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An Analysis of Adolescents' Science Interest and Competence in Programs with and without a Competitive Component

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Abstract

The exploratory study examined science interest and perceived science competency in middle and high school youth (N=116) who took part in science-related contests (n=49) and non-competitive special interest science programs (n=67). Study participants were dispersed between females (48.3%) and males (51.7%). Three-fourths (75.1%) of the participants belonged to the racial category, white. The majority of youth attracted to science-related professions selected medicine and science and engineering as the top choices. Both science interest and science competence were high among youth in the study. Analysis of science competency indicated a statistically significant difference between girls and boys, with girls scoring higher than boys. The difference in scores between youth participating in competitive programs and non-competitive programs was also statistically significant. As a result of this study, it is recommended that high-quality, cutting edge, hands-on programs are offered to youth in both middle school and high school that emphasize science and provide opportunities for self-challenge as well as challenge against others.

Keywords: Competition; non-competitive; science; career; interest; adolescents

Globalization and exponential advances in science, technology, engineering, and math (STEM) have driven the United States' economy, creating well-paying careers and supporting an elevated standard of living (Rothwell, 2013). At the same time, America's segment of innovative STEM-based businesses is decreasing, which puts the United States' position as a global trailblazer at risk (Hausman & Johnston, 2014). A contributing factor to this decrease is the lack of a sufficiently prepared workforce who comprehends scientific concepts and demonstrates basic STEM skills necessary to thrive in a global economy (Roberts, 2012). Not only is there an inadequately prepared labor force negatively impacting the United States economy, a dramatic shortfall of scientists is expected in the coming years (Rotherham, 2011). This shortfall of scientists, coupled with the U.S. dependence on advanced technology, has the potential to even more adversely affect the economy as well as the country's status as an innovative leader in science and technology (STEM Food and Ag Council, 2014).

The possible decrease in STEM scientists is especially alarming considering the need for highly trained agricultural professionals (STEM Food and Ag Council, 2014). According to Goecker, Smith, Smith and Goetz (2009), the career opportunities within the field of agriculture are increasing. Krogstad (2012) shared that colleges are seeing a higher demand for degrees in agriculture. Universities are looking at how an interest in the intricacies of STEM innovation can be used to promote agricultural careers (Goecker et al., 2009).

With the United States' critical reliance on science and technology, it is imperative that youth are exposed and encouraged to pursue STEM careers as a potential solution to the lack of sufficiently equipped scientists. Research suggests that students are not aware of available careers

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and requirements for success within STEM fields of study (Rotherham, 2011; Subotnik, Tai, & Rickoff, 2010). Jacobs (2005) found a significant link among STEM competence, interest, and career aspirations. Other researchers have also identified science interest and competence as foundational factors affecting students' inclination to engage in STEM vocations (Fredricks & Eccles, 2002; Rice, Barth, Guadagno, Smith, & McCallum, 2012). In a longitudinal study, Tai and colleagues (2006) found that efforts to promote science interest in younger students served as important avenues to encourage aspiration towards science-related careers.

Science Interest and Competence

Interest as an overall construct is often vaguely defined and has different meanings depending on the theoretical perspectives of the researchers (Renninger & Hidi, 2011). According to Krapp (2002), interest is focused on a thing, activity, or subject matter area. Interest has a distinct, networked system of both affective and cognitive mechanisms (Hidi & Renninger, 2006). Researchers believe that the recurring psychological state of interest leads to enduring domain-specific interests (Swarat, Ortony, & Revelle, 2012). This is relevant to the study of science interest because it suggests that repeated exposure to STEM content and activities may lead to enduring interests in science (Hidi & Renninger, 2006; Krapp, 2002).

Competence is often described by words such as ability, aptitude, capability, competence, and skill. While competence can be ascribed to individuals, collective groups, or institutions, individual competence is having the capability that results in routine performance in an efficient, effective manner (Teodorescu & Binder, 2004). Researchers posit that perceived competence is a critical foundation that informs STEM career aspirations (Bandura, Barbanelli, Caprara, & Pastorelli, 2001; Ferry, Fouad, & Smith, 2000; Mau, 2003).

Nationally, the 4-H Youth Development Program has recognized the need for increasing science interest and feelings of competence as precursors to making a decision to pursue a STEM career. As a result of the National 4-H Science movement, the 4-H Youth Development Program is addressing the science deficiency with the goals of engaging youth in high quality STEM programming and of producing one million new scientists (National 4-H Council, n.d.). Involving youth in STEM activities is not a new concept within the 4-H Youth Development program. For many years local, area, and state professionals and volunteers have been actively working with youth to cultivate the STEM skills needed for them to thrive (Horton & Konen, 1997; Williamson & Smoak, 1999). Some research suggests that 4-H Youth Development programs increase youths' interest in science careers (Cater, Fox, & Tassin, 2013; Fox & Cater, 2013; Nichnadowicz, 2004) as well as promote feelings of science competence (Cater et al., 2013; Ponzio, 2006; Ponzio, Junge, Manglallan, & Smith, 2000; Tarpley, 2011).

