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"I Love Science": Opinions of Secondary School Females Toward Science and Science Careers

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Abstract

How to address the gender gap in STEM has been widely debated. Among the ways to encourage females to pursue STEM careers are outreach programs offered by schools and universities. This manuscript reviews the implementation of a novel program, the Women in Science Experience (WISE), a STEM-focused residential summer camp for high school females, located on the campus of a small university in the USA. Upon the conclusion of WISE, participants were asked to respond to a series of open-ended questions about their perceptions of science and science careers. Using thematic analysis, responses were coded and organized. Three themes emerged from this analysis. Love of Science showed how WISE participants appreciate science. Aspirations for Success resulted from career and life interests. Impact of WISE demonstrated how students' experiences at WISE affected future goals. The findings from this article speak to ongoing debates about how to maintain interest in STEM fields by females in secondary and post-secondary education.

Keywords Gender and STEM · Informal science education · Qualitative research · Secondary education

Introduction

Encouraging students to maintain interest in science, technology, engineering, and mathematics (STEM) can be challenging, a difficulty exacerbated by perceptions of students' abilities within these fields, especially when it comes to females (Cheryan, Ziegler, Montoya, & Jiang, 2017; Legewie & DiPrete, 2014; Master & Meltzoff, 2016; Sax, Kanny, Riggers-Piehl, Whang, & Paulson, 2015). Women earn less than men over the course of the first 10 years of employment in STEM, even when accounting for factors such as race, college entrance exam scores, and selectivity of higher educational

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institutions (Xu, 2015). Representation of women in STEM careers is low. In the USA, females represent about 24% of all participants in STEM careers; however, as much as 50% of females in STEM careers leave these careers within the first 10 years (Emeagwali, 2016). Specifically, in the state of North Carolina, just 10% of engineering degrees awarded at community colleges in a single year were awarded to women (Morris, 2014). While some studies explore efforts to combat these negative perceptions (e.g. Cheryan, Plaut, Davies, & Steele, 2009), outreach programs to encourage female participation in STEM fields represent one of the most recent innovations (Emeagwali, 2016). Outreach programs can occur in a variety of formats, including after school activities or summer camps.

A novel summer camp known as the Women in Science Experience (WISE) was developed as a means to encourage females to develop and maintain interest in STEM. The camp was held at Mount St. Joseph University, a small, liberal arts instruction located in the USA in a suburban area near Cincinnati, OH. It was co-developed by the author and by faculty in the institution's School of Behavioral and Natural Sciences as a 4-day, three-night summer camp for girls of ages 14 through 17. During WISE, students participated in experiments in water quality in the field and in the laboratory, working along with female faculty who have expertise in chemistry, biology, and environmental science. Water quality was chosen as the theme because of the knowledge of the female faculty who directed the students in the experiments. Evening programming included interacting with female scientists in diverse fields in formal and informal conversations about careers along with participating in social activities while staying in campus housing. At the conclusion of WISE, participants presented their findings at a dinner attended by parents, teachers, and university faculty and staff.

In order to gain some understanding of the experiences of camp participants, a survey was given on the final day of camp. On the survey, students were asked a series of open-ended questions which prompted students to give their opinions and perspectives about interest in science and in scientific careers. The survey was intended to answer the following research question: How do student participants in the Women in Science Experience perceive their future potential to become a scientist or have a science-related career? These responses were analyzed via qualitative research methods to obtain themes and patterns among student responses (Coffey & Atkinson, 1996). Three themes emerged from the analysis of student responses: Love of Science, addressing students' prior interests in studying science; Aspirations for Success, which arose from students' future goals in education and in life; and Impact of WISE, showing how students felt about their participation in WISE.

Review of the Literature

Gender and STEM Careers

Differences in paths to STEM careers according to gender have been explored at the secondary and post-secondary levels. One explanation involves examination of choices of students according to gender in terms of the classes in which they enroll. At the secondary level, for instance, enrollment of females in high school physics courses across the USA was lower than males in 2013, especially in advanced physics courses,

while females enrolled more in chemistry and biology courses than males (National Science Board, 2018). One possible reason for this difference in selection of physics courses among secondary school students involves the local environment of a high school, which can have an effect on females taking science classes (Legewie & DiPrete, 2014). Not only can the local high school environment affect participation of females in high school science courses, but the surrounding local community can also factor into course selection. In one case, the number of women employed in science in a community was related to some extent to participation of females in high school physics classes. In other words, having more women in STEM careers as role models could affect participation in STEM courses, including physics courses (Riegel-Crumb & Moore, 2014). Other differences have been examined in terms of achievement. On the most recent administration of the Trends in International Mathematics and Science Study (TIMSS), males outperformed females in seven of nine education systems in advanced mathematics and in eight of the nine education systems in physics (Provasnik, Malley, Stephens, Landeros, Perkins, & Tang, 2016). On another international study, the Program for International Student Assessment (PISA), males outperformed females in 29 of 35 countries in 2015 in both mathematics and science, the most recent administration for which data is available (Organization for Economic Cooperation and Development, 2019).

