museum in New York City and took place over the course of seven weeks in the summer of 2005. There were 19 students in the internship program from throughout the New York City metropolitan area, representing a racially and socioeconomically heterogeneous group of highly motivated science students. A mixed-methods approach is used to gauge changes in students' science self-efficacy, attitudes towards science, and locus of control, including quantitative scales for locus of control and science self-efficacy and open-ended as well as constrained writing samples for attitudinal data. Reliability and validity of the instruments is also discussed.

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Introduction

Science learning takes place both in and out of school, and many instances of learning in an out-of-school setting are characterized as informal. The impact of learning science in informal settings can not be disregarded (Dierking, Falk, Rennie, Anderson, & Ellenbogen, 2003; National Research Council, 1996; National Science Teachers Association, 1998). Learning science in out-of-school settings can affect both students' basic understanding of and identity in science as well their choices within school science (Fadigan & Hammrich, 2004). Studying museum experiences as one type of informal learning environment may be a means to better understanding of the educational achievement and choices of students. However, few studies have looked at the specific effects of informal learning experiences on students (Fadigan & Hammrich, 2004). To fill this gap, this study evaluates student's reactions to a unique summer internship in a museum setting – in particular describing the effect this experience has on their science self-efficacy, locus of control, and identity in science.

As a type of informal learning environment, museums are unique in the way they treat both the context and the control of learning, allowing students to construct meaning from a structured yet novel environment through personal choice, where students control the means (but not the objectives) of learning (after Mocker & Spear, 1982). This is in contrast to other informal learning environments, which may be structured and novel but do not allow for control over interactions leading to learning (e.g., reading a magazine), or yet others that do allow for personal choice but are not structured (e.g., learning with objects). One way to frame research in museum settings is to use the three-category model from Rennie & Johnston (2004). In this model, three aspects of learning are

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particularly useful to take into account when studying learning in museums: (1) learning is personal, (2) learning is contextualized, and (3) learning takes time. While this model was proposed for research on learning by museum visitors, we believe its usefulness can be extended to other groups of learners within the museum context. In the specific case of this study, this model can be used to structure a discussion of the frequently utilized but infrequently studied case of high school internships (McComas, 1993). This study is unique in this regard, placing the study of a common yet poorly understood phenomenon (high school internships) within the context of an informal learning environment model (the museum).

To investigate the effects of the internship on students, a mixed-methods approach is used, with quantitative scales for science self-efficacy and locus of control and qualitative analysis of open-ended and constrained writing samples for attitudinal data. Self-efficacy is “people’s beliefs in their capabilities to produce given attainments” (Bandura, 1997) and has been found to predict choice of college major (Hackett, 1985), academic achievement (Lent, Brown, & Larkin, 1984), and perceived career choices (Lent, Brown, & Larkin, 1986). Locus of control concerns whether an individual believes outcomes are determined by outside forces or by their own actions. Higher internality for locus of control measures has been found to correspond to higher achievement test scores (Gozali, 1973) and to increased subject knowledge (Gambro & Switzky, 1992). However, others have found no correlation between verbal ability, GPA, and locus of control (Edwards & Waters, 1981). It remains to be seen whether the locus of control construct is a significant predictor for future academic success and educational choices. While there have been numerous studies on how attitudes towards science are affected by variables in classroom settings (cf. Francis & Greer, 1999), science attitudes have only rarely been used as predictive indicators for future academic achievement (Oliver & Simpson, 1988).

Design & Procedure

Program Design & Setting

The internship took place over the course of seven weeks during the summer of 2005, with the first week used for training and the following six weeks encompassing the main body of the internship. During the training week, interns learned both the science content and public relations skills needed to successfully operate three activity carts in a public setting. The activity carts include numerous hands-on, participatory experiments and demonstrations illustrating various ideas found in the museum halls. The three carts are themed broadly around the topics of light, telescopes, and planets. Their experiences with the carts were scaffolded by first introducing them to the pedagogical content knowledge (PCK) most useful for operation of the carts, including demonstrations of the primary activities on the carts. After working through the PCK, students were allowed to freely explore the three carts’ activities, followed by facilitated experiences interacting with the public. To move rapidly from students’ initial state of little content-specific knowledge and no prior experience with activity carts to more proficiency, the training week activities were supplemented with content-specific readings and lectures given by museum scientists. At the conclusion of the training week interns transitioned into working in teams of two for 2-hour shifts on the activity carts, initially observed and supported by program staff.