Program Delivery

When it comes to program design, both the 4-H Youth Development Program and the National FFA Organization use the experiential learning model as their foundational education model (Arnold, 2003; National FFA Organization, 2006). The FFA and 4-H Youth Development Programs apply the experiential learning model to a variety of settings and delivery modes. For example, special interest programming is a delivery mode utilized in both 4-H and FFA contexts. Meadows (2005) describes special interest programs as targeted learning opportunities that last a minimum of six hours and that are delivered to an organized group of youth. The goal of a special interest program is to introduce subject matter within a short time frame to generate interest and develop participants' knowledge and skills in a content area. Special interest programs tend to be non-competitive in nature (Garst et al., 2006).

Contests or competitive events are another delivery mode utilized by both 4-H Youth Development and FFA Programs. Researchers have shown competition as an avenue of developing skills in youth (Kieth & Vaughn, 1998; Radhakrishna, Everhart, & Sinasky, 2006). While there is great variation among state 4-H and FFA programs, competitive activities include projects, shows, career development events, fair exhibits, judging contests, presentations, demonstrations, records, and scholarships (Kieth & Vaughn, 1998).

Although there have been numerous research studies exploring science interest (Baram-Tsabari & Yarden, 2011; Cater et al., 2013; Falk, Storksdieck, & Dierking, 2007; Lin, Lawrenz, Lin & Hong, 2013; Mau, 2003; Renninger, Ewen, & Lasher, 2002) and science competence (Cater et al., 2013; Lin et al., 2013), more information is needed to design nonformal school STEM learning environments that promote STEM career aspirations. Research is needed to better understand how different learning strategies, specifically competitive events and special interest programs, impact the connections among interest, competence, and career interest. This study aligns with the American Association for Agricultural Educators Research Agenda Priority #4: Meaningful, Engaged Learning in All Environments (Doerfert, 2011).

Theoretical and Conceptual Framework

Over the last half century, the concept of career development has been ever-changing. In recent years, researchers have examined cognitive factors and the practices that direct career interest and behavior. In the field of non-formal science education, consideration has been given to the intersection of problem-solving strategies, self-efficacy, and career orientation (Nugent et al., 2015). Building from Bandura's (1997) Social Cognitive Theory which emphasizes self-efficacy, defined as the extent of an individual's belief in their ability to complete specific tasks and accomplish goals, Social Cognitive Career Theory (SCCT) constructs theoretical connections that make suppositions about an individual's capability to impact their career growth (Lent, Brown, & Hackett, 1994). Cognitive strategies, like problem-solving methods used in everyday science activities, provide a space for connecting SCCT self-efficacy beliefs and career outcome expectations by exploring both precursor and mediating variables. In this case, cognitive strategies are precursor variables that may build science interest and, ultimately, career interest.

In addition to the emphasis on cognitive variables, the part that individuals play as engaged participants in their own career development has emerged. Researchers discovered that individuals based career outcomes on their views about themselves, their abilities, their settings, and potential careers. These views allude to the often complex pathways connecting science competence and career outcome expectations. Early research suggests that creative self-efficacy, feelings of ability to continue with creative actions despite obstacles (Bandura, 1997), supports the development of perceived science competence (Beghetto, 2007). Perceived science competence is strongly linked to STEM career interests (Potvin & Hasni, 2014).

In applying SCCT to the context of this study, SCCT suggests that the likelihood an individual will follow a career and thrive in a specific professional field increases when the individual feels competence (Diegelman & Subich, 2001; Lent et al., 1994). Researchers found that SCCT offered clarifications on associations between individuals and contextual factors embedded in career stage formation and development. The career formation stages include the growth of an individual's cognitive or vocational interests; identification and exploration of related professional path; and an individual's performance and pursuit in relationship to educational and professional opportunities (Lent et. al, 1994). Hence, the SCCT principles provide a theoretical foundation for the understanding and clarification of the role career focused educational programs play in helping students become aware of viable science-related career options and generate an interest in science-based agriculture and related fields. Figure 1 provides the theoretical framework for this study.