At the post-secondary level, differences in preferences of STEM fields continue to persist among men and women. The United Nations' Organization for Economic Cooperation and Development (2017) reported in its most recent biennial report on science and technology that about 30% of degrees awarded in STEM are awarded to women. Men in higher education in the USA have majored in STEM fields more than women for decades in almost all areas. Women have closed the gap in majors in mathematics, and women have majored more than men in the biological sciences since the late 1970s and early 1980s (Sax et al., 2015). These trends have continued to the present in the USA, where men earned more bachelor's degrees in physics, computer science, and engineering, while women earned more bachelor's degrees in biological and agricultural fields, with these trends continuing at both the masters and doctoral levels (National Science Board, 2018). In particular, at the doctoral level, women may be less likely to graduate with a doctorate when there are no females in their entering cohort, while having females in an entering cohort could increase the rate at which women graduate with their advanced degree (Bostwick & Weinberg, 2018).

There have been efforts to attempt to explain why there are differences in STEM career choices according to gender at the secondary and post-secondary levels. In a study of 558 secondary school students, girls expressed less interest were less interested than boys in careers in the physical sciences, while boys expressed less interest than girls in careers in health sciences. This was found to be the same when looking at both co-educational and single-sex schools (Cherney & Campbell, 2011). When comparing interest in health care and people-related careers versus STEM careers, high school females had lower interest in STEM careers than people-related careers, which was tied to self-efficacy beliefs and, to a lesser extent, social belonging (Tellhed, Backstrom, & Bjorklund, 2017).

Gender-based preferences in STEM fields originate, in part, from stereotypes related to social belonging and ability. The idea of a lack of social belonging in

STEM comes from beliefs that certain STEM fields such as computer science are stereotyped as masculine (Cheryan et al., 2009). Stereotypes of male-dominated careers in physics, computer science, or engineering are often coupled with differences in personal beliefs of success (i.e. self-efficacy) among males and females, in concert with a lack of experience in these fields at an early age (Cheryan et al., 2017). Parents and teachers who promote the stereotype that women cannot excel in mathematics reinforce and sharpen these negative beliefs (Gunderson, Ramirez, Levine, & Beilock, 2012; Shapiro & Williams, 2012). Some work even argued that the stereotypes that women do not belong in STEM and have lower math ability are the leading causes of why girls and women do not go into STEM fields (Master & Meltzoff, 2016). Personal interests according to gender can explain preferences for further study and for careers. For instance, in examining preferences to work with people or work with things, females scored higher than males in terms of their preference to work with people, while males tended to score higher in preferences toward things (Yang & Barth, 2015). Among adults who had participated in the Science Talent Search competition in the USA as secondary school students, men rated themselves higher than women in their beliefs that they could achieve success in STEM and that they were talented in STEM fields (Heilbronner, 2013). Another perception that can affect participation in STEM is belief in the ability to be successful in mathematics. In a study of over 1.4 million men and women who intended to major in a STEM field, 54.6% of men rated themselves above average or higher in math ability, compared to 36.1% of women. Moreover, just 13.8% of men rated themselves below average or lower, while 25.7% of women rated themselves to have low math ability (Sax et al., 2015).

Efforts to overcome stereotypes can encourage women to persist in STEM fields, such as an intervention around social belonging in an engineering program, in which women developed positive friendships with male colleagues (Walton, Logel, Peach, Spencer, & Zanna, 2015). While these efforts worked with students who are already majoring in a STEM field, there are other ways to reach students who have some interest in STEM but are reluctant to pursue STEM beyond their initial interest. The research described in this article came from WISE, which was developed to encourage young females to go into STEM fields regardless of current interest in STEM and to maintain interest of those female students who wanted to further their education in STEM topics.