Each of the six working weeks of the internship began with a ‘seminar day,’ devoted to community building, learning science content, and exposure to realistic scientific experiences. During these seminar days, interns had the opportunity to interact with museum scientists and graduate students to learn more about their work as scientists. The remainder of each week was dedicated to paired two-hour shifts, requiring interns to complete a total of eight hours of time working on the three activity carts. During their required time on the carts, each intern interacted with a wide-range of public visitor, ranging from individual adults and multi-age family groups to large camp groups of school-age children. The myriad forms of interactions interns were required to adapt to while maintaining control quickly forced them to adopt pedagogical techniques specific to the type of group they were dealing with.

Students accepted into the program were highly motivated individuals with a strong interest in science. Intern’s specific backgrounds in science ranged from little formal schooling in science to completion of AP-type courses and experience with lab research. Level of experience was most often dictated by grade level, with 12th graders having more extensive background than both 11th and 10th graders. Of the 19 interns participating in the program, six were going into 10th grade, two were going into 11th grade, and eleven were going into 12th grade. Interns represented both public (14 interns) and private (5 interns) high schools from across the New York metropolitan area. As a group, interns were ethnically and socioeconomically diverse, with eleven different ethnic groups and a range of socioeconomic backgrounds representative of the New York metropolitan area.

Theoretical Background

Two theories provide the basis for this study: social constructivism and social cognitive theory. Social constructivism is an appropriate lens with which to view this study because a fundamental part of the internship is the ‘real-world’ learning associated with working on the activity carts and in the social interactions that provide the majority of the defining internship experiences (Blumenfeld, Marx, Patrick, Krajcik, & Soloway, 1997). In addition to allowing for interns to socially construct a personal meaning of science, the internship also serves to acculturate them into the science community through interactions with practicing scientists and graduate students. Providing interns with opportunities to ‘do’ science, teach others about science, and talk to scientists means they can experience a more complete picture of the scientific enterprise than is provided by traditional school science.

Beyond the social constructivism framework for the internship, both the science self-efficacy and locus of control constructs are based on social cognitive theory. This theory explains how personal affect (self-efficacy and control) can be viewed as a mechanism for change in diverse domains (Bandura, 2001). Under this theory, both self-efficacy and locus of control determine and are influenced by behaviors and environment (Pajares, 2002). In this way, it can explain how people acquire and maintain certain behaviors (i.e. pursuing science-related experiences).

Methods

This study follows a mixed-methods approach to investigate the various effects of the internship on students. Methods include quantitative scales for locus of control (LOC) and science self-efficacy (SSE), open-ended written responses, science autobiographies, and a daily written logbook.

Locus of Control

Locus of control is concerned with whether an individual believes outcomes are determined by outside forces or by their own actions. The LOC scale is designed to explore the source of student's motivation, especially in regard to how they view their ability to act and be acted upon. Starting with Rotter's (1966) well-studied 29-item LOC scale, both filler and politically-based items were removed to create the final 18-item scale. Each item contains an internal- and external-based belief statement, with students scoring one point for each external statement selected. Within the possible range of scores from zero to eighteen, lower scores indicate higher internality in locus of control.

Science Self-Efficacy

Self-efficacy is "people's beliefs in their capabilities to produce given attainments" (Bandura, 1997), so science self-efficacy describes an individual's belief in their own ability in various science domains. The SSE scale is used to explore student's belief in their ability in various science domains and was created using the *Guide for constructing self-efficacy scales (Revised)* (Bandura, 2001). The final scale includes eight items, each one based on a 10-point scale and resulting in a range of possible scores from zero to eighty, with larger scores indicating higher levels of science self-efficacy.