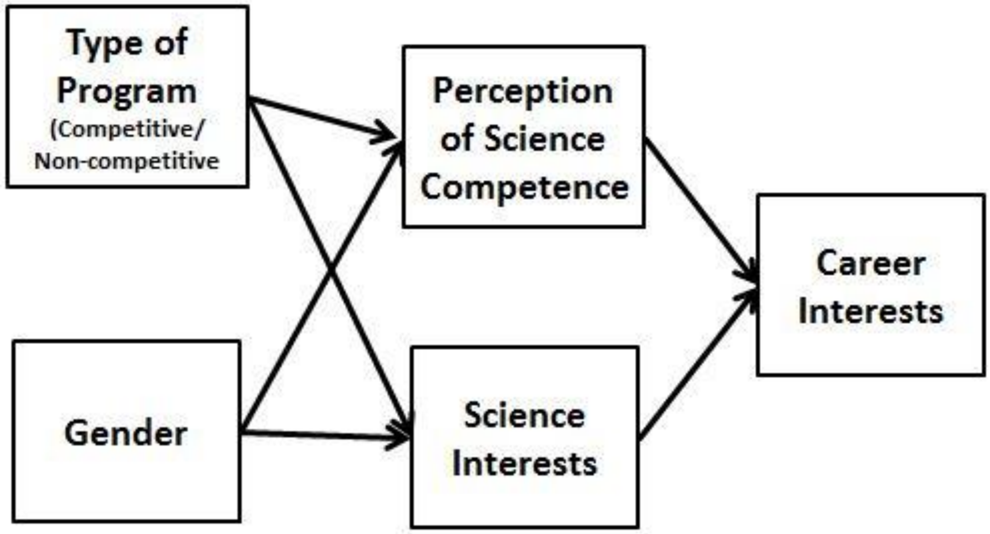

Figure 1. Theoretical framework for the 4-H science interest and competence study.

Purpose

The purpose of this study was to determine if differences exist in science career interests, science interest, and science competence between youth participating in competitive or non-competitive science programs. The study objectives were as follows:

1. To describe 4-H youths' science interest;
2. To describe 4-H youths' perception of science competency;
3. To describe 4-H youths' career interests;
4. To determine if differences in science competence and science interest exist between youth participating in competitive and non-competitive programs;
5. To determine if gender differences exist related to science competency and/or science interest; and
6. To determine if differences in perception of science competence and science interest exist between youth with science career interests and those with other career interests.
7.

Method

This study is a secondary analysis of data collected as part of a program evaluation. The study was approved by the Louisiana State University AgCenter Institutional Review Board. The target population for this study was seventh through twelfth grade youth participants in a state level conference who participated in science-based contests or non-competitive science programs.

Study Site

Each summer, the 4-H Youth Development Program hosts a statewide conference where youth participate in either a competitive event or a seven-hour program that is non-competitive in nature (i.e., special interest program). A focus of both programs is career exploration in a variety of STEM areas. This four-day, three-night conference attracts seventh through twelfth grade students from across a southeastern state. Youth select to participate in either contests or non-competitive special interest programs. Youth who participate in contests prepare in advance for participation in a subject matter specific contest. The youth in the non-competitive track select a seven hour, two-day workshop, also focused on specific subject matter. The competitive and non-competitive experiential events are held at a local University with University professionals providing leadership to both types of events.

Participants

When selecting participants, the researchers first identified STEM special interest programs and STEM contests from the university event. The special interest programs were defined as the non-competitive forensics, forestry, and robotics classes. The reciprocal competitive options were computer simulation, environmental conservation illustrated talk, environmental threat resolution, and forestry. Surveys were completed by a census of participants (N=116) in the identified special interest (n=67) and competition-based (n=49) programs.

Survey respondents were almost equally represented by gender with 56 females (48.3%) and 60 males (51.7%). Respondents were predominantly white (see Table 1).

Table 1

Race of Study Participants

Race	*n*[a]	%
White	86	74.8
African American	27	23.5
American Indian	1	0.9
Other	1	0.9
Total	115	100.0

[a]1 youth did not report race

The largest percentage of study participants were in 10th grade (see Table 2), though grades 8, 9, and 11 were equally well-represented.

Table 2

Grade Level of Study Participants

Grade	*n*	%
7th	7	6.0
8th	22	19.0
9th	23	19.8
10th	30	25.9
11th	27	23.3
12th	7	6.0
Total	116	100.0

Instrumentation

For the purposes of this study, *science interest* was defined as the psychological condition of interest in science which includes both established interest over time and temporary interest elicited by exposure to a science context (Swarat et al., 2012). Several existing science interest scales were reviewed for use with this study. Reviews of existing instruments revealed that negatively worded items were commonly used. Given research which suggests that negatively worded items are often misinterpreted by youth (Borgers, Hox, & Sikkel, 2004; Marsh, 1986), a determination was made to use five positively worded items from the Modified Attitudes toward Science Inventory (MATSI) (Weinburgh & Steele, 2000) which represented science interest and four positively worded science interest items from the National Assessment of Educational Progress (2009). These nine items were selected because they had been previously validated and because the wording of the items closely aligned with our definition of youths' science interest. Since the items were not used as originally validated, exploratory factor analysis was conducted to determine the psychometric properties of the items. A single construct emerged explaining 66.8% of the variance. An examination of internal consistency with participants in this study returned a Cronbach's alpha score of 0.95 for this nine item scale.