Outreach Programs

Programs such as WISE are innovative in that they can be developed through partnerships between secondary and post-secondary institutions, often in combination with partners in the community. These partnerships are innovative in that they can bring in stakeholders from a variety of areas and can reduce the barriers to STEM education and training for females. One such endeavor was completed at the University of Central Florida, which specifically attracted students who were of low socioeconomic status. This program had students come to campus for one of a series of 2-day camps that looked at STEM from both university and industry perspectives (Bryant Davis & Hardin, 2013). A program that targeted female students included a series of workshops for middle school female students, known as Girls in Engineering, Math, and Science (GEMS), which was run by female scientists (Dubetz & Wilson, 2013). Another

program developed by a high school in Massachusetts was a week-long camp that immersed middle school girls in STEM concepts, leading to increased enrollment at the high school (Emeagwali, 2016). A program at South Dakota State University engaged Native American female students in STEAM (science, technology, engineering, arts, mathematics) in a program known as STEAM Girls that honored Native American culture while promoting overall interest in STEM (Kant, Burckhard, & Meyers, 2018).

Creation and development of a program to teach STEM concepts outside of the classroom is challenging, and measuring a program's effectiveness can be just as daunting. Research has shown that there are three criteria needed to ensure that the participants in a STEM program that is outside of school: the program must engage the students on many levels, it must reflect the interests and experiences of the students, and it must be able to connect STEM to other settings beyond the classroom (National Research Council, 2015). Some difficulties in evaluation of a program can occur due to participant attrition. The STEAM Girls program at South Dakota State University had as many as 25 girls in attendance in their enrichment program but only had 17 students respond to a post-program survey. This decreased to 13 for the second half of the survey, and just 7 participated in an in-depth focus group about their experience (Kant et al., 2018).

Research Context

While much has been written on how females are discouraged to go into STEM fields and how to mitigate these issues, there is not as much written on the opinions of these female students before and after participation in an informal science experience specifically for females. The research reported in this paper, then, is an initial attempt at exploring the opinions of female students who participate in an informal science experience. The opinions of participants are valuable and insightful, but existing research tends to focus on outcomes (e.g. percent of women in a field, test scores), and outcomes are a function of preparation, confidence, attitudes, and ability. These are key mechanisms in determining outcomes that have not been explored by existing research. Thus, there is a need to explore opinions of female students in the context of participation in an outreach program. This led to the development of the research question which guided the collection and analysis of the opinions of students who were involved in WISE: How do student participants in the Women in Science Experience perceive their future potential to become a scientist or have a science-related career?

The author co-developed WISE with female science faculty as an innovative and novel outreach program at a small, liberal arts institution in the USA. WISE recruited young females, ages 14 to 17, who completed lab experiences while working with female professors, learning from females who are engaged in science or science-related careers, and presenting their findings in a public setting. In addition, students lived in campus housing and participated in activities in order to have an introduction to life at a university. Over the course of WISE, participants interacted with at least six female scientists in the field, in the laboratory, and through formal and informal conversations (Table 1). Work at a local water stream was led by a female professor who studied the stream for over 20 years. This professor's specialties included environmental science and earth science, and her work with the WISE students occurred on the first full day of the camp. During her time with the students, she led the students to the stream, gave an overview of the experiments that were

Table 1 Details of WISE

Day	Events
1 (Evening only)	Check into dorm rooms. Meet with WISE staff, including analytical chemistry professor. Icebreaker and social activities
2	Travel to stream to study water quality with environmental science professor. Conduct laboratory experiments onsite at steam: invertebrate analysis, chemical tests on water. Collect water samples. Conduct laboratory experiments on campus with analytical chemistry professor: total suspended solids, total dissolved solids. Skype interview/discussion with biology professor about research in Alaska. Social activities
3	Continuation of laboratory experiments on campus with analytical chemistry professor: alkalinity, spectroscopy of samples to determine presence and amount of metal ions. Analysis of data and preparation of final presentations with analytical chemistry professor. Career panel with other female scientists who work in varied occupations. Social activities
4	Completion of laboratory experiments. Final preparation of presentations (including practice). Administration of camp survey. Checkout of dorm rooms. Presentation dinner

The first year of WISE lasted 5 days. Thus, activities in day 4 in subsequent years were spread out over days 4 and 5 in the first year, with the presentations being given at a luncheon on day 5. The camp survey was administered prior to the luncheon on day 5 in the first year

conducted, and assisted students as they studied the stream in small groups and had questions. On-campus laboratory work was overseen by a female analytical chemistry professor with 10 years of experience who also served as co-director of the camp, meaning that she was with the students each day of the camp. She interacted with students as they completed experiments, analyzed their data, and prepared presentations. The Internet-based session in the evening on day 2 was with a female biology professor who worked for over 20 years in the field to study owls and plant life in the state of Alaska. Students discussed this professor's research and what it was like to be conducting research outside of the laboratory. The panel session in the evening on day 3 of the camp occurred during the evening and involved three to five female scientists who worked in a variety of settings, including academia, industry, medical facilities, educational outreach, and political lobbying. All of the panelists had university degrees in science, and the number of female scientists who participated in the panel varied each year from as few as three to as many as five. During the panel session, the scientists discussed how they have used their education and training in science in their current career, even when their career paths did not have them directly working in science. This was done to allow WISE participants to learn about possible career opportunities that directly or indirectly applied knowledge in science obtained through higher education. The length of the camp in the first year was over 5 days but was reduced to 4 days after perceptions that students were exhausted and less productive toward the end of the camp in the first year. It was decided to move the presentations to the evening from the afternoon to encourage parents and educators to attend the presentations at a more convenient time.

Methods

Data was collected through a survey conducted on the final day of the camp, which was done to ensure that students' responses could be obtained before they left campus. Since the

camp was held over the summer, it was not practical to have students take the survey in a timely fashion in the weeks following the conclusion of the camp. The survey consisted of two parts: a Likert-style survey of 12 questions in which students rated features of the camp, followed by a series of six open-ended questions (Table 2) which asked students to talk about science, science careers, and how WISE did or did not influence their opinions. For the purposes of this article, only the six open-ended questions are addressed here, and results of the Likert-style survey will be addressed in an article published elsewhere. The questions for the entire survey were designed to capture student information in a short period of time (15 to 20 min). The only directions given to the students to answer the six open-ended questions were the following: "Answer the following questions based on your experiences." The six questions were designed to look at prior conceptions and experiences of students before WISE and to examine if the students' perceptions changed, if at all, from their experience in WISE. In addition, the questions were designed as an initial attempt at understanding student perceptions about science and science careers, since there is little to no knowledge in the literature about student opinions on science and science careers when participating in an outreach program such as WISE.

In order to participate in the survey, parental consent and student assent had to be given, as per the approved protocol submitted to the institution's Institutional Review Board (IRB). Because of a lack of parental consent, three students in the first year of the camp did not participate in the survey. To preserve anonymity, students did not provide a name or other demographics on the survey. However, all survey participants were females whose ages ranged from 14 to 17 years. In addition, these students came from schools located within 80 km (50 miles) of the institution where WISE was conducted, including public and private schools located in urban, suburban, and rural areas. As a result, students came from a variety of backgrounds, including some students who attended WISE on scholarship for either academic achievement or financial need. A total of thirty-eight students ($n = 38$) responded to the survey over the 4 years in which WISE operated.

The data received from the six open-ended questions found in the survey was converted from pencil-and-paper form to electronic form, with pseudonyms assigned to students' responses. A thematic analysis approach was used to code the data, using an open coding style (Braun & Clarke, 2006; Coffey & Atkinson, 1996). The data was analyzed initially by reading the responses of each student, noting key phrases that were said in similar ways by different students. This led to the creation of a set of codes that were then applied to all student responses. The data was then analyzed multiple times, across students and across each of the six open-ended questions, in order to apply the codes that were created. Codes were then organized into categories based on their relationship to each other. The categories were refined further after reviewing the

Table 2 Open-ended questions

What motivated you to attend WISE?
Were you interested in science as a career prior to attending WISE? Why or why not?
Has attending WISE affected your career decisions? Why or why not?
What is your opinion about pursuing a career in science?
Has attending WISE made an effect on your opinions about science careers? Explain.
What are your future plans for furthering your education?

responses of the students again. The categories were then clustered into themes. At this level, three themes were developed, with the categories being re-defined as subthemes. Another researcher who has expertise in qualitative research reviewed the codes, subthemes, and themes in a process known as check-coding as described by Miles and Huberman (1994) and used by other educational researchers (McAlister, Lee, Eldert, Kajfez, Faber, & Kennedy, 2017). In this measure of reliability of the data analysis, the other researcher coded a subset of the data separately and met with the author to review the coding. Analysis of the data was modified by the author and the researcher until there was a minimum of 95% agreement between both parties.

Findings

From among the responses of the 38 WISE participants who completed the six open-ended questions, there were three themes which emerged from the coding of the data. These themes are grounded in the responses provided by WISE participants. The themes that emerged, then, are the following: Love of Science, Aspirations for Success, and Impact of WISE.

Love of Science

This particular theme demonstrated that a significant majority of the WISE students had a great appreciation for science. Students would specifically say things such as "I love science" or similar phrases to show that science was a subject for which they cared. Three subthemes related to the love of science stood out from the rest (Table 3). The first subtheme, Interest in Science, showed how WISE participants appreciated science in general. This subtheme is consistent with one of the three facets that are critical for a successful outreach program like WISE, in that an outreach program should reflect student interests (National Research Council, 2015). The second subtheme, Before WISE, arose from a number of students mentioning how they appreciated science prior to attending WISE. The final subtheme, Already Good at Science, indicated that a number of WISE participants excelled in learning science.

Interest in Science

Most of the students (79%) had expressed that they were interested in science. For instance, Alice, who said she did "…love the science side of school," stated, "Yes, I've

Table 3 Theme 1: love of science

Subtheme	Definition	Example quote
Interest in Science	Student had a curiosity about science as a topic	"I love science and chemistry so I thought the camp would be perfect for me." (Francine)
Before WISE	Student had interest in science prior to attending WISE	"I love science and I also wanted to see what college was like and have a chance to study with professors." (Isabel)
Already Good at Science	Student believed that she excelled in learning science	"I've always excelled in Science and Math." (Olive)

always wanted to do something with science because it tends to be what I enjoy the most & what I'm good at." Beatrice express her interest through more specific topics within science, including animals: "I'm interested in animals and how the environment is super connected. I also love how the human body works and the career opportunities that are demanded because of how the body works." Celeste was similar in her thinking when she stated "…I love animals and discovering new things. I have always been curious and eager to be the first to discover things." Bernice echoed a similar sentiment when she responded, "I have always found biology very interesting, but I also wanted to help people in a specific way." Thus, student interest in science comes from a variety of interests and personal beliefs about what they may be able to accomplish in a scientific field.

Before WISE

A majority of participants in the survey (68%) knew that they wanted to pursue a career in science prior to attending WISE. Cora, like many other students, believed that WISE could help with future goals: "It [WISE] was something that I wanted to attend to see if I really like 'science' or go into nursing…like I want or was thinking." Bernice, on the other hand, thought that the topics covered in WISE were of interest to her, in part because of this sentiment: "Science has always been one of my favorite subjects in school!" Other students expressed interest in science but were interested to learn more. Specifically, Shelly mentioned she was "kinda" interested in science before WISE: "Because I love science class but wasn't sure how to make a career out of it." Irene had a similar notion as Shelly: "I was interested in science but not an actual career. I never really thought of being a scientist." These ideas reinforce the notion that teachers need to continue to motivate students to pursue interests in science when the students exhibit passion for science. Olive also wanted to further her time in science and explore opportunities through WISE: "I've always loved science, but I didn't know what I wanted to do. I wanted to come to get a better feel of what I wanted to do." Later on, Olive reinforced her interest of science when she stated that "…science is awesome!"

Already Good at Science Though not as commonly found among WISE participants, there was a group of students (18%) who admitted that they liked science because they excel in the field. When Olive noted that science was "awesome," she commented, "I've always excelled in Science and Math." Another student, Mae, reflected on her academic ability in science: "I like science & apparently (test scores show) I'm great at it." From this statement, it can be seen not only that Mae possibly was unsure why she was good at science but also that she may not have confidence or a strong belief in her talent in science, as has been previously reported (Heilbronner, 2013). Eleanor, who said she was "very interested in science," had similar opinions to those of Olive and Mae: "…I have always been good at science and math and they were always my strong suits." Alice, who said that she "loves the science side of school," wanted to pursue a career in science, "…because it tends to be what I enjoy the most and what I'm good at." Perhaps students were not as explicit in commenting that they were good as science, despite expressing interest in science, from either a lack of belief in their abilities in STEM or from a lack of belief in self-efficacy (Tellhed et al., 2017).

Aspirations for Success

Students were asked about careers and future education plans as part of the end-of-camp survey. From this, it was determined that WISE campers wanted to be successful in life as they get older, based on three subthemes (Table 4). The first subtheme, College Bound, indicated that most WISE participants were interested in postsecondary education. Making a Difference/Caring for Others, the next subtheme, illustrated what many of the females wanted to accomplish in their careers. Medical Careers, the last subtheme, arose from being the career specifically mentioned by WISE participants most often.

College Bound

Among the students who participated in the survey, a significant majority (89%) specifically indicated that they were going to continue their educational careers beyond the secondary level. Some students were succinct in their decision, such as Gladys, who said, "College, graduate school, job. You learn as you live." Others, such as Paulina, were looking to "attend college and pursue a Doctorate in Science (possibly Chemistry or some type of Engineering)." Paulina was among nine students who indicated that they wanted to pursue a graduate degree. Students have given thought to their potential majors in college, specifically mentioning biology, chemistry, or medical-related areas (as will be described later).

Making a Difference/Caring for Others

When looking into their futures, a group of students (32%) mentioned that they wanted to make the world more positive through their career paths. In other words, these students thought of their careers as being something more than a job that earns money. This construct was in line with findings from the STEAM program for Native American girls mentioned previously (Kant et al., 2018). Alice thought of a scientific career as "…a place where you can really make a difference with your research," while Cora wanted a career "…that will help others in the long way." Other students wanted to volunteer "at parks" (Helene) or "when I can" (Delores). Liesl, despite her lack of

Table 4 Theme 2: aspirations for success

Subtheme	Definition	Example quote
College Bound	Student expressed that she will pursue education beyond secondary school	"After high school I intend on going to a University to further my studies." (Gina)
Making a Difference/Caring for Others	Student wanted to help others and/or make a positive contribution to society	"I think science could be a good career for me because it would be the way to take care of the health of others." (Delilah)
Medical Careers	Student expressed an interest in a health-related career	"I'm wanting to attend an Ivy league medical school for neurosurgery." (Janette)

interest in science, was looking to her future when she said that she wanted to "…get a degree and a good job that I can be able to take [care] of my family and be able to provide for myself…" Nancy said that she wanted to "be a missionary nurse" and to "impact the world," and Cora expressed a similar notion: "I want to be a nurse, I just want to care for people."

Medical Careers

Nancy and Cora were among a set of students (32%) who wanted to go into a career related to health care. Students such as Nancy and Cora who seek medical careers tend to have a people orientation in a similar fashion as college students who major in biology or health-related fields (Yang & Barth, 2015). Among this subset of students, nursing was the most popular career choice. Others were looking to become doctors or veterinarians. Janette, for example, said that "I'm super driven to become a neurosurgeon."

Impact of WISE

Though the camp was less than 1 week in length, WISE did make an impression on the students who participated. This impact was seen through four subthemes that emerged from student responses (Table 5). Each of the four subthemes, which are based on the perspectives of the WISE participants, are consistent with two aspects needed for a successful outreach program, namely that the students are engaged and that students are seeing STEM beyond the classroom (National Research Council, 2015). The first of the subthemes, More Possibilities in Science, emerged from student perceptions of the many experiences they encountered at WISE. What Scientists Really Do emerged in a similar manner and came from interactions with female scientists throughout WISE.

Table 5 Theme 3: impact of WISE

Subtheme	Definition	Example quote
More Possibilities in Science	Student learned other ways to have a career in science or a science-related field through participation in WISE	"I have learned more about how broad Scientific careers are and about how many different research topics there are." (Paulina)
What Scientists Really Do	Student realized what scientists can do inside and outside of a laboratory through participation in WISE	"I think the camp has shown me the reality and daily work of scientists. It has changed my opinion and shown me the types of things scientists regularly do." (Lola)
Confirmation of Prior Goals	Student had reaffirmation of goals in a science career through participation in WISE	"…it [WISE] made me more sure that I want to go into science because I want to love my job like the scientists I've met." (Helene)
Confirmation of Interest in Science	Student had reaffirmation of curiosity about science through participation in WISE	"It [WISE] confirmed my love for science and my career choice." (Therese)

Confirmation of Prior Goals and Confirmation of Interest in Science demonstrated how students wanted to continue to become a scientist or learn more about science.

More Possibilities in Science

Since part of the purpose of the WISE camp was to educate students about different topics in science, it made sense that a majority of survey respondents (55%) learned about more ways to engage in science. Many of the students commented on the panel discussion held on the third evening of the camp in which women who were involved in scientific careers talk about their experiences in furthering their education and how their careers have flourished. For example, Olive, who had already stated that she was good at science, noted the following about the panel: "Before the panelists, I thought that there weren't as many science careers, just chemistry biology, and physics. Now I know that there much more and many go together." Interacting with female scientists, a predominant feature of WISE, is important to maintaining interest of females in STEM fields, as has been seen elsewhere (Riegel-Crumb & Moore, 2014). When looking at the future, Olive seemed to be encouraged to learn more about science: "My future plans are to take as many math and especially science classes in high school so that I have a better idea of what I want to do when I get to college." Alice was similar to Olive in excelling in science prior to WISE, but Alice had a different idea about what WISE did for her, when she stated, "I've realized that there are a ton more different science careers than I had previously thought there were." Delores also reflected on the panel and her time in WISE when she said, "Attending WISE and actually talking to the panel members showed me there are a lot of things that can and have been accomplished through science and I want to try this again!" Janette, who wanted to become a neurosurgeon, thought about science a little differently as a result of participating in WISE: "It's made me think of careers in science in a wider range and with more respect. Scientists are what make the world go round (they discovered orbit anyhow)." Bernice addressed this subtheme more simply when she said, "I have a better idea of the diversity within the field and how you can find your own path." Another student, Irene, had said that before WISE, "I was interested in science but not an actual career. I never really thought of being a scientist." After her participation in WISE, Irene's perspective had changed: "I want to do something with sciences as a career. This program kind of opened my eyes."

What Scientists Really Do

In addition to what students realized about the different possibilities of career paths in science, a sizeable portion of students (39%) realized that scientists do not always work in a lab, such as Tammy: "…before I thought it was all about staying in a lab but you can be a scientist in other places…" This is consistent with the concept of the National Research Council (2015) that students observe STEM in action outside of the classroom when participating in an outreach program. On the first full day of experiments (day 2 of the camp), Tammy and the other WISE students completed laboratory experiments alongside a water stream located 20 min away from campus, examining water quality through counts of invertebrate animals and through chemical tests on water samples taken directly from the stream. Another student, Kensington, thought of

her experience at WISE this way: "I have never thought of science the way I do now. I used to think it was only experimenting, not like making things…or testing water quality." Like Tammy, Kensington was able to see that science experiments can have variable outcomes that derive from a variety of objectives. Students in WISE were able to interact with scientists in a variety of settings beyond the laboratory and in the field, by engaging in informal conversations. The informal conversations during WISE included the Internet-based conference call with a faculty member conducting research several thousand miles away from campus on day 2 and with more locally based scientists who worked in industry, medicine, and government on day 3.

Conversations and interactions with female scientists during WISE led some students to change their beliefs about science careers. Fiona, who mentioned that she wanted to become a marine biologist, said that WISE was helpful with this career choice: "…I was not sure what being a biologist would entail and now I have a better idea." This was also seen in Celeste, who said that she was "leaning towards a science career" and that "I feel more experienced with what it would be like to have a science career" from participating in WISE. Abigail, who believed that a career in science "would be cool," and who plans to have a science career, commented that "before WISE I though a career in a science would be boring," but she no longer believes that, since WISE "…made me more curious about science." As far as her future would go, Abigail said, "I plan on going to college to become a vet or something in science."

Confirmation of Prior Goals

Celeste was among a group of students (39%) who believed that WISE helped them continue with career and educational goals. Celeste, who wanted to major in biology in college and explore careers in biological fields, said this about her experience, "WISE has solidified my feelings that science is so important as a career." This was after she stated "It [WISE] had confirmed my thought of becoming a biologist" and that "…I admire those who pursue further knowledge in the area." She goes on to say about her future that, because of WISE, "…now I have a lot more to consider for career possibilities and graduate school!" Janette, who wanted to become a neurosurgeon, felt that "WISE made me feel empowered as a woman and driven to prove everyone wrong in being a super successful neurosurgeon." Comments from students such as Celeste and Janette demonstrated how the structure of WISE, with its mix of lab experiments and discussions with several female scientists who worked directly or indirectly in science, was beneficial to students whose interest in science would continue as these students prepared for higher education.

Confirmation of Interest in Science

While some students expressed that their career or educational goals were supported by their participation and experience in WISE, other students (34%) explicitly mentioned that WISE maintained their interest or even strengthened their interest in science. One of the students who expressed the latter idea was Helene, who said "I wanted to go into science for several years before." Although the lab experiments conducted during WISE were not in her interests, Helene did say that WISE "…made me more sure that I want to go into science because I want to love my job like the scientists I've met."

Another student who had expressed an increase in interest in science was Delores, who had mentioned that she liked "taking care of animals and wanted to know like how I could apply myself to finding a career." After attending the camp, Delores believed that WISE "…makes me want to pursue even more things than just animals but also like human behavior and more." For Delores, then, her interests in science were confirmed, but also expanded, because of her participation in WISE. A student with a different perspective was Shelly, mentioned previously as liking science classes but unsure how to have a science career, who stated that WISE "…has shown me pros and cons about science careers. Mostly pros because I've learned new and fun things." In terms of her future, then, Shelly stated, "I have a vague idea but it definitely will be in the science field." The idea that students were able to learn "new and fun things," as Shelly stated, demonstrated that the activities of WISE were both educational and interesting for students.

Discussion

The WISE students provided a snapshot into their thinking about science, science careers, and how their participation in WISE affected their views. The three themes that emerged from the coding have addressed how student perceptions about science and science careers before and during their time in camp. The student participants appeared to have a strong interest in science and had mostly positive opinions about science and science-related careers. While not all of them were interested in science, WISE participants were able to perceive their involvement in WISE as a means of furthering their education, often leading to careers that require additional knowledge in science. Many of those interested in science maintained their interest in several different ways and were exposed to new ideas throughout the camp. These ways included changes in perceptions of what career they might select and what methods would be needed to achieve their career goals. Almost all of the students perceived that their future education would go beyond secondary school and many had indicated that they wanted to pursue graduate or degrees, with some doing this to become a caring individual in their work or community.

Programs such as WISE, then, can affect female students' perceptions about science and science-related careers. These educational opportunities allow students to explore different topics in science, interact with students who may have similar interests and learn from experts in science. This was seen through much of the statements and opinions made by the students who participated in WISE, which the events and activities throughout the WISE experience did make a positive difference in their attitudes toward science and science careers, with unique learning opportunities from female educators and scientists, along with more possibilities for success in science. Further, interacting with scientists who are in the midst of the careers was a benefit for many of the students who saw unique ways to pursue a career in science that the students did not know until they came to WISE. Their goals to pursue higher education were additionally confirmed by WISE through some of the non-academic activities. For instance, WISE allowed students to live on campus, enabling the students to gain perceptions of a campus-like atmosphere, living in dorms and eating in campus dining halls. Thus, students in WISE and other overnight programs at a university can not only

learn about the academic nature of higher education, but they can also learn about the social and cultural aspects, which occurred through interactions with university staff and students beyond the classroom or science laboratory.

Recruiting women to pursue further education in STEM requires efforts, such as a program at a community college that was able to double the number of females in engineering and technology fields with the aid of federal grants (Morris, 2014). Educators are primary advocates for females to go into science, and there are many ways in which teachers and professors can encourage young women to pursue science. Among these ways are being a mentor, making connections to internships, having a learning community for students who want to pursue STEM fields, encouraging students to do well on exams, and finding ways to have females in science careers nurture and develop students' interests in STEM (Davis, 2016). In many ways, these methods were utilized within WISE. The panel discussions that most students enjoyed during WISE helped to maintain and nurture interest in STEM, for example. Students were intrigued in particular by the research being conducted by faculty in biology and environmental science, with the water quality experiments being one instance of actual research taking place, since the female researcher who led the water quality experiments in the stream had been studying the particular stream for a couple of decades prior to WISE.

Limitations

Despite the findings presented here about female high school students and their perspectives on science and science-related careers, some cautions need to be addressed when interpreting the results. First is the idea that the responses of the students are a one-time "snapshot" of student opinions. There were no follow-up interviews done with the student participants, nor were there follow-ups on all of the students in terms of their future education. In addition, while the questions were open-ended in nature, the responses provided by the participants were not in depth as they could have been. The responses were sufficient enough, however, to be analyzed to find the themes that have been presented. Since WISE only lasted less than a week, it is possible that a novelty effect was observed, meaning that the students may have favorably responded to survey questions as a result of WISE being different and new to the students. Finally, the responses provided by the research participants should not be seen as being representative of the beliefs of all high school females. However, they do reflect what these students believe from their past experiences and from their time as participants in WISE.

Implications and Future Research

The study presented in this article provides an initial attempt to understand how high school females perceive science as a discipline and as a career possibility. Thus, future research should address how students who participate in science-themed experiences outside of formal schooling change and evolve as they complete secondary school and enter higher education. A more specific study of secondary school females can ascertain what features of science that students like and dislike and how those features have shaped their opinions about science. Also, the students can be asked to describe

features of science and science education that have encouraged them to pursue science in education and in career opportunities. This could include asking what educators and schools can do to encourage females to pursue additional learning opportunities in any scientific field. Further, schools at the secondary and post-secondary levels should offer opportunities for students to explore careers in science, including summer camps such as WISE, so that students can make informed decisions about their futures. Some efforts to encourage females to go into STEM fields include girls' robotics teams and other science competitions (Ullman, 2017). Students need to be shown all possible options for life as a scientist or in other careers where knowledge of science is important. Programs are attempting this concept, such as Million Women Mentors, which allows females in secondary and postsecondary levels to be connected to adults already in STEM fields to provide guidance and direction in STEM (Emeagwali, 2016). Another such endeavor can be found in California, known as the STEM Conference for Girls, which has had participation of over 400 secondary school females in a span of 5 years (Walker & Dalmage, 2016). These efforts, then, can allow for increased participation in all areas of science by female students, allowing for more diversity in scientific fields, and could lead to additional opportunities for future students.

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Compliance with Ethical Standards

In order to participate in the survey, parental consent and student assent had to be given, as per the approved protocol submitted to the institution's Institutional Review Board (IRB).

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