Open-ended Written Responses

Two open-ended written response questions are used to illicit student's attitudes towards and identity in science. The questions are: (1) "Describe any recent experiences that have changed your view of science and explain how your views have changed," and (2) "Explain how and why you view yourself as a scientist." The first question is coded for type of experience identified (In-School, Out-of-School) and the result of that experience (Learned Something New, Changed View). Similarly, the second question is coded to identify themes among the ways students viewed themselves as scientists (Thinks like a scientist, Acts like a scientist, Does science, Likes science, Learns science, and Educates other about science). To provide corroboration and checks on validity, the themes identified are checked against those identified in the science autobiographies.

Science Autobiographies

For the science autobiography, students were instructed to "write your science autobiography," and were told that it should "be an account of your life as a scientist, starting as far back as you deem important to give a full account and projecting into the future as far as you can imagine." They were also given an example of a science autobiography. Basing a description of student's attitudes towards science on a personal and concrete account of their relationship to science allows us to develop common themes based on student responses. From the science autobiographies and the second open-ended question the three primary categories in our coding scheme are (1)

‘Relationship to Science,’ (2) ‘Feeling towards Science,’ (3) and ‘Learning of Science.’ Each of these categories is further divided based on student responses.

Daily Logbook

Finally, a daily logbook is used to look for significant events in student experiences during the internship and to allow students to identify important ideas and themes for themselves. The logbook was used by interns to reflect on each shift and to write about any experiences or thoughts pertaining to the internship. The logbook was kept as a public document to which all interns had access and were encouraged to read, creating a social vehicle for students to discuss a wide range of topics (some related to the internship, others unrelated) in written form as well creating an impetus for verbal discussions among interns.

To create a narrative of student affect and to track effects over time, the LOC and SSE scales were combined with the two open-ended questions into a single questionnaire that was administered four times across the internship: once during the interview process prior to the internship, a second time during the first (training) week, a third time half-way through, and a fourth time at the conclusion of the internship. Due to the short separation in time between each administration, there are likely significant retesting effects for all three methods and therefore the explanatory power is likely reduced. In addition, not all interns chose to participate in the study and not all participants returned every questionnaire, resulting in a variable number of participants for each administration, ranging from a minimum of eleven to a maximum of fifteen. However, the large volume, inclusiveness (all interns wrote after every shift), and fine temporal scale of the logbook data provides a complimentary analysis and corroboration of findings from the questionnaire. In a similar vein, the science autobiography provides a thick narrative analysis of some of the same ideas present in the questionnaire.

Results

Quantitative

Comparing aggregated means for Locus of Control (LOC) and Science Self-Efficacy (SSE) across administrations, we find no apparent change across the course of the internship in either LOC or SSE for the interns as a group (see Tables 1 & 2). Interns’ LOC scores exhibit a range of 0-15, with mean scores indicating a balance between internal and external locus of control. Intern’s SSE scores range from 41 to 78, with mean scores suggesting a moderately high level of science self-efficacy.

time	mean	s	n
1	8.00	3.58	13
2	6.93	3.77	14
3	7.14	3.84	14
4	10.18	3.28	11

Table 1. Locus of Control (LOC) mean scores across the four administrations. LOC scale ranges from 0-18, with lower scores indicating higher internality in locus of control.

time	mean	s	n
1	64.8	7.44	13
2	64.9	9.93	15
3	65.7	9.60	14
4	64.7	5.97	11

Table 2. Science Self-Efficacy (SSE) mean scores across the four administrations. SSE scale ranges from 0-80, with higher scores indicating higher self-efficacy in science.

Instead of looking at group differences over time, it is illuminating to explore subgroup differences within each administration of the questionnaire. Following this procedure, we find no significant ($p < 0.05$) differences between males and females on both LOC and SSE scores at any of the four times. However, when interns are divided into groups by grade we find 10th graders score significantly higher than 12th graders on the SSE scale at both Time 1 (mean difference = 10.17, $p = 0.019$) and Time 2 (mean difference = 11.75, $p = 0.044$). This gap closes over the next two administrations but the difference always remains in the same direction (10th graders scoring higher). Besides the differences between 10th and 12th graders at Times 1 and 2 for SSE, there do not appear to be any other significant differences between groups of interns.

Even though interns as a group exhibit no differences over time in both LOC and SSE, there are a few notable individual differences over time. In particular, there are significant ($p < 0.05$) differences between the 3rd and 1st (score at Time 3 minus score at Time 1) as well as the 4th and 2nd (score at Time 4 minus score at Time 2) administrations for both LOC and SSE (see Tables 3 & 4). In addition, there is a significant increase in SSE scores between Time 3 and Time 2. Corroborating the aggregated group data, the difference scores for Time 4 minus Time 1 show no significant differences in either LOC or SSE.

Diff. Score	T	df	Sig. (2-tailed)	Mean Difference
t2-t1	-2.29	8	.051	-1.67
t3-t2	0.36	10	.724	0.18
t4 -t3	2.24	9	.052	1.50
t3-t1*	-3.74	8	.006	-2.11
t4-t2*	2.34	8	.047	1.89
t4-t1	0.00	7	1.00	0.00

Table 3. t-test for LOC difference scores, with a test value of 0 (no difference). * $p < .05$

Diff. Score	T	df	Sig. (2-tailed)	Mean Difference
t2-t1	-0.92	10	.379	-1.18
t3-t2*	2.40	11	.035	3.42
t4-t3	0.74	9	.479	0.40
t3-t1*	2.37	9	.042	2.00

t4-t2*	2.53	9	.032	4.50
t4-t1	1.84	8	.104	2.67

Table 4. *t*-test for SSE difference scores, with a test value of 0 (no difference). * $p < .05$

Qualitative

Due to the large quantity and comprehensiveness of the qualitative data, a select portion is used to confirm the quantitative results as well as provide evidence for the validity of the quantitative instruments. From the open-ended written responses, eleven themes are identified that provide an indication of student attitude towards and identity in science. From the first question (“Describe any recent experiences that have changed your view of science and explain how your views have changed”), responses can be divided into two sections, ‘Type of experience identified’ and ‘Result of experience.’ These categories correspond to the two parts of the question and are indicative of the scope of responses. Under ‘Type of experience identified,’ the two themes are: (1) In-school and (2) Out-of-school. Under ‘Result of experience,’ the three themes are: (3) Learned something new, (4) Taught science to someone else, and (5) Changed view of science. From question two (“Explain how and why you view yourself as a scientist”), six themes can be identified: (6) Thinks like a scientist, (7) Acts like a scientist, (8) Does scientific activities, (9) Likes science, (10) Learns science, and (11) Educates others about science. Most responses to question one are based on out-of-school events (43 responses compared to 10 for in-school) and are most often discussed as being a change in their view of science (38 responses) or as learning something new (37 responses), with only one response indicating the intern educating someone else about science. These results are summarized in Table 5. A representative response for question one is:

“I used to believe that science was completely definite facts that were established beyond a question of doubt. However, after doing some research on scientific theories, I've realized that much of what we learn is not fact based, but should occur according to mathematics and indirect observations. For example, the existence of black holes has not been completely confirmed. We are almost certain they exist because of their affect on nearby objects.”

This example is coded as an ‘Out-of-school’ experience with the result being a ‘Changed view of science’ and ‘Learned something new.’ As in this example, intern’s responses often demonstrate more than one result from their experience.

In question two responses, the most frequent themes are ‘Acts like a scientist’ (31 responses) and ‘Thinks like a scientist’ (27 responses). The other four themes have lower and similar response rates (12 for ‘Does scientific activities,’ 15 for ‘Likes science,’ 13 for ‘Learns science,’ and 10 for ‘Educates others about science’). These results are summarized in Table 5. A representative response for question two is:

“I view myself as a scientist because I think like a scientist when solving a problem (systematically but with some creativity). I also enjoy the science classes not because they are "easy", but because I find the subject matter interesting. Lastly, I dedicated time this summer to learning new things and spreading scientific knowledge to patrons of the museum.”

This response exhibits evidence for themes six (Thinks like a scientist), nine (Likes science), ten (Learns science), and eleven (Educates others about science). The ten categories and their corresponding frequency of appearance and level of detail define the results for the open-ended written responses.

Question	Theme	Frequency in Responses
1. Describe any recent experiences that have changed your view of science and explain how your views have changed	1. In-school	10
	2. Out-of-school	43
	3. Learned something new	37
	4. Taught science to someone else	1
	5. Changed view of science	38
2. Explain how and why you view yourself as a scientist	6. Thinks like a scientist	27
	7. Acts like a scientist	31
	8. Does scientific activities	12
	9. Likes science	15
	10. Learns science	13
	11. Educates others about science	10

Table 5. Themes and their frequency identified in open-ended written responses.

Identifying themes in the same fashion as the open-ended written responses, three primary categories ('Relationship to Science,' 'Feeling towards Science,' and 'Learning of Science') are found in the science autobiographies, resulting in eight secondary themes. The eight themes are: (1) Acts/Thinks/Feels scientific, (2) Likes to/Wants to be a scientist, (3) Has positive view of science, (4) Is interested in science, (5) Likes/Achieves in school science, (6) Likes/Finds it easier to learn out-of-school science, (7) Likes to/Wants to educate others about science, (8) Learns science. The first two themes fit in the 'Relationship to Science' category, the third and fourth fit into 'Feeling towards Science,' and the last four are part of the 'Learning of Science' category.

Unlike the structured responses for the open-ended questions and the science autobiographies, the daily logbook gave interns the opportunity to identify important themes in a naturalistic and unprompted fashion. Interns used the logbook to report interesting experiences, self-discovered teaching tips, observations, and for general comments on the internship. A typical entry often includes more than one type of reflection, for example one intern wrote after his first shift:

"The groups were relatively large today, and since it was the planet cart, it was quite messy. One to note is that when one person starts touching the flour, they all do. Just make sure they don't eat it (some did; be careful!). It's also good to make analogies in accordance to conventional objects, don't say 3.5-4.0 tons, say about 2 cars. Furthermore, leave 5 min. for cleaning."

This example is typical not only in content but also in length, with a few interns often writing short and non-descriptive entries (e.g. “I worked on the light cart today. It wasn’t that crowded.”), while others wrote lengthy detailed descriptions:

“Today, I devised a standard lesson plan for teaching people about the telescope cart. First: I lure people to the cart by asking them to ease my job by finding the piggy (or *ciero*, in Spanish) and handing it to me. Second: I demonstrate how the real image of the pig is created, step-by-step (i.e. showing what the top mirror projects, showing what the bottom mirror projects by reflecting the top mirror’s image, and finally explaining that the light needed to create the real image of the pig would never meet if the top mirror did not have a central hole). Step 2 is extremely provocative. In fact it inspired 3 men in front of the cart to argue about the real image’s appearance: what is it, and am I really seeing light meeting 1 cm above the top mirror? I think one person even mentioned something about Schrodinger’s cat in response to step 2. -To resolve the arguments, I showed the men what spherical concave/convex mirrors do to light: first by using flat parabolic concave/convex mirrors and the laser ray box, and then by representing the situations using ray diagrams. Third: I then explained concave/convex mirrors using a laser ray box and the box-like mirrors. Fourth: I linked the box-like mirror concepts to the spherical convex/concave mirror situations. Fifth: I showed everybody the effects of concave and convex lenses on light (using the laser ray box). Sixth: I showed everybody to the telescope, whereby they looked through eyepiece. Seventh: I demonstrated the telescope’s use of lenses and mirrors (using the laser ray box and flat-edged mirrors). Eighth: I handed out prism goggles Ninth: I demonstrated what the prisms in the goggles did to incident light rays (using lasers from the laser ray box).”

Interns took ownership of the logbook almost immediately, as evidenced by their use of informal language in entries and the use of the logbook as a stimulus for social interactions and communication. This is exhibited by entries such as:

“Thursday planet cleaning crew represent!! Yo!! Cleaning the planet cart can actually be fun.”

Here interns made a previously unwelcome task (cleaning the activity cart) a welcome event through socialization and by creating a shared experience.

Reliability

One aim of this study is to determine the usefulness of our methods and constructs in describing the important effects (if any) of the internship on the participating students. As part of this effort, a discussion of the reliability of the quantitative instruments is included. Using item analysis, both LOC and SSE scales were found to be highly reliable (Cronbach’s alpha > 0.7). Results are reported in Table 6.

	Time1	Time2	Time3	Time4
LOC	.756	.803	.814	.701
SSE	.777	.919	.925	.714

Table 6. Reliability analysis for the LOC and SSE instruments. Values represent Cronbach’s alpha.

The decrease in reliability from Time 3 to Time 4 is likely attributable to a corresponding decrease in the number of participating interns from 15 (Time 3) to 11 (Time 4). From this analysis, it appears our measures are internally consistent, albeit based on a small number of participants.

Validity

Following guidelines from the *Standards for Educational and Psychological Testing* (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 1999), we view validity as the development of sound scientific arguments to support the interpretation of results. This view of validity lends itself to the mixed-methods approach taken in this study, where triangulation of results and the complimentary nature of the methods provide a strong base of validity evidence (Mathison, 1988). In addition to triangulation, evidence of validity includes methodological alignment, content validity evidence, and internal consistency of instruments. Methodological alignment refers to a match between the constructs we hope to measure and the methods used to measure them, with evidence provided by literature support for the application of the chosen instruments in our context (Edwards & Waters, 1981; Gibson & Chase, 2002; Oliver & Simpson, 1988). Content validity refers to the link between instrument items and the underlying domain, with support provided by the literature on locus of control, science self-efficacy, and attitudes towards science and their measurement. Internal consistency of the instruments is evidenced by the reliability analysis above, with strong internal consistency of both quantitative instruments shown at all four administrations.

Discussion

This study investigates the effects of a summer internship on high school students and at the same time evaluates the effectiveness of the methods used for this purpose. In particular, we are interested in how student's locus of control, science self-efficacy, and attitudes towards science are affected by the internship experience. Using a mixed-methods approach provides a more theoretically-grounded and valid approach than has often been taken in studies of museum learning (Ramey-Gassert, Walberg, & Walberg, 1994), and attempts to address calls for research more properly aligned with the museum context (Rennie & Johnston, 2004). From analysis of our quantitative data, we find six major results. First, we find that students have a moderately high level of self-efficacy in science. This result is not surprising given the strong background and identity in science of the majority of interns, as well as the fact that they were all confident enough in their science background to apply for this intensive summer internship. In addition, their science autobiographies showed a wide range of science-related experiences for which they ascribed their interest in science as both a cause and effect.

A second central result is that students exhibit a balance in their locus of control between internal and external, with neither extreme strongly represented. In isolation this result explains little about the effect of the internship on students, but rather aids in describing the type of student who selects to participate in such a program. This type of student attributes neither all of their actions to internal motivation nor to external forces.

The third major result is that, as a group, we find no apparent change in students' level of science self-efficacy and locus of control over the full course of the internship but we do find individual differences in these same attributes over shorter periods. Describing the students as a single group may obscure any individual differences across time, as selective participation changes the sample at each administration. This possibility is supported by the analysis of individual differences across time, which reveals changes in both science self-efficacy and locus of control. In particular, we find that students feel greater internal control in the middle of the internship as compared to the time prior to internship, as well as feeling more internal control at the start of the internship as compared to the end (i.e. locus of control decreases from Time 1 to Time 3 but increases from Time 2 to Time 4). In other words, students appear to have the greatest sense of internal control around the first half of the internship, possibly resulting from experiencing a sense of power (internal control) after being accepted to the internship which then disappears during the course of the internship.

This loss of internal control can be recast in terms of a redefinition of their identity, whereby students come to realize there are numerous external factors and practical considerations that control how scientists carry out science. This idea is supported by students' responses to open-ended questions as well as their science autobiographies. For example, one student says in their science autobiography: "Being a part of museum programs has also given me an idea of how careers in science involve much more than just pure science. Proposals, and paperwork, and money are needed. The ability to sell ideas is important." This sentiment is echoed in one of their open-ended responses: "I've learned that there's a lot more than just science that's important in the real world. Funds, paperwork, publishing papers, critiquing scientists, all play a part in the science world." In a similar analysis, individual students' level of self-efficacy in science exhibited an increase from the interview period to the middle of the internship (Time 1 to Time 3), from the start of the internship to the middle of the internship (Time 2 to Time 3), and also from the middle of the internship to the end of the internship (Time 2 to Time 4). In this analysis it is clear that the beliefs of individual students about their ability to 'do science' increases over some portion of the internship. This is not surprising given the moderately high level of students' self-efficacy in science and the strength of their belief in themselves as scientists.

A fourth main result is that we find no gender difference in locus of control or science self-efficacy at any point before, during, or after the internship. This result can be explained entirely in terms of the sample characteristics, as there are a small number of students participating (11-15 students), all interns are self-selected, and most have strong science identities.

The fifth and final major result is 10th graders exhibiting a higher level of science self-efficacy than 12th graders, especially in the first two administrations. This result is surprising given that the younger 10th grade students have had less science experiences than the 12th graders and should therefore feel less able to do the types of tasks assessed by the SSE instrument. Based on the authors' familiarity with the interns, the 10th graders' lack of science experience is likely balanced out and even surpassed by their

sense of identity as a scientist. This idea is borne out in the application and selection process for the internship, as we looked for a strong sense of motivation and ability in the younger applicants and a strong science background in the older students.

It is important to acknowledge several limitations of the present study. First, the small sample size (less than 20 students) and their variable level of participation limit the conclusions that can be drawn. However, because a mixed-methods approach is used the limitations caused by the small sample size are minimized. Second, the short time between questionnaire administrations likely resulted in significant retesting effects and may be a cause for the limited participation by some students. This issue was taken into account during the planning phase of this study when the questionnaire was designed by limiting the length of the quantitative scales. Third, interns may have provided answers based on what they thought we wanted to hear and not on their own beliefs. This type of response can often be identified in the written responses but is difficult to identify within quantitative scales and therefore may further limit any conclusions drawn from these measures.

Despite limitations, this study found significant results on a number of measures using a mixed-methods approach that is well-suited to internship experiences. The daily logbook in particular provides an exceptional tool for program evaluation and planning as well as a naturalistic method for assessing the impact of internship experiences on students. In addition, this study provides a unique examination of a common yet poorly understood phenomenon (high school internships) within the context of an informal learning environment (the museum). As such, it furthers the science education research on both high school internships and informal learning environments. The research base is also enriched by the inclusion of an ethnically heterogeneous sample of students.

Conclusion

The main point of this study is that high school science internships have the potential to foster and create strong science identities in students. In addition, a strong science identity may transcend common barriers to science-related fields such as gender and race. While the overall approach of this study dovetails nicely with the type of internship, the effectiveness of using personal affect measures (locus of control and self-efficacy) to describe important effects of experiences on students' future science trajectory remains to be seen. It is clear however, that a student's strong sense of ability, knowledge, interest, and power in science is likely to have lasting effects on their life as a scientist.

The present results also point to directions for further research, including the potential for case-study analysis and longitudinal follow-up studies, as well as a more extensive use of naturalistic methods. Research on informal learning environments in particular could benefit from more mixed-methods studies and the inclusion of in situ research techniques.

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