Science competence was defined as youths' "self-judgments about their ability to be successful in a particular domain or activity" (Beghetto, 2007). Three items were used for the science competence portion of this study (Bevan, 2008). The items aligned with the definition of self-judgment of a person's ability to be successful in science and in a science-based career. Exploratory factor analysis was used to establish the psychometric properties. A single construct emerged explaining 73.7% of the variance. The Cronbach's alpha score for the science competence scale was 0.89. Responses for both constructs, science interest and science competency, were collected using a 4-point Likert scale (1 = strongly disagree to 4 = strongly agree).

Career interest was gauged using a single item (Bevan, 2008). Twelve choices were provided, 11 responses representing career categories and 1 don't know response (see Table 5). Choices aligned with groups listed in the Bureau of Labor Statistics Occupational Outlook Handbook (2011). All items comprising the instrument were reviewed by two youth development experts with non-formal science program evaluation experience. Pilot testing of the instrument with middle and high school was conducted to establish its validity with the population.

Data Collection

Youth educators for the program were given one-on-one training in the data collection protocol and were supplied with a data distribution checklist that outlined the steps in the process. As part of the training, educators were instructed on how and to whom to distribute the survey, on participants' right to refuse to participate, and on how to return completed surveys to the researcher. Participants completed the paper survey at the conclusion of the conference.

Data Analysis

Data were analyzed using the Statistical Package for Social Scientists (SPSS) 22.0. Research objectives one through three (i.e., science interest, perception of science competence, career interests) were descriptive in nature and were analyzed using frequencies, percentages, means, and standard deviations. Objectives four through six were comparative. Specifically, objective four compared perception of science competence and science interest by gender. Objective five compared perception of science competence and science interest by youth participating in competitive and non-competitive programs. Objective six compared perception of science competence and science interest by career interests (i.e., science or non-science). Objectives four through six were analyzed using independent t-tests. In order to limit the Type I error risk, the Bonferroni correction was used. Since this procedure is very conservative, the experiment-wise alpha was set at .10 yielding a per-comparison alpha of 0.017 (Warner, 2013).

Findings

The first objective of the study was to describe participants' science interest. A 4-point Likert scale, 1=Strongly Disagree, 2=Disagree, 3=Agree, and 4=Strongly Agree, was used to collect responses. "I like science" garnered the highest agreement (*n* =98; 84.5%). Participants were least likely to agree with the statement "When I graduate from high school, I would like a job related to science" (*n* = 70; 60.8%). Means scores were computed using the nine items of the science interest scale. The overall group mean for the science interest construct was 2.92 (SD=.669). Higher science interest scores were reported by youth participating in the non-competitive program, by females, and by youth who were interested in science careers (see Table 3).

Table 3

Mean Scores for Science Interest by Selected Sub-groups

Sub-Group	M^a	SD^a
Type of Program		
Non-Competitive	2.97	.58
Competitive	2.86	.78
Gender		
Female	2.99	.64
Male	2.86	.70
Career Interest		
Science Career Interest	3.10	.68
Non-Science Career Interest	2.71	.63

[a]Overall Group M = 2.92 (SD = .669)

Describing youths' perception of science competency was the purpose of the second study objective. This scale also used a 4-point Likert scale. Youth reported the strongest agreement with the statement "I learned new things about science at this event" (*n* = 89; 77.2%). Means scores were computed using the three items of the science competency scale. The overall mean for science competency was 2.86 (SD = .724). Non-competitive track participants, females, and youth with science career interests had the highest scores on the science competency scale (see Table 4).

Table 4

Mean Scores for Science Competency by Selected Sub-groups

Sub-Group	*M*[a]	*SD*[a]
Type of Program		
Non-Competitive	3.02	.59
Competitive	2.63	.83
Gender		
Female	3.01	.69
Male	2.71	.73
Career Interest		
Science Career Interest	2.91	.78
Non-Science Career Interest	2.80	.69

[a]Overall Group *M* = 2.86 (*SD* = .724)

The third objective of the study was to describe the career interests of the participants. Respondents could choose one category of the twelve that were listed. Career categories that were defined as science-based included agriculture, architecture and construction, medicine, and science and engineering. The remaining career types were classified as non-science: arts, entertainment, sports, communication, and tourism; business and marketing; education and counseling; finance; government, law, and security; manufacturing and repair; and transportation. A larger percentage of youth indicated an interest in science-based careers (n = 65; 58.1%) than in non-science careers (n = 45; 36.6%).The career category with the highest number of responses was medicine (n = 30; 26.8%); manufacturing and repair received the fewest responses (n = 1; 0.9%) (see Table 5).

Table 5

Frequency and Percentage of Youth Selecting Each Career Type

Career	*n*	%
Medicine	30	26.8
Science and Engineering	21	18.8
Arts, Entertainment, Sports, Communication, Tourism	13	11.6
Education and Counseling	11	9.8
Agriculture	10	8.9
Government, Law, Security	10	8.9
Architecture and Construction	4	3.6
Business and Marketing	2	1.8
Finance	2	1.8
Transportation	2	1.8
Manufacturing and Repair	1	0.9
Career	*n*	%
Don’t Know	6	5.4

The fourth objective of the study was to determine if differences existed between youth participating in competitive programs and non-competitive programs. Levene’s test for homogeneity of variances indicated that the variances for both science interest (F = 9.736; $p < .01$) and science competence (F = 11.004; $p < .01$) scores were not equal. Results of the independent t-test, equal variances not assumed, indicated a statistically significant difference in science competency scores of non-competitive program participants and competitive participants (t = 2.79, p < .01). Youth in the non-competitive program had statistically higher science competence scores than youth in the competitive program. Cohen's *d* was 0.617 indicating a medium practical effect. The science interest scores of contest and non-competitive program participants were not significantly different (see Table 6).

Table 6

Independent t-test Results for Youth by Program Type

Factor	*t*	*df*	*p*
Science Interest[a]	.897	84.269	.372
Science Competence[b]	2.790	81.667	.007

[a]Non-Competitive Program (*M* = 2.97; *SD* = .58); Competitive Program (*M* = 2.86; *SD* = .78)
[b]Non-Competitive Program (*M* = 3.02; *SD* = .59); Competitive Program (*M* = 2.63; *SD* = .83)

The purpose of objective five was to determine if gender differences existed related to science competency and/or science interest. There was no significant difference in science competence or science interest between males and females (see Table 7).

Table 7

Independent t-test Results for Youth by Gender

Factor	*t*	*df*	*p*
Science Interest[a]	1.082	114	.282
Science Competence[b]	2.276	114	.025

[a]Female (*M* = 2.99; *SD* = .64); Male (*M* = 2.86; *SD* = .70)
[b]Female (*M* = 3.01; *SD* = .69); Male (*M* = 2.71; *SD* = .73)

The purpose of the sixth study objective was to compare science interest and science competence scores of youth who expressed an interest in a science career with those interested in other types of careers. When comparing these two groups using an independent t-test, there was no significant difference between groups when compared on perception of science competence (see Table 8); however, there was a statistically significant difference in science interest (t = 2.926; p < .01). That is, youth with science career interests had significantly higher science interest scores than did youth with non-science career interests. Cohen's *d* (Cohen, 1988) was 0.574 indicating a medium practical effect.

Table 8

Independent t-test Results for Youth by Career Interest

Factor	*t*	*df*	*p*
Science Interest[a]	2.926	104	.004
Science Competence[b]	.726	104	.470

[a]Science Career Interest (M = 3.10; SD = .68); Non-Science Career Interest (M = 2.71; SD = .63)
[b]Science Career Interest (M = 2.91; SD = .78); Non-Science Career Interest (M = 2.80; SD = .69)

Discussion

Competitive versus Non-Competitive Strategies

Both competitive and non-competitive program delivery models have value in increasing youths' science interest and competence. Competition is perceived by youth to foster learning and excellence and to act as a motivator (Miller, Pater, & Mynatt, 2013; Radhakrishna, Everhart, & Sinasky, 2006). Non-competitive program models often offer youth chances to collaborate and socialize with peers (Miller et al., 2013). In this study, science competence scores were significantly higher for non-competitive program participants than for competitive participants, and no difference was found between the two groups on science interest scores. At least in terms of science interest, this may suggest that youth are equally drawn to competitive and non-competitive delivery methods. Given the lower science competence scores of youth in the competitive portion of this study, careful consideration may be given to how competitive programs are designed so that all youth develop a sense of competence, regardless of later competitive placing. Design features that support this objective may include offering in-depth science skills trainings before competition to help youth recognize and improve their science skills, using experiential approaches that allow youth to experience success applying science skills before a competition, and connecting youth to both peer and adult mentors who can assess their needs and support science skill development.

Gender

A common hypothesis is that girls are less interested in science than boys. Earlier research revealed the perception of science professions as male-oriented fields while more recent studies have shown that societal gender norms have had a negative influence on girls' STEM interest which may imply that girls feel unable to compete in scientific subjects (Andre, Whigham, Hendrickson, & Chambers, 1999; Ceci, Williams, & Burnett, 2009; Fredricks & Eccles, 2002). This study documented no statistically significant relationship between science interest and gender. That is, girls were no more or no less interested in science than boys. These results mirror those of a recent meta-analysis which found no support for the claim that girls are less interested in science than boys (Potvin & Hasni, 2014). Findings also indicated that the difference in science competence scores of males and females was not statistically significant. Although non-significant, females did have higher competence scores than males. Existing research suggests that females tend to have lower scores than males (NCES, 2011). This was an interesting finding of this study that should be explored in more depth to determine if female perceptions of science competence may be shifting.

Whether used with in-school or out-of-school environments, strategies that will encourage a shift in the culture supporting girls' science career interests and feelings of science competence are essential. One of the strategies that program developers may use is to design programs that offer girls a safe and inclusive place to explore science concepts. Psychological safety is of paramount importance; that is, girls should feel free to actively engage in learning that is free from ridicule and embarrassment. Adults who model and teach open communication and respect for individuality help youth build their own communication skills while also building a safer, more inclusive environment. Another strategy that program developers may use to support girls' science career interests and feelings of science competence is targeting STEM career development programs at elementary and middle school audiences (Broadley, 2015). Science career interests that originate in elementary and middle school years are more likely to persist into post-secondary career training and professions while also allowing girls to initiate feelings of science competence at a younger age (Broadley, 2015). An ecological systems approach is a third strategy that may support girls' science career interests and feelings of science competence. An ecological systems program design includes schools, out-of-school time science programs, and parents as equal, contributing members of any intervention. Recent studies show that both parents and informal educators have a significant influence on girls' science career interests; thus, it's not just a school's responsibility to nurture science interest into science career interests and feelings of competence (Broadley, 2015; Nugent et al., 2015).

Career Interest

While Americans trail their Japanese and Chinese counterparts in the pursuit of science degrees by a large margin, it is promising to note that youth who are interested in science are also more likely to have an interest in a science career (Jahn & Myers, 2015). In this study, 58.1% of youth expressed interest in a science-based career. This articulation of a science career interest aligns with respondents' high agreement (60.8%) with the science interest scale item "When I graduate from high school, I would like a job related to science." Previous research suggests that exposure to science professions is an effective approach to boost interest in STEM career involvement (Blustein & Flum, 1999; Dorsen, Carlson & Goodyear, 2006). Youth involved in the competitive program portion of this study had the chance to meet industry professionals both as part of their training for competitive events and at the competition itself. Youth who participated in the non-competitive, special interest programs worked with industry professionals who were co-teaching or guest speaking at the program. In both instances, youth were exposed to STEM careers through their interactions with these professionals and had the opportunity to gain a better idea of how science played a role in each professional's job.

Since science career outcome expectations are strongly influenced by science interests (Lin et al., 2013; Nugent et al., 2015), it is important to both increase and maintain science interest. In this study, the overall group mean for youths' science interest levels ($M = 2.92$) was relatively high. Bourdeau (2004) maintained that the experiential learning model was an effective way to increase youths' science interest because the hands-on learning approach was both fun and engaging. Hands-on learning may be strengthened by the use of cognitive-oriented strategies to promote interest and stimulate engagement in STEM activities (Lin et al., 2013). An example of a cognitive strategy is using self-reflection at the end of a science activity so that youth think about and articulate the procedures they used to solve a problem. The reflection questions help youth make sense of the activity by linking to prior knowledge and everyday phenomena and by aiding them to develop their own internal, replicable self-questioning procedures.

One challenge facing programs like 4-H and FFA is to showcase the versatility of agricultural-based science programs. Youth in this study showed the greatest interest in medicine as a career (26.8%) as compared to only 8% of the youth who were interested in pursuing agricultural careers. Both 4-H and FFA have a history of offering programs which develop general science inquiry skills. Program efforts that demonstrate the "pipeline" from formal and non-formal youth agricultural programs to undergraduate degrees to professional programs are critical to helping youth understand the value of these experiences. One example of how youth may build an awareness of this pipeline is through hands-on agriculture workshops led by extension animal specialists. These workshops introduce 4-H and FFA youth to basic science concepts (e.g., animal genetics) that are useful immediately in their livestock projects. Through intentional program planning, youth may also be exposed to a potential undergraduate field of study and also be introduced to how a career path in animal science can lead to dental school or medical school. The intentionality of the program plan is key to helping youth to see the pipeline. This can be accomplished through simple conversations with the youth that are purposely incorporated throughout the workshop or through formal presentations.

Youth reported feeling a sense of competence in science that may best be described as above average. There was no difference in perception of science competence between youth with science career interests and those youth with other career interests. These finding are similar to those of Lin et al., (2013) who also found no relationship between perceived competence and career interest. While the psychometric properties and reliability of the science competence scale were well within acceptable ranges, it should be noted that it is a three-item construct and that the brevity of the scale could be a potential limiting factor.

Conclusions, Recommendations and Implications

Youth learn more effectively when they understand how science content applies to everyday life, particularly when the educational setting is more life-like and less classroom-based (Brown, Collins, & Duguid, 1989; Threeton & Pellock, 2010). Educational organizations such as 4-H Youth Development and FFA offer real world, experiential models that promote science interest and competence in real-world educational settings. Practical implications of this study address both program design and program delivery. In terms of delivery, it is recommended that programs target youth in elementary, middle, and high school so that interest and competence are initiated at a younger age and sustained through high school. This suggests that the program should be designed to offer a logical sequence of opportunities through which to progress from middle school to high school. Another recommendation is to design programs specifically for improving science interest, competence and science career interests in girls. It is also recommended that program developers design programs based on ecological systems theory. These theory-based programs should include both formal education systems and youth organizations working together to expose youth to science careers. Finally, at both levels of school and community, diverse program offerings (e.g., both competitive and non-competitive) are key to engaging a larger youth audience.

In terms of research needs, while the use of reflection questions is common in non-formal education settings, it is not as well-researched as their use in formal education settings. The influence of cognitive strategies on increasing science interest in non-formal education settings along with the long-term effect on science career interest is one future direction for research. While the scope of this study is much too small to generalize to a wider population, it may be possible that a cultural shift is occurring where girls are becoming equally confident to pursue their interest in science and science careers. Meta-analysis is one method that provides deeper insight into the net benefit of interventions by combining results of independent studies. This would be particularly useful when looking at programs that specifically target building science interest and science career interest in girls. We recommend further study of girls' perceptions of science competence to determine if a positive shift is occurring.

References

Andre, T., Whigham, M., Hendrickson, A., & Chambers, S. (1999) Competency beliefs, positive affect, and gender stereotypes of elementary students and their parents about science versus other school subjects. *Journal of Research in Science Teaching*, 36(6), pp. 719-747. doi:10.1002/(SICI)1098-2736

Arnold, M. E. (2003). Using multi-site methodology to evaluate 4-H leadership retreats. *Journal of Extension*, 41(6). Retrieved from www.joe.org/joe/2003december/rb1.php

Bandura, A. (1997). Self-efficacy: The exercise of control. New York: Freeman.

Bandura, A., Barbanelli, C., Caprara, G. V., & Pastorelli, C. (2001). Self-efficacy beliefs as shapers of children's aspirations and career trajectories. *Child Development*, 72(1), 187-206. doi:10.1111/1467-8624.00273

Baram-Tsabari, A., & Yarden, A. (2011). Quantifying the gender gap in science interests. *International Journal of Science and Mathematics Education*, 9(3), 523-550. doi:10.1007/s10763-010-9194-7

Beghetto, R. (2007). Factors associated with middle and secondary students' perceived science competence. *Journal of Research in Science Teaching, 44*(6), 800-814. doi:10.1002/tea.20166

Bevan, B. (2008). Student survey on interest and ideas about science. Unpublished survey.

Blustein, D. L., & Flum, H. (1999). A self-determination perspective of exploration and interests in career development. In M.L. Savickas & A. Spokane (Eds.), Vocational Interests: Their Meaning, Measurement, and UseiIn Counseling, (pp. 345-368). Palo Alto, CA: Davies-Black Publishing.

Borgers, N., Hox, J., & Sikkel, D. (2004). Response effects in surveys on children and adolescents: The effect of number of response options, negative wording, and neutral mid-point. *Quality & Quantity, 38,* 17-33. doi:10.1023/B:QUQU.0000013236.29205.a6

Bourdeau, V.D. (2004). 4-H Experiential Education – A Model for 4-H Science as Inquiry. *Journal of Extension*, 42 (5). Retrieved from http://www.joe.org/joe/2004october/tt3.php

Broadley, K. (2015). Entrenched gendered pathways in science, technology, engineering and mathematics: Engaging girls through collaborative career development. *Australian Journal of Career Development, 24*(1), 27-38. doi:10.1177/1038416214559548

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, 18(1), 32-41.

Bureau of Labor Statistics. (2011). *Occupational outlook handbook.* Washington DC: US Bureau of Labor Statistics.

Cater, M., Fox, J. E., & Tassin, M. G. (2013, February). *An analysis of competition and non-competitive programs on science interest and competence in adolescents*. Eastern Educational Research Conference, Sarasota, FL.

Ceci, S. J., Williams, W. M., & Burnett, S. M. (2009). Women's underrepresentation in science: Sociocultural and biological considerations. *Psychological Bulletin*, 135, 218-261. doi:10.1037/a0014412

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Earlbaum Associates.

Diegelman, N. M., & Subich, L. M. (2001). Academic and vocational interests as a function of outcome expectancies in social cognitive career theory. *Journal of Vocational Behavior*, 59(3), 394-405. doi:10.1006/jvbe.2001.1802

Doerfert, D. (Ed.). (2011). *National research agenda: American Association for Agricultural Education's research priority areas for 2011-2015.* Lubbock, TX: Texas Tech University, Department of Agricultural Education and Communications.

Dorsen, J., Carlson, B., & Goodyear, L. (2006, February). Connecting Informal STEM Experiences to Career Choices: Identifying the Pathway. ITEST Learning Resource Center.

Falk, J. H., Storksdieck, M., & Dierking, L. D. (2007). Investigating public science interest and understanding: Evidence for the importance of free-choice learning. *Public Understanding of Science,* 16(4), 455-469.

Ferry, T. R., Fouad, N., & Smith, P. L. (2000). The roles of family context in a social cognitive model for career-related choice behavior: A math and science perspective. *Journal of Vocational Behavior*, 57, 348-364. doi:10.1006/jvbe.1999.1743

Fox, J. E., & Cater, M. (2013, February). *An examination of gardening interest among students participating in school gardens.* Eastern Educational Research Conference, Sarasota, FL.

Fredricks, J. A., & Eccels, J. S. (2002). Children's competence and value beliefs from childhood through adolescence: Growth trajectories in two male-sex typed domains. *Developmental Psychology,* 38(4), 519-533.

Garst, B. A., Hunnings, J. R., Jamison, K., Hairston, J., Meadows, R. R., & Herdsman, W. R. (2006). Exploring the adolescent life skill outcomes of State 4-H Congress participation and the different outcomes of gender and race groups. *Journal of Extension,* 44(6). Retrieved from www.joe.org/joe/2006december/rb2.php

Goecker, A. D., Smith, G. P., Smith, E. & Goetz, R. (2009). Employment opportunities for college graduates in food, renewable energy, and the environment. Washington, D.C.: National Institute for Food and Agriculture. Retrieved from http://www3.ag.purdue.edu/USDA/employment/Documents/USDAEmployOp2010.pdf

Hausman, A., & Johnston, W. (2014). The role of innovation in driving the economy: Lessons from the global financial crisis. *Journal of Business Research, 67*(1), 2720-2726. doi:10.1016/j.jbusres.2013.03.021

Hidi, S. & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist*, 41(2), 111-127. doi:10.1207/s15326985ep4102_4

Horton, R., & Konen, J. (1997). 4-H classroom science programs enriching the learning environment. *Journal of Extension* [Online], 35(6) Article 6FEA1. Retrieved from http://www.joe.org/joe/1997december/a1.php

Jacobs, J. E. (2005). Twenty-five years of research on gender and ethnic differences in math and science career choices: What have we learned? *New directions for child and adolescent development,* (110), 85-94. doi:10.1002/cd.151

Jahn, J., & Myers, K. (2015). "When will I use this?" How math and science classes communicate impressions of STEM careers: Implications for vocational anticipatory socialization. *Communication Studies, 66*(2), 218-237. doi:10.1080/10510974.2014.990047

Kieth, L., & Vaughn, P. (1998). The value of 4-H competitive activities as perceived by the parents of 4-H members. *Journal of Agricultural Education*, 39(3), 41-50**.** doi:10.5032/jae.1998.03041

Krapp, A. (2002). Structural and dynamic aspects of interest development: Theoretical considerations from an ontogenetic perspective. *Learning and Instruction*, 12(4), 383-409. doi:10.1016/S0959-4752(01)00011-1

Krogstad, J. M. (2012, August 5). Colleges see higher demand for degrees in agriculture. *U. S. A. Today*. Retrieved from http://usatoday30.usatoday.com/money/industries/food/story/2012-08-01/agriculture-industry-studies-surge/56809406/1

Lent, R.W., Brown, S.D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of Vocational Behavior, 45*, 79-122. doi:10.1006/jvbe.1994.1027

Lin, H. S., Lawrenz, F., Lin, S. F., & Hong, Z. R. (2013). Relationship among affective factors and preferred engagement in science-related activities. *Public Understanding of Science, 22*(8), 941-954. doi:10.1177/0963662511429412

Marsh, H. (1986). Negative item bias in ratings scales for preadolescent children: A cognitive-developmental phenomenon. *Developmental Psychology, 22*(1), 37-49. doi:10.1037/0012-1649.22.1.37

Mau, W. C. (2003). Factors that influence persistence in science and engineering career aspirations. *Career Development Quarterly*, 51(3), 324-243. doi:10.1002/j.2161-0045.2003.tb00604.x

Meadows, R. R. (2005). Virginia 4-H delivery modes matrix. Blacksburg, VA: Virginia Cooperative Extension. Retrieved from http://www.ahnrit.vt.edu/TechSupport/HelpDesk/4hSupport/documentation/4hDeliveryModesMatrix.pdf

Miller, A., Pater, J., & Mynatt, E. (2013). Design strategies for youth-focused pervasive social health games. Proceedings from 7th International Conference on Pervasive Computing Technologies for Healthcare and Workshops.

National 4-H Council. (n.d.). 4-H science programs. Retrieved from http://www.4-h.org/youth-development-programs/4-h-science-programs/

National Assessment of Educational Progress. (2009). Science student background questionnaire. Washington DC: National Center for Education Statistics.

National Center for Education Statistics (NCES). (2011). The Nation's Report Card: Science 2009. NCES 2011–451. Institute of Education Sciences, US Department of Education 2011. Retrieved from http://nces.ed.gov/nationsreportcard/pdf/main2009/2011451.pdf

National FFA Organization. (2006). *National FFA career development events handbook.* Indianapