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Blind Salamanders beneath and Resident Scientists within our science classrooms: Secondary Student Attitudes in a NSF GK-12 Program

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Abstract

The purpose of this three-year study was to examine secondary school students' attitudes about science in classrooms with *resident scientists* who had been trained in inquiry science teaching. The study was based upon a National Science Foundation (NSF) program called Project Flowing Waters, a five-year NSF Graduate STEM Fellows in K-12 Education (GK-12) program. The program funded 26 doctoral students, known as NSF GK-12 Fellows, who served as bi-weekly resident scientists in science classrooms in local schools. We analyzed 15 teacher-resident scientist partnerships involving 609 secondary students using a mixed-methods design. We surveyed student attitudes in three categories: (a) science and scientists, (b) student abilities in science, and (c) importance and usefulness of science. We found significant differences in positively changing student attitudes, in the category *science and scientists,* in 3 of the 15 partnerships although with small Cohen's d effect sizes. We found a significant difference in a positive direction in one partnership in the category *attitudes about own science ability,* with a medium Cohen's d effect size. We also surveyed, using open-ended questions, students' perspectives about their resident scientists and what they had learned. Students indicated that resident scientists had affected their learning with 72% of the responses being positive. The five most common responses concerning resident scientists were: "helps me understand science better", "made it more interesting", "easier to understand", "I have learned new things", "helpful and helps with the labs." We also found common themes in student comments concerning what they had learned from their resident scientists including endangered species such as blind salamanders.

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Introduction

To observe a Texas blind salamander, *Eurycea rathbuni*, in San Marcos, Texas, one needs to cave-dive deep into the dark aquatic underworld of the Edwards Aquifer. For San Marcos residents, this endangered species is in their "backyard" in Central Texas, living deep beneath their feet. As San Marcos residents travel about on the surface, the existence of blind salamanders and other endangered cave species is dependent upon stewardship of citizens for the land above and the water below in the aquifer.

The National Science Foundation (NSF) Graduate STEM Fellows in K-12 Education (GK-12) program began in 1999 and ended program solicitations in 2011. It was established to partner science teachers and their students with graduate students of science (Moreno, 2012). Our NSF GK-12 program, *Project Flowing Waters*, was a partnership between our university and a local school district (Project Flowing Waters, n.d.a, n.d.b). Our major objective was to stimulate interest of secondary school students in science. To increase student interest, our GK-12 program leaders chose inquiry science curricular topics that were based upon the students' own local experiences in the San Marcos, Texas area. This included stewardship for local endangered species, such as blind salamanders living below in the Edwards Aquifer, and aquatic ecosystems. In our program, secondary students were taught science by their science teachers partnered with science doctoral students funded as GK-12 Fellows. These NSF Fellows served as *resident scientists,* comparable to a *resident artists* program, in the classroom twice a week for the entire school year. Hereafter, we will refer to the GK-12 Fellows as resident scientists. We surveyed student attitudes towards science and scientists during the first three years of the program. Our science education research in Project Flowing Waters focused on student *attitudes* rather than assessment of specific knowledge outcomes in accordance with Osborne, Simon, & Collins (2003) research findings from a review of 20 years of literature in student attitudes towards science and its implications. They noted that attitudes *endure* longer than knowledge.

> For lest it be forgotten, attitudes are enduring while knowledge often has an ephemeral quality. The price of ignoring this simple fact and its implications is the potential alienation of our youth and/or a flight from science – a phenomenon that many countries are now experiencing. There can, therefore, hardly be a more urgent agenda for research. (Osborne et al., 2003, p. 1074)

One of the national GK-12 program objectives, stated in the 2007 NSF GK-12 program solicitation, was that students should develop an "increased interest in STEM disciplines and careers," (NSF, 2007, p. 6). As stated earlier, our GK-12 program embraced and measured this objective. However, few if any of the 300 awarded GK-12 programs have reported systematically measuring whether K-12 students have an *increased interest* in STEM disciplines by having *changed attitudes* towards science after being with their resident scientists for an entire school year. The comment from Osborne et al. (2003) that "attitudes are more enduring*"* stressed the importance of this national GK-12 objective concerning attitudes in science and its importance as an "urgent agenda for research." (Osborne et al., 2003, p. 1074) Thus, the "value" in conducting this research is to see whether students became *more* interested in science after being with resident scientists for a year.

There is currently a lack of published studies regarding the effects of GK-12 resident scientists on secondary student attitudes about science *from the students'* perspectives. Interestingly, there are *few* published studies concerning the effects of having year-long resident artists in public schools on student attitudes towards art and artists from the students' perspectives as indicated from an extensive online search. An analogous research question posed in an art education study was "In what ways does first-hand exposure to an artist affect students' attitudes and beliefs about art and artists?" (Bumgarner, 1992, p. 56) In this U.S. study, as in most studies, student attitudes were described from adult participants in the programs such as teachers or the resident artists rather than the students. For example, Bumgarner (1992) reported:

> The presence of an artist in the classroom frequently produces "excitement" or "stimulation" to varying degrees among residency participants and can enrich the learning environment through the provision of alternative, informal, interactive "arts experiences" for students. (Bumgarner, 1992, p.63)

Another example from a resident artists program in Scotland specifically described a student's interest in art from the resident artist's perspective:

> Rosie's rice paintings started by using shells and food coloring because she was interested in making a painting without using paint. When she discovered using rice made a really beautiful texture she became interested in it as a common food... so her paintings took on yet a new meaning ... (Adams, 2005. p. 27)

Unlike most student attitude research in resident artist and/or resident scientist programs, our GK-12 program Project Flowing Waters, measured students' attitudes about science before and after being with GK-12 resident scientists *from their perspectives*. Our study is one of the few, if not the only, study at this time that contributes needed research data in this area.

Purpose of Study

The purpose of this three-year study was to examine secondary school students' attitudes about science before and after experiences with inquiry science trained resident scientists in their science classrooms for an entire school year.

Research Questions

How did secondary students' attitudes and/or interests towards science change in three attitude categories: (a) science and scientists, (b) student abilities in science, and (c) importance and usefulness of science after being with resident scientists for an entire school year? What were perceptions of the students towards resident scientists and science at the end of the year?

Conceptual Framework

Our GK-12 program Project Flowing Waters embraced the GK-12 objective that students should develop an "increased interest in STEM disciplines and careers," (NSF, 2007, p. 6). To fulfill that objective, we used the conceptual framework that inquiry-based teaching promotes students' interests in science. We based this framework on recommendations and reviews concerning effective science teaching practices from the National Research Council (NRC) in the

United States (NRC, 1996), the National Assessment of Educational Progress (NAEP, 2012) and the National Center for Education Statistics, (NCES, 2012). The NAEP indicators, linked to positive attitudes and higher science achievement, were both teacher reported and student reported. As a result of our review, we chose to emphasize inquiry-based activities in our GK-12 program with the expectation that students' attitudes and/or interests towards science would change after a year. Due to this conceptual framework, our resident scientists were trained in inquiry science teaching techniques prior to their entry into secondary school science classrooms. Secondary school students were thus not only exposed to scientists and their research but also to scientists that were trained in inquiry science teaching techniques. Our conceptual framework is primarily based upon the effects of inquiry science teaching due to the lack of studies concerning the effects of resident scientists on student attitudes. The conceptual framework that guided our curriculum development, namely that teaching inquiry-based science would promote student interest in science, is soundly based upon the theoretical framework of (a) constructivism on how people learn and (b) psychological theories on the motivation to learn.

Theoretical Framework

The theoretical framework we propose to support our conceptual framework that inquiry science teaching promotes student interest in science is based upon: (a) constructivist epistemology and (b) self-determination theory concerning the motivation of students to learn. As stated earlier, theories of learning in connection to resident scientists in secondary science classrooms have not been developed due to the rarity of resident scientists in classrooms.

The core of constructivism is that individuals "construct" understanding or new knowledge based upon what they already know from their own life experiences. In constructivism, knowledge is obtained through actual involvement with new content rather than just imitation or repetition (Ismat, 1998). To have students become *involved* with new content, instructional *constructivist* strategies are often used. Ismat (1998) clearly defined constructivist instructional strategies.

> Learning activities in constructivist settings are characterized by active engagement, inquiry, problem solving, and collaboration with others. Rather than a dispenser of knowledge, the teacher is a guide, facilitator, and co-explorer who encourages learners to question, challenge, and formulate their own ideas, opinions, and conclusions. 'Correct' answers and single interpretations are de-emphasized. (Ismat, 1998, p.1)

The experiential world that is emphasized in inquiry-based science teaching is based upon a constructivist epistemology.

The desire to learn or to become interested in a specific area, such as science, concerns *motivation*, both intrinsic and extrinsic, within the individual. An individual who is intrinsically motivated is internally rewarded just by their enjoyment and satisfaction in learning about the subject (Ryan & Deci, 2000). On the other hand, individuals who are extrinsically motivated require external rewards such as awards and grades to be interested in the subject. There are three innate human psychological needs: competence, autonomy and relatedness that will enhance motivation to learn. Self-determination theory (SDT) is a psychological approach that has been used to study the conditions that fosters the growth of these three psychological needs

(Ryan & Deci, 2000). Competence, sometimes referred to as self-efficacy, has to do with whether an individual feels they are able to understand the subject. Autonomy refers to whether an individual feels that their behavior, interest, is self-directed. Lastly, relatedness refers to connections to other people in the learning process. Teachers that are friendly and interested in their students build relationships that establish a learning community. Individuals are more motivated when they feel they are part of that community. In the classroom, teachers need to develop conditions that will increase the motivation of student to learn about a subject. In the following quote, Ryan and Deci (2010) outline conditions in an environment that would foster these needs and enhance motivation to learn.

> …choice, acknowledgment of feelings, and opportunities for self-direction were found to enhance intrinsic motivation because they allow people a greater feeling of autonomy. Field studies have further shown that teachers who are autonomy supportive (in contrast to controlling) catalyze in their students greater intrinsic motivation, curiosity and desire for challenge. Students taught with a more controlling approach not only lose initiative but learn less effectively, especially when learning requires conceptual, creative processing. (Ryan & Deci, 2000, p.70-71)

Inquiry science teaching, through its ordered approach of engaging students first followed by student exploration of the subject, allows students that "greater feeling of autonomy" that was emphasized by Ryan and Deci (2000) as being important in the development of motivation to learn content. Also, inquiry science teaching is often characterized by teachers who are "autonomy supportive" through the building of strong relationships between students and teachers in an environment of respect and encouragement of students' thoughts, questions and ideas about science. As noted earlier by Ryan and Deci, strong relationships in a classroom are very important in the development of motivation to learn or to become interested in science.

Literature Review

Link between Inquiry Science Teaching and Student Attitudes and Achievement

Student attitudes towards science are important to the overall "health" of a modern society due to the close relationship between student attitudes towards science and student achievement in science (NCES, 2012). In the United States, and in most nations, a public understanding of science or scientific literacy is generally considered vital to a nation's economic development and stability. Thus, how science is taught in a nation is important to the public good.

Students that learn science through inquiry methods in the United States generally develop positive attitudes towards science and perform better on national science assessment tests (NCES, 2012). To illustrate, let us examine the results from the National Assessment of Educational Progress (NAEP) that is a national test of scientific literacy in the United States. The NCES is an organization that reports the scores from the NAEP (NCES, 2012). Since 1969, the NAEP has been considered the United State's *educational yardstick*. The most recent NAEP, in 2011, included survey questions for both teachers and students to identify indicators in the classroom that resulted in higher achievement. Two indicators, as reported by teachers, were linked to higher NAEP science scores: (a) hands-on projects that were done every day or almost every day, and (b) students working together on science projects weekly or daily. Two indicators, as *reported by students*, were linked to higher NAEP science scores: (a) students did science-related activities that were not for schoolwork, and (b) students either *liked or strongly liked* science (NCES, 2012). Students that liked science were correlated with higher achievement in science on the NAEP. Again, we see the importance of students having positive attitudes towards science as shown in the NAEP data.

Inquiry-science teaching, known to be effective for student learning and achievement, has been recommended as an effective teaching strategy by national science organizations in the United States. For example, the National Research Council (NRC), one of the societies of the National Academy of Science, sets the standards for research and science education in the United States. In its seminal 1996 document *National Science Education Standards* (NSES), the NRC stressed inquiry as an effective science teaching practice.

> Science teaching must involve students in inquiry-oriented investigations in which they interact with their teachers and peers. Students establish connections between their current knowledge of science and the scientific knowledge found in many sources; they apply science content to new questions; they engage in problem solving, planning, decision making, and group discussions; and they experience assessments that are consistent with an active approach to learning. (NRC, 1996, p. 20)

The primary purpose of inquiry-based teaching, as an effective science teaching practice, is to build understanding from prior science knowledge but also to *foster interest* in science. Students that are disinterested in science develop interest in science from hands-on activities wherein real-life experiences are emphasized (Hulleman & Harackiewicz, 2009). Kahle's (1983) gender research in secondary students demonstrated that students increase their interest in science if they are provided with authentic experiences in science. In their comprehensive study of inquiry-based research studies, Minner, Levy & Century (2010) found that inquiry-based science teaching was effective in science learning. A synthesis of their findings in their Inquiry Synthesis Project on studies from 1984 to 2004 concluded:

> 138 analyzed studies indicate a positive trend favoring inquiry-based instructional practices, particularly instruction that emphasizes student active thinking and drawing conclusions from data. Teaching strategies that actively engage students in the learning process through scientific investigations are more likely to increase conceptual understanding than are strategies that rely on more passive techniques. (Minner, et al., 2010, p.474)

Although shown to be effective, inquiry-based science teaching is generally not occurring throughout the United States due to the current emphasis on preparation for high stakes science standardized tests that primarily evaluate science vocabulary (Alberts, 2009, Minner, et al., 2010). High-stakes standardized science tests, such as the Eighth Grade STAAR (State of Texas Assessments of Academic Readiness) tests, was present even in some of the partnerships in our GK-12 program. Next, we will examine how GK-12 programs across the United States, some inquiry-based and some not, are affecting student attitudes towards science.

Effects of NSF GK-12 programs on K-12 Student Attitudes towards Science

In a national study of NSF GK-12 programs conducted by ABT Associates, 740 GK-12 participant teachers were surveyed concerning their perceptions about the effects of the GK-12 program on their students. Ninety-four percent of GK-12 participant teachers believed there was a positive impact on the students' interest and excitement about learning mathematics or science in school. However, the report also indicated that 33 percent of teachers felt that the GK-12 program had no effect on students' interest in mathematics or science extracurricular activities and 23 percent reported that there seemed to be no effect of GK-12 programs on students' decisions to take advanced science courses (Gamse, 2010). Overall, it is not clear from this comprehensive national study how GK-12 programs affected the attitudes of secondary students towards science.

As stated previously, few of the more than 300 NSF GK-12 programs have *systematically* measured changes in student attitudes towards science and/or scientists after participation in GK-12 programs. One of the few is the *Engineering Fellows Program,* a NSF GK-12 program that used the *Draw an Engineer Test* to document significant differences in primarily African-American sixth grade students' perceptions of the applied science discipline of engineering. This study compared groups of students who had graduate student level engineers, GK-12 fellows, in their classrooms with those that did not. Those groups of students with GK-12 fellows were more likely to draw engineers as designing, presenting, and creating versus just constructing or being in building trades. One student commented, "engineers are people who help other people," (Thompson & Lyons, 2008 p.197). In this project, fellows had the role of "planning and implementation of STEM-related lessons, research presentations, and resource gathering" (Thompson & Lyons, 2008, p. 198). The Engineering Fellows Program project did not specify whether their planned lessons were inquiry-based. Next, we will describe three GK-12 programs that used inquiry-based methods in their curriculum designs and documented the effects in different ways.

In the NSF GK-12 program PROBE, (Partnerships for Research Opportunities to Benefit Education), GK-12 PROBE fellows implemented inquiry-based laboratory activities primarily by rewriting existing laboratory manuals to make them more inquiry-oriented (Gengarelly &Abrams, 2009). The PROBE fellows reported anecdotal evidence of secondary student attitude changes as *"*the more they invited/encouraged students to actively participate in the process of science, the more 'energetic', 'positive', 'interested', and 'motivated' the students were*"* (Gengarelly & Abrams, 2009, p. 78). The PROBE GK-12 program listed several benefits of inquiry-based teaching for secondary students, *as viewed by their fellows*. One of these benefits included improvement in students' attitudes towards science (Gengarelly & Abrams, 2009). One PROBE GK-12 fellow remarked about students:

> "It creates more self-esteem and more interest because they're thinking about things that they want to think about---even if they're things that the teacher wants them to think about; they want to as well. That makes for a happier environment for everyone." (Gengarelly & Anbrams, 2009, p.80)

The GK-12 Program at Binghamton University was a program based on the 5E (Engage, Explore, Explain, Elaborate and Evaluate) instructional model. The 5E method is a five-step method based upon science inquiry teaching (Bybee et al., 2006). As reported by project directors, the program "gave teachers and resident scientists more confidence in the abilities of their students to learn the science behind the terms" and "observed in their students an increase in scientific knowledge and enthusiasm for science" (Stamp & O'Brien, 2005, p 5).

The GK-12 program, Brooklyn College's *City-As-Lab* investigated student attitudes towards science through place-based inquiry learning in the city parks and other outdoor spaces (Handle & Johnson, 2010). The City-As-Lab fellows used the free Ning.com network, a free open source social networking site, that allowed 11^{th} grade students to reflect on their inquiry experiences. They reported the Ning network was successfully utilized by students to reflect on their experiences through blogs, discussion boards, surveys and other written assignments (Handle &Johnson, 2010). This program also used an attitude instrument, the SASEE [Science Attitudes and Self-Efficacy Evaluation], to monitor changes in student attitudes towards science (DiFrancesco, et al., 2011) but results have not been published at this time.

In summary, although there has been over 300 awarded GK-12 programs over approximately 10 years, only a few have measured and reported student attitude changes after being with resident scientists in their classrooms for a year. None of these have utilized inquiry-science in their curriculum *and* surveyed perspectives from the students themselves. Thus, our GK-12 program Project Flowing Waters, which does both, is a unique contribution in this area of science education.

Methods

Our research methodology was chosen based upon our conceptual framework that inquiry-science teaching promotes student interest in science and from our research questions concerning student attitudes towards science. We chose to do a mixed-methods analysis of student attitudes involving both traditional survey design and open-ended survey questions to ensure a thorough examination of the student perspectives. The Institutional Review Board (IRB) granted IRB Exemption 13-59394 for human subjects research prior to inception of the study.

Research Procedure

Instrument.

We chose to use the instrument Student Attitudes about Science Instruction (SASI) from the NSF Science Work Experience Programs for Teachers (SWEPTs) (SWEPT, n.d.) to survey student perspectives about science rather than use a new untested instrument. We created the abbreviation *SASI* for convenience and clarity when referring to the instrument. The instrument included three attitude categories: (a) science and scientists, (b) student abilities in science, and (c) importance and usefulness of science. The SASI instrument was used to assess student attitudes in the NSF SWEPT program. It was derived from the International Center for the

Advancement of Scientific Literacy (ICASL) (ICASL, n.d). The instrument items have been analyzed repeatedly within the SWEPT and ICASL programs for adequate validity and reliability parameters. Each of the items was derived originally from student statements to establish validity for the items. The reliability and validity of the survey were subjected to a rigorous review process with the NSF SWEPT managers and advisory board and subjected to additional testing with students prior to its use in the NSF SWEPT program for assessing student attitudes (Jon D. Miller, ICASL, personal communication, 08/15/2010). To double-check the reliability of the instrument in our GK-12 program setting, the SASI was also tested with students in the first year, 2008/09, of Project Flowing Waters. We calculated Cronbach's alpha coefficients for the items in each of the three attitude categories. The alpha coefficients for all three categories were in an acceptable range, ($0.6 \leq \alpha \leq 0.8$), indicating that the items had reliability or internal consistency.

Science education researchers that explore student attitudes towards science generally use questionnaires that involve Likert-like scale items (Osborne et al., 2003). The SASI also consists of Likert-like scale items. Each item is clumped into a construct or category that it is intended to measure such as attitudes towards science. In the student attitude surveys, the students chose whether they *Strongly Agree*, *Agree*, *Not Sure*, *Disagree*, or *Strongly Disagree* with different statements concerning their attitudes. The scoring ranged from the *Strongly Agree* choice scored with a five to the *Strongly Disagree* choice scored with a one for the positively worded items. On the SASI, the higher number on each of the items is considered a more positive attitude. A reversed scoring procedure was used for the negatively worded items. Also, we included in the SASI survey an open-ended comments section assessing students' attitudes towards their resident scientists and science (see Appendix).

The questions in the SASI category concerning *science and scientists* surveyed opinions that were directly related to science or scientists. The following statements were taken from the SASI instrument:

Scientists often don't have very good social skills.
Scientists usually work with colleagues as part of a team.
Working as a scientist sounds pretty lonely to me.
Studying hard in science is not cool to do.

For the SASI category concerning *student abilities in science*, the survey contained statements that addressed students' feelings while they are "doing" science. The following statements were taken from the SASI instrument:

I enjoy science.
Doing science often makes me feel nervous or upset.
I am good at science.
I usually understand what we are doing in science class.
Science is difficult for me.
I will probably take more advanced science courses available to me at this school.

The SASI category concerning *importance and usefulness of science* contained survey statements as to whether science affects lives. Statements taken from the SASI instrument that were used for this category are as follows:

Science is useful in every day.
Science challenges me to use my mind.

The science instruction that I have received will be helpful for me in the future.
Advancements in science and mathematics are largely responsible for the standard of living in the United States.
Knowing science really doesn't help get a job.
Overall, science and mathematics have caused more good than harm in our lives.

The open-ended student comments section contained three questions. The following questions were asked on the survey:

What are your thoughts about the resident scientist in your classroom?

Has the resident scientist affected your learning of science? (Circle one: Yes/No) If so, in what way has the resident scientist affected your learning? (post-survey only)

Have you learned about the San Marcos River, water ecosystems, or endangered species this semester (Circle one: Yes/No) If yes, what are some things that you learned?
(Year 1 and Year 2, post-survey only)

Have you learned about the environment this semester? (Circle one: Yes/No) If yes, what are some things that you learned?" (Year 3 post-survey only)

Partnerships and Training.

Secondary science teacher and resident scientist partnerships were established by the program principal investigator (PI) and co-principal investigators (Co-PIs). We followed the typical model of most GK-12 programs by placing resident scientists in K-12 classrooms twice a week for 10 hours per week. Our program placed eight resident scientists twice a week in middle and high school classrooms in one public school district. Program PIs determined the pairing of resident scientists with teachers based upon subject content, grade level, and compatibility. They paired the resident scientists' research areas with the subject areas of the teachers. For example, a resident scientist with a geology research background was paired with an Earth science teacher. The teacher-resident scientist pairings were established each year in May at a *Headwaters Meeting*. At this two-day meeting, the new fellows worked one-on-one with their partnered teachers on the inquiry-based curriculum that would be taught during the following school year. In June, the resident scientists were trained in inquiry-science teaching during the first summer school session. The PI trained the resident scientist in the 5E inquiry-based teaching model (Bybee et. al. 2006) for lesson planning in the summer course *BIO 7100 Professional Development-Inquiry Science Teaching*. In the course, resident scientists created 5E lessons based upon the TEKS (Texas Essential Knowledge and Skills) standards in their assigned grade levels. In August, the resident scientists and their partnered teachers reconvened in a two-day *Confluence Meeting* at which they continued to work together on inquiry-based science lessons. The 5E inquiry lessons that were presented during the school year came from the early development of lessons at the Headwaters and Confluence meetings. Due diligence was exercised in the implementation of inquiry science teaching through academic year site visits, resident scientist monthly journals, and middle and end-of-year presentations of lessons.

Sample.

Three schools selected for this study were: Olson Middle School, Mayfield Middle School, and Centerville High School. Overall, most of the students in all three schools were

Hispanic and economically disadvantaged across all three years. The student demographics for the 2009-2010 school year are presented in Table 1 (Texas Education Agency Academic Excellence Indicator System, 2010).

Table 1
Student Demographics

Demographic	Olson M.S.	Mayfield M.S.	Centerville H.S.
Hispanic	73 %	61%	66%
White	21%	32%	26%
African-American	5%	5%	7%
Economically-Disadvantaged	71%	61%	60%

Fifteen teacher/resident scientist partnerships comprised the sample as listed in Table 2. The teacher/resident scientist partnerships were assigned pseudonyms in the interest of confidentiality in accordance with IRB guidelines.

Table 2
Number of students that participated within partnerships

Partnership	Year	Number of students (n)
Bailey	1	70
Sam	1	59
Angela	2	25
Bailey	2	78
Carrie	2	59
Derek	2	69
Eleanor	2	44
Bailey	3	24
Derek	3	33
Eleanor	3	18
Hannah	3	29
Ingrid	3	30
Kale	3	22
Sam	3	34
Tiana	3	15
Total	15	609

Four of the teachers participated for multiple years but not always with the same resident scientists. The number of students with paired pre- and post-surveys per partnership as shown in Table 2. Survey data from partnerships with 20 or more paired pre- and post-student surveys was analyzed for statistical significance. Year 1 is the first year (08-09), Year 2 is the second year (09-10) and Year 3 is the third year (10-11) of the study. A total of 609 students participated in the study.

Data Collection

In August of each year, the resident scientists and their partnered teachers informed students' parents about the GK-12 program and the surveys. Letters in both English and Spanish were sent home to inform parents about the program. Parental permission was requested for their children to participate in the study. Signed parental permission forms were obtained for every student participant. In September and April, the resident scientists and their partnered teachers surveyed their secondary school students about their attitudes in the three areas previously described.

Control.

The pre-survey data served as the *control* for each student unit since they had not had experience with resident scientists previously. Thus, by comparing student attitudes towards science before their experiences with resident scientists to their attitudes towards science after their experiences, we were able to document changes in student attitudes. We chose *not* to include a *control population* from another school or school district that lacked resident scientists because our purpose was to examine student attitudes towards science in a GK-12 program. Our research was not designed to test an experimental model with an outside control population as a comparison. The classic design in experimental science of a control population does not always fit research questions in social science research. If we had chosen to use an experimental research model with a control, it would not be possible to create a true "control" due to having to control for the many human variables including demographic factors, (e.g., socioeconomic and ethnic differences), class size, curriculum, teacher experience, teacher quality and teaching styles etc. Furthermore, if we chose to control for teacher effects by splitting individual teachers' classes into those that had resident scientists and not those that did not have resident scientists (control), it would be unfairly discriminatory. Students without resident scientists would not receive equal educational opportunities. We chose our research design and control to address our research questions and to be in full accordance with Institutional Review Board (IRB) guidelines for research on vulnerable populations including minors or underage human subjects.

Data Analysis

The SASI surveys were administered, collected, hand-scored and then paired at the end of the school year. In classes where there were twenty or more paired surveys, the pre- and post-scores were analyzed using a two-tailed t test for significance. Results were analyzed statistically to ascertain whether there were significant changes in student attitudes in the three categories: (a) science and scientists, (b) student abilities in science, and (c) importance and usefulness of science. Our null hypothesis was that there was *no* difference between the means of the pre and post-survey scores. Based upon on conceptual framework, we predicted that students' attitudes would improve as indicated by higher numbers on the scoring of the post-surveys. We chose a two-tailed t test to see if there were any significant changes in either a positive or negative direction (Bartz, 1981). One of the most commonly used effect sizes for the t-test is Cohen's d. We used Cohen's d analysis to see if there were any differences between the pre-mean and post-means that were *meaningful* or *practical* regardless of their statistical significance. Although there are not strict guidelines with the use of Cohen's d, we used the generally accepted guideline of .2 being a hardly visible effect, .5 being a moderate effect and .8 and above being a large or plainly evident effect (UCSD, n.d.). We restricted our statistical analysis to those classes that had at least 20 matched pre- and post-surveys. In some classes, students were absent on either the pre- or post-survey collection days and thus, those surveys could not be matched.

The answers to the open-ended questions were coded based upon their similarity. For example, "he is cool" and "cool scientist" were placed together. The coding was based upon traditional qualitative research techniques involving code classification where similar repeating phrases are placed into categories (Patton p. 403, 1990). Two coders independently analyzed the data. The inter-rater reliability between the coders was appropriate for the study. For example, in the third year, a check on the inter-rater reliability between the coders was high at 98% agreement. After an independent assessment of the students' comments by the coders, the results of the coding were compared and discussed. The two raters collectively determined the top five codes for each question.

We coded the open-ended answers in a secondary analysis concerning positive, negative, indifferent and no response statements for each question. Student remarks were coded as positive, negative, indifferent or no response. Phrases like "cool", "smart", and "awesome" were considered positive comments. Any phrase that sounded productive or positive like "made learning more fun" was also included in the positive category. Words like "nothing" or calling the resident scientists a negative name was considered a negative comment. The indifferent code was solely based on the statement "I don't know."

Results

The results from the SASI survey categories were summarized by teacher partnership and year since each partnership was a separate entity. Although both positive and negative attitude changes were seen in the partnerships by the end of the year, we will focus our attention only on statistically significant changes in attitudes.

Category- Attitudes about Science and Scientists

There were three partnerships (Bailey 09/10, Carrie 09/10 and Derek 09/10) out of 13 that showed evidence of a statistically significant positive direction (higher post-survey mean than pre-survey mean) in this attitude scale as shown in Table 3. These partnerships had small Cohen's d effect sizes. For example, Derek's partnership had the highest Cohen's d effect size of .32.

Table 3
Attitudes about science and scientists, pre/post means

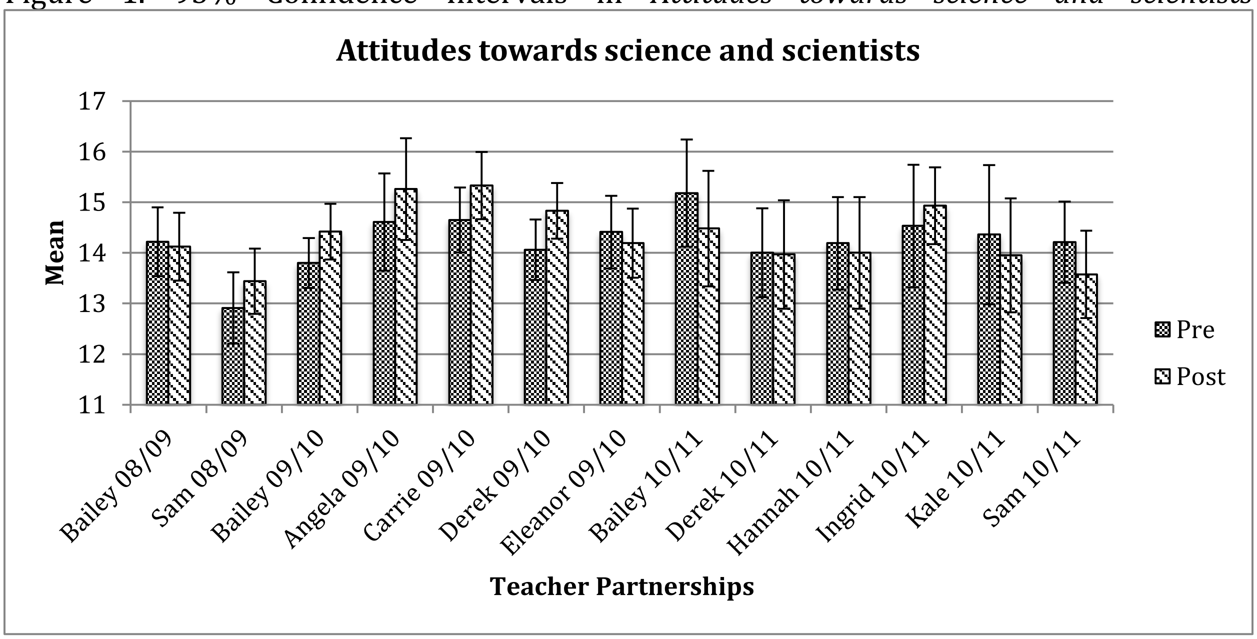
Partnership	Year	Pre Mean	Post Mean	t-test	Cohen's d
Bailey	08/09	14.22	14.12	ns	0.04
Sam	08/09	12.91	13.44	ns	0.21
Bailey	09/10	13.80	14.42	*	0.26
Angela	09/10	14.61	15.26	ns	0.27

Carrie	09/10	14.65	15.33	*	0.27
Derek	09/10	14.06	14.83	*	0.32
Eleanor	09/10	14.41	14.19	ns	0.10
Bailey	10/11	15.18	14.48	ns	0.26
Derek	10/11	14.00	13.97	ns	0.01
Hannah	10/11	14.19	14.00	ns	0.07
Ingrid	10/11	14.53	14.93	ns	0.14
Kale	10/11	14.36	13.95	ns	0.14
Sam	10/11	14.21	13.57	ns	0.26

statistical significance: $*p \leq .05$

Figure 1 represents the variability in the pre/post means with 95% confidence intervals (CI). Note there is an overlap in CI error bars by at least half the average arm length in three of the partnerships (Bailey 09/10, Carrie 09/10 and Derek 09/10), thereby representing statistical significance. Significant change in this attitude category only occurred in 09/10 year.

Figure 1. 95% Confidence Intervals in *Attitudes towards science and scientists*



Category- Attitudes about Student Abilities in Science

There were two partnerships out of 12 showed that showed evidence of a statistically significant trend, with one (Ingrid, 10/11), in a positive direction. Table 4 lists the partnerships with pre and post means and those with statistical significance and moderate Cohen's d effect sizes above 0.5.

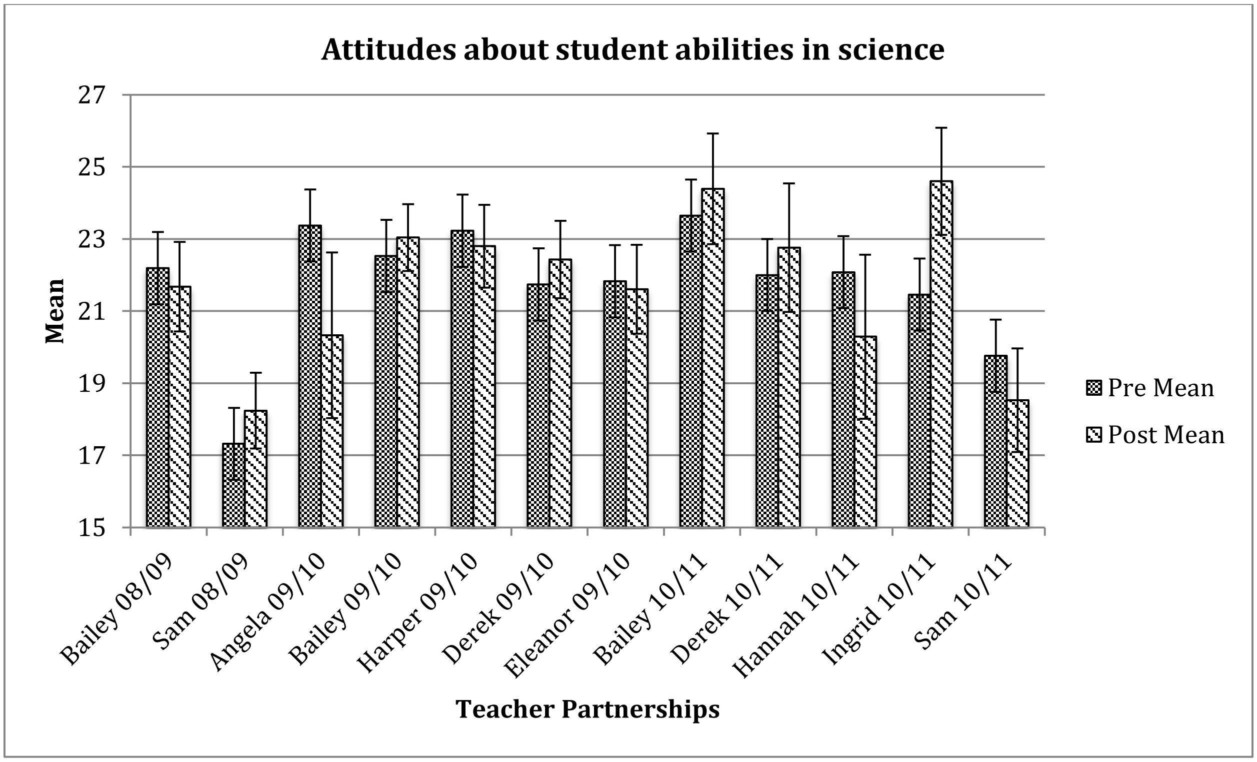
Table 4
Attitudes about student abilities in science, pre/post means

Partnership	Year	Pre Mean	Post-Mean	t-test	Cohen's d
Bailey	08/09	22.19	21.68	ns	0.10
Sam	08/09	17.32	18.24	ns	0.22
Angela	09/10	23.37	20.33	**	0.61
Bailey	09/10	22.53	23.04	ns	0.13
Carrie	09/10	22.23	22.80	ns	0.10
Derek	09/10	21.74	22.43	ns	0.16
Eleanor	09/10	21.83	21.61	ns	0.06
Bailey	10/11	23.65	24.39	ns	0.19
Derek	10/11	22.00	22.76	ns	0.14
Hannah	10/11	22.08	20.29	ns	0.34
Ingrid	10/11	21.46	24.6	**	0.71
Sam	10/11	19.76	18.53	ns	0.29

statistical significance: $*p \leq .05$, $** p \leq .01$

Figure 2 represents the variability in the pre- and post-survey means with 95% confidence intervals (CI). Note, there is an overlap in CI error bars by at least half the average arm length in 2 partnerships (Angela, 09/10 and Ingrid 10/11), thereby representing statistical significance.

Figure 2. 95% Confidence Intervals in *Attitudes about student abilities in science*



Category- Attitudes about Importance and Usefulness of Science

Across all three years, none of the partnerships showed evidence of a statistically significant trend in this attitude category. Table 5 lists the partnerships with pre and post means. The largest Cohen's d effect size across all partnerships was .4, which is less than a moderate effect.

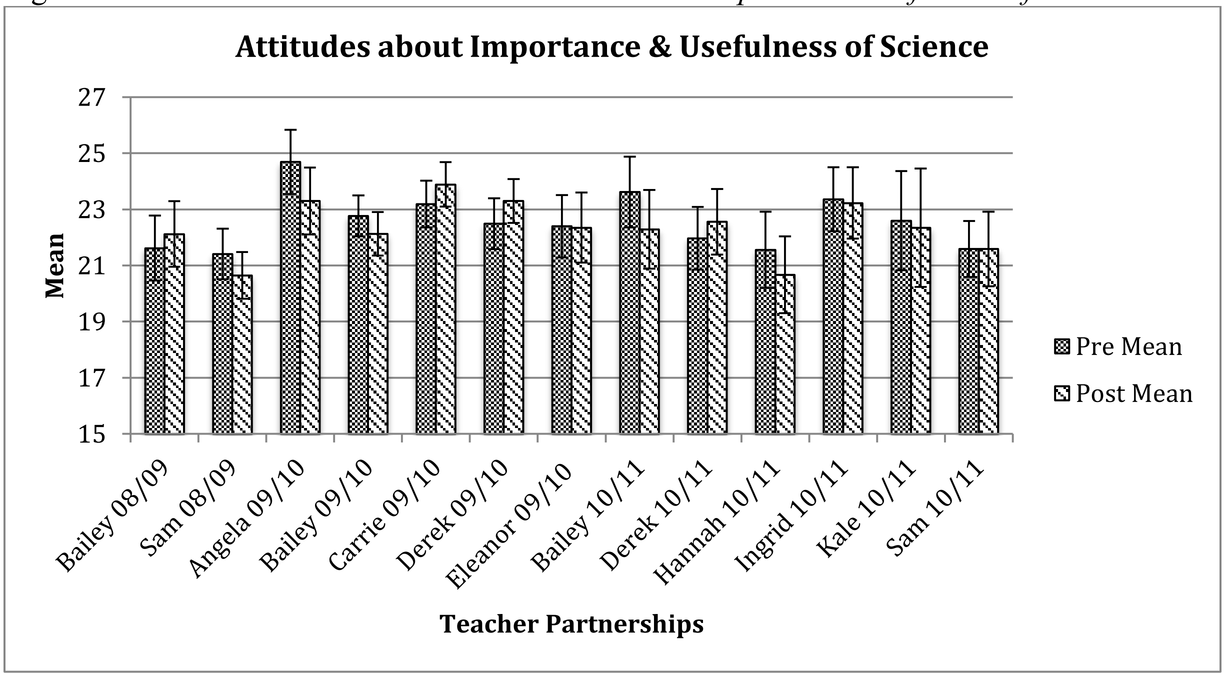
Table 5
Attitudes about Importance/Usefulness of Science, pre/post means

Partnership	Year	Pre Mean	Post-Mean	t-test	Cohen's d
Bailey	08/09	21.62	22.12	ns	0.10
Sam	08/09	21.41	20.65	ns	0.24
Angela	09/10	24.69	23.30	ns	0.36
Bailey	09/10	22.77	22.13	ns	0.19
Carrie	09/10	23.19	23.89	ns	0.22
Derek	09/10	22.49	23.30	ns	0.21
Eleanor	09/10	22.40	22.35	ns	0.02
Bailey	10/11	23.62	22.29	ns	0.40
Derek	10/11	21.97	22.56	ns	0.17
Hannah	10/11	21.56	20.67	ns	0.24
Ingrid	10/11	23.36	23.23	ns	0.04
Kale	10/11	22.60	22.35	ns	0.06
Sam	10/11	21.59	21.59	ns	0.00

statistical significance: $*p \leq .05$

Figure 3 represents the variability in the pre/post means with 95% confidence intervals (CI). Note that the size of the overlap in error bars indicates lack of significance.

Figure 3. 95% Confidence Intervals in *Attitudes about Importance/Usefulness of Science*



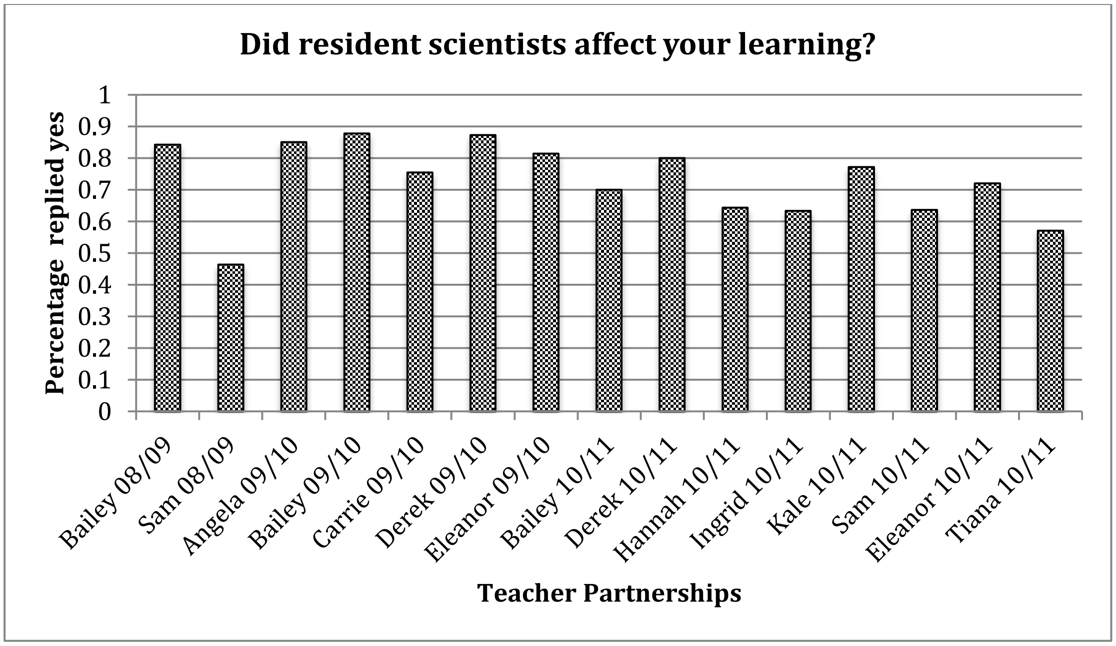
Overall, statistical significance in changing student attitudes was primarily seen in *Attitudes towards science and scientists* but only in 3 teacher partnerships in the 09/10 school year. There was little to no significance in terms of change in the other 2 attitude categories.

Open-ended survey questions.

The students' answers to the first question, "What are your thoughts about your resident scientist?" were highly varied on post-surveys. The five most common responses, codes on the post-survey, were "cool", "good", "nice" "helpful", and "makes learning fun". By far, the most common comment was that their resident scientists were "cool".

We asked students, on the second question, whether the resident scientists affected their learning and if yes, in what ways. The results to whether the resident scientists affected their learning are presented in Figure 4.

Figure 4. Percent of students responding yes that resident scientists affected their learning



Note that across all 15 partnerships, except Sam in Year 1, the majority of students (see Figure 4) stated *yes,* the resident scientists had affected their learning. The responses to the second part of the question, "*If yes, in what way*?" were coded positive, negative, indifferent, or no response as previously described. Their responses are categorized in Table 6.

Table 6
Open-ended survey about resident scientists

Partnership	Y	Has the resident scientist affected your learning? %Yes	If yes, in what ways has the resident scientist has affected your learning? (# responses) Positive	Negative	Indifferent	No response
Bailey	1	84	55	1	0	14
Sam	1	46	25	0	0	31
Angela	2	85	16	0	1	3
Bailey	2	88	59	0	1	14
Carrie	2	75	41	1	0	12
Derek	2	87	48	0	1	14
Eleanor	2	81	28	0	1	14
Bailey	3	70	19	1	0	0
Derek	3	77	27	1	2	0
Eleanor	3	72	16	0	1	1
Sam	3	61	29	0	2	0
Ingrid	3	63	19	9	0	2
Hannah	3	64	22	4	0	2
Kale	3	77	19	1	1	1
Tiana	3	53	13	1	0	1
Total			436			

As shown in Table 6 above, there were a total of 436 positive responses out of 609 responses across all three years. This indicates that 72% of responses were positive about ways that resident scientists affected their learning. There were many different answers to the second question, based upon the types of activities that were designed by the partnerships and their resident scientists. Many of the frequent comments such as “helpful” or “makes learning fun” that were responses to the first questions were also responses for the second question. The five most common responses were: “helps me understand science better”, “made it more interesting”, “easier to understand”, “I have learned new things”, “helpful and helps with the labs.”

The students’ answers to the third question varied according to the year. In the first and second year, the question was, “Have you learned about the San Marcos River, or endangered species this semester?” If yes, what are some things that you learned?” In the third year, the question was made more open-ended to simply ask, “Have you learned about the environment this semester?” The results are shown in Table 7.

Table 7
Open-ended survey about San Marcos River/endangered species/environment

Partnership	Year	Have you learned about the San Marcos River, or endangered species this semester? (Years 1, 2) % Yes	Have you learned about the environment this semester? (Year 3) %Yes
Bailey	1	65	
Angela	2	91	
Bailey	2	83	
Carrie	2	75	
Derek	2	96	
Eleanor	2	77	
Bailey	3		91
Derek	3		76
Eleanor	3		94
Ingrid	3		86
Kale	3		90
Tiana	3		100

In Years 1 and 2, in all of the partnerships’ classes, the majority of students in all the classes indicated that they had learned about the San Marcos River or endangered species. Sam’s classes in those years were not included since they were not provided instruction in the San Marcos River or endangered species as they were using a different level curriculum. As to what the students learned in these areas, the five most common coded comments in Years 1 and 2 were:
1) “blind salamanders and/or developed to live in the dark,”
2) “river has species, fish that only live here so be careful what we do,”
3) “pollution affects the environment,”
4) “endangered ecosystem and food chain and web,”

5) "water cycle."

In Year 3, the majority of students in the partnership classes indicated they had learned about the environment. Sam and Hannah's classes were not included here since they did not provide instruction in these areas as they were using a different level curriculum. As to what students learned in Year 3, in this area concerning the environment, in the five most common coded comments were:

1) "pond/river environments,"
2) "habitat and ecosystems,"
3) "ecology and succession,"
4) "different animal species",
5) "pollution."

Discussion

Attitudes towards Science and Scientists – Survey Data

The results indicate statistically significant differences in a positive direction between pre-means and post-means in the survey category *science and scientists* in three out of 13 partnerships. Although this is a significant finding in three partnerships, the effect sizes were small and the question remains as to why attitudes did not change towards science and scientists in more partnerships. One may conclude from these survey results that simply having an inquiry science trained resident scientist in the classroom may not always be enough to affect student attitudes towards science or scientists. First, significant change only happened in the second year, 09/10 school year, of the program, in three out of the 5 partnerships (Bailey, Carrie and Derek). In the second year, unlike the first or third year, most of the resident scientists had been resident scientists previously since the GK-12 fellowships were two years in length. The variable of having a "seasoned" resident scientist versus a new resident scientist may have been a factor in this category. Second, a closer look at the four category items reveals that an average partnership score of 16 and above would indicate that most students in those partnerships "agree" with the four statements since "agree" is scored with a four. All of the partnerships' pre-means scored around a 13 or above (see Table 3) indicating that most students were in the positive range at the beginning of the school year. Students, for the most part, were already fairly positive about science at the beginning of the year. As a result, there may not have been much "wiggle room" to see a significant difference in this area.

The category *science and scientists* primarily addressed student perceptions of scientists especially as to how they work with others and about the subject of science. The perceptions of scientists working alone on their research because they are lonely people and lack social skills may have changed significantly for the students in the three partnerships as a result of being with resident scientists each week in their classrooms. It should be noted that the students in Project Flowing Waters were primarily Hispanic and economically disadvantaged (see Table 2) and thus, may not have had access to scientist role models in their daily lives. That some of the partnerships had significant changes in this attitude category corroborates earlier research findings in the GK-12 program *Engineering Fellows Project*. This program found positive changes in African-American student perceptions about engineers and their work (Thompson & Lyons, 2008). Program researchers in the GK-12 program at Binghamton University also found positive changes in student attitudes reflected as "enthusiasm towards science" (Stamp &

O'Brian, 2005). The 5E inquiry-based instruction in the three classrooms in the Binghamton University GK-12 program may have altered the atmospheres of the students' learning environments by allowing students to think and share thoughts with others. This may have changed their motivation to learn science and their attitudes towards science. The psychological need of *relatedness* in students, or feeling a part of something, may be more easily met in inquiry-based classrooms that tend to more community-oriented. As mentioned earlier, relatedness in a classroom is linked to motivation in students (Ryan & Deci, 2000). We suggest that in our GK-12 program, *Project Flowing Waters*, the three 09/10 school year partnerships (Bailey, Carrie, and Derek) that demonstrated a significant difference in the category *science and scientists* in a positive direction may have been more inquiry-oriented and perhaps had more "relatedness" than the other partnerships. Upon further examination of resident scientist journals and lesson plans, we might find that some of the other partnerships were less inquiry-oriented and more focused on preparing for high-stakes science testing. Another reason that there are differences in scores *between* the partnerships may be due to the teaching experience of the teachers. For confidentiality purposes, that information is not provided here but some teachers in our program were highly experienced with over 25 years teaching experience whereas others had fewer than five years. Thus, the support and resources for inquiry-teaching methods may have varied due to the teaching experience of the teachers in our GK-12 program.

Attitudes towards Science and Scientists – Open-Ended Question Data

We asked students about their attitudes toward science and scientists at the end of the year in an open-ended question format. This served as a *qualitative check* in the category: attitudes towards science and scientists. The majority of the students in all the partnerships, except in Sam's partnership in the first year (see Table 6), reported that the resident scientists affected their learning. Of those, 72% of students had positive feelings towards their resident scientists at the end of the school year as indicated by positively coded responses. We expected that the partnerships of Bailey, Carrie and Derek in the 09/10 school-year would have primarily positive comments in the open-ended question data since there were significant changes in student attitudes towards science and scientists in the survey data. However, in addition to these three partnerships, we were pleased that students in *all* but one of the partnerships had primarily positive comments about their resident scientists. The most widespread comment was that the resident scientists were "cool." That students felt the residents scientists were cool rather than the common stereotype of scientists as nerdy males in white lab coats, as typically seen in students' drawings in the Draw a Scientist Test (DAST) which may reflect an attitude change about scientists (Losh, Wilke, & Pop, 2008). Interestingly, the other comments about the resident scientists such as "helps me understand science" or "helpful" may address the psychological need of *relatedness* in increasing motivation to learn. It is evident from research, such as the recent NAEP (2012) study, that positive attitudes towards science are indicators of students who perform better on science achievement tests. With this link between attitudes and achievement in science, it is notable that the *majority* of students in our program reported that they had learned about environmental issues and could describe what had they had learned such as the blind salamander, ecosystems etc.

Let us look again at the success of resident artist programs in affecting students' attitudes towards art and artists. As stated by Bumgarner (1994) in her comprehensive review of resident artist programs:

> If a residency is to have any extended or significant impact, then it must be linked to, and subsequently integrated with, a planned and regularly offered course of study. The basic links between the strength of the school arts program, students' preparedness and receptivity, the host teacher's ability to collaborate fully with the artist throughout the residency's planning and implementation, and the ability of the resident artist to contribute significantly to student learning in the arts cannot be ignored (Bumgarner, 1994, p.16).

Variables that impact the success of artist residency programs such as Bumgarner's (1994) comment concerning the "host teacher's ability to collaborate fully with the artist throughout the residency's planning and implementation" would also apply to a resident scientist program. These variables, no doubt, played a role within our GK-12 resident science program partnerships, as there were partnerships that were better at collaborating and perhaps leading to more inquiry-oriented activities.

Attitudes towards student abilities in science – Survey Data

Only Ingrid's (10/11) partnership showed a significant difference between pre-mean and post-mean in a positive direction with a moderate Cohen's d effect in the category, *student abilities in science*. There are six items in this category. Hence, an average partnership score of 24 and above would indicate that most students in those partnerships "agree" with the six statements since "agree" is scored with a four. Most of the partnerships' (10 out of 12) pre-means scored at least a 21 or above (see Table 4) indicating that most students were in the range of "not sure" and "agree" at the beginning of the school year. As a result, as seen before, there may not have been much "wiggle room" to see a significant difference in this area. Students, for the most part, were already fairly positive about their own abilities in science.

Attitudes towards Importance and Usefulness of Science

None of the partnerships, achieved statistically significant differences between pre-mean and post-mean in the category, *importance and usefulness of science*. There are six items in this category. Hence, again, an average partnership score of 24 and above would indicate that most students in those partnerships "agree" with the six statements since "agree" is scored with a four. All of the 13 partnerships' pre-means scored at least a 21 (see Table 5) indicating that most students were in the upper range of "not sure" and "agree" at the beginning of the school year. As a result, as seen before in the other two categories, there may not have been much "wiggle room" to see a significant difference in this area either. Students in this category were fairly positive about the importance and usefulness of science at the beginning of the school year.

Overall, the results are mixed in terms of the effects of biweekly inquiry resident scientist in classrooms on student attitudes towards science. Our survey results indicated no significant student attitude changes except in four partnerships and those had small or moderate meaningful effects as measured by Cohen's d analysis. Yet, the vast majority of students noted in the open-ended question sections that their resident scientists affected their learning in a positive manner. Results from this study are noteworthy as a contribution to the student attitude literature from GK-12 programs. As stated earlier, our student attitude research was unique as a contribution since most GK-12 programs did not survey the students themselves about their attitudes towards science but instead surveyed the teachers or fellows (resident scientists) about the students' attitudes (Gengarelly & Anbrams, 2009, Stamp & 0'Brian, 2005, Thompson & Lyons, 2008).

Conclusion

The purpose of this three-year study was to examine secondary school students' attitudes about science before and after experiences with resident scientists in their science classrooms for an entire school year. We asked, in our overall research question, what were the perceptions of the students towards science and scientists at the end of the year? We have shown through open-ended student surveys that the majority of the students in our NSF GK-12 program Project Flowing Waters, over the first three years, felt their learning in science was affected by the presence of research scientists in their classrooms. Also, 72% percent of those students felt they were affected in a positive manner as determined by their comments such as "helps me understand science better", "made it more interesting", "easier to understand", "I have learned new things", "helpful and helps with the labs." Furthermore, students identified topics that they had learned as a result of being with resident scientists. The most frequent topics included blind salamanders, adaptations in the darkness of caves, caring for fish, pollution, food chains, food webs, and water cycle etc. That most students were affected by resident scientists in a positive manner *and* were able to list concepts that they had learned from the resident scientists suggests positive attitudes towards science. As expected, students mentioned science topics such as *blind salamanders* most frequently since they live just above these endangered species. As we know from constructive epistemology, individuals "construct" understanding or new knowledge based upon what they already know from their own life experiences. Science teachers that teach concepts that are relevant to the students' own life experiences may increase their interest in science.

The open-ended research question in this study concerned students' perspectives about science and their resident scientists. The students' perspectives were overwhelmingly positive. Students from 14 partnerships reported far more positive than negative comments about their resident scientists. The students also reported that their resident scientists had affected their learning positively. Furthermore, they were also able to describe specific concepts that they had learned during the year from the resident scientists.

The specific research questions that guided this study were: How did secondary students' attitudes and/or interests towards science change in three attitude categories: (a) science and scientists, (b) student abilities in science, and (c) importance and usefulness of science after being with resident scientists for an entire school year? This study demonstrated in the first three years since its inception in 2008, a significant difference in positively changing student attitudes in the category, *science and scientists* in three of the partnerships. As indicated earlier, the *Project Flowing Waters* program is based on the 5E method of inquiry science teaching. The positive changes in student attitudes may be due to the presence of 5E inquiry-trained GK-12 resident scientist in their classrooms every week. A changed *more active* environment could be the key to explain the significant differences that were observed between the pre- and post-surveys in this category. This attitude category concerns views about science and scientists. One of the statements in this category concerned the social skills of scientists. After being with a real scientist for a year in their classrooms, students may view scientists as being more sociable than before, when they may have held stereotypical views of scientists as “loners.” Also, by being able to get to know a scientist each and every week, students may also better understand that scientists usually work as “part of a team” and they are not usually lonely people. Finally, students may have discovered that studying science might be a cool thing to do through their interactions with resident scientists. All of these ideas about science and scientists are contained in the *attitudes about science and scientists* category. Although significant differences were not seen in the other partnerships, it is pertinent to note that the majority (72%) of students in the partnerships who responded on the open-ended part of the surveys had positive perceptions of the resident scientists by the end of the school year.

These results clearly demonstrate the value of some of the teacher-scientist partnerships in fostering desirable attitudes toward science. On the other hand, it was disappointing that in the rest of the partnerships, a significant difference between the pre and post-mean survey scores indicating favorable changes in students' attitudes towards science and scientists could not be demonstrated. Of course, it should not be expected that every teacher-resident scientist partnership would be equally capable of transmitting to students their enthusiasm for science or that every partnership was on equal footing in terms of teaching experience, curriculum, grade level, student abilities and high-stakes science testing mandates.

The categories *attitudes about own science ability* and *attitudes about the importance and usefulness of science* had only one significant positive change between pre-mean and post-mean surveys. It was expected that students in this program would personally enjoy science more, and understand the importance of science due to the inquiry science methods implemented. That was not demonstrated at least not in the SASI survey items in terms of statistical significance. Due to the nature of inquiry-based teaching activities which is not based on simple memorization of science terms but instead on higher order questions and critical thinking skills, students may have felt less comfortable about their abilities and knowledge in science. It is always easier to just memorize a term. These results suggest that just “getting to know” a scientist every week on a personal level does not cause one to change their attitudes about their own science ability or the importance and usefulness of science. On the other hand, as stated earlier, it may be that students already had fairly positive views in these areas at the beginning of the school year and thus, it may be difficult to see a *significant* change in these areas.

Future Research

A future research question for *Project Flowing Waters* would be to examine the variables in the three classes/partnerships (Bailey in 09/10, Carrie in 09/10, Derek in 09/10) in which statistically significant changes in student attitudes towards science and scientists were seen albeit with small Cohen’s d effect sizes. Why were these particular partnerships, to some degree, more successful in changing student attitudes in a positive direction? What were the specific variables in these classrooms with resident scientists that may have contributed to positive significant changes in student attitudes? For example, was preparation for high-stakes standardized science tests a variable to be considered?

In the United States, there is a move to increase “underrepresented populations” in science careers. Generally speaking, these populations do not “get to know” scientists on a personal level every week. Would having a resident scientist in their classrooms cause students from underrepresented populations consider a career in science? The student population in our GK-12 program was primarily “underrepresented in science”, since most were Hispanic and “economically disadvantaged” but we did not specifically address whether students would consider STEM careers. Instead, our purpose in this study was to examine student perspectives concerning their resident scientists. However, in the future, we may examine the long-term impacts of our GK-12 program resident scientists on students especially those “underrepresented in science”, and whether they are more likely to graduate from high school and pursue a science course of study in a technical school, a community college or at the university.

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Appendix

Student Attitudes about Science Instruction [SASI]

Name of Science Teacher ______________________________

1. What are your thoughts about the resident scientist in your classroom? (Short answer)

2. Has the resident scientist affected your learning of science? (Circle one: Yes/No) If yes, what way has the resident scientist affected your learning? (Short Answer)

3. (asked in Years 1 and 2) -Have you learned about the San Marcos River, or endangered species this semester? (Circle one: Yes/No) If yes, what are some things that you learned? (Short Answer)
(asked in Year 3) -Have you learned about the environment this semester (Circle one: Yes/No) If yes, what are some things that you learned? (Short Answer)

4. DIRECTIONS: The statements in this survey have to do with your opinions and attitudes about science instruction in school and the importance of science in your life. Please read each statement carefully, and **circle the number that best expresses your own feelings. Remember this is not a test, and there are not "right" or "wrong" answers.**

Read the statements below. Circle the number that expresses your feelings.	Strongly disagree	Disagree	Not sure	Agree	Strongly agree
a. I enjoy science	1	2	3	4	5
b. Science is useful in every day	1	2	3	4	5
c. Scientists often don't have very good social skills	1	2	3	4	5
d. Doing science often makes me feel nervous or upset	1	2	3	4	5
e. Science challenges me to use my mind	1	2	3	4	5
f. The science instruction that I have received will be helpful for me in the future.	1	2	3	4	5
g. Scientists usually work with colleagues as part of a team	1	2	3	4	5
h. I am good at science	1	2	3	4	5
i. Advancements in science and mathematics are largely responsible for the standard of living in the United States.	1	2	3	4	5
j. I usually understand what we are doing in science class	1	2	3	4	5
k. Knowing science really doesn't help get a job	1	2	3	4	5
l. Science is difficult for me.	1	2	3	4	5
m. Working as a scientist sounds pretty lonely to me.	1	2	3	4	5
n. Studying hard in science is not cool to do	1	2	3	4	5
o. Even without a strong background in science, I will probably end up with the kind of job I want.	1	2	3	4	5
p. Overall, science and mathematics have caused more good than harm in our lives	1	2	3	4	5
q. I will probably take more advanced science courses available to me at this school.	1	2	3	4	5

Note: The SASI instrument has been adapted from the SWEPT Multi-Site Student Outcomes Instruments that are public domain. Retrieved from http://scienceteacherprogram.org/SWEPTStudy/instruments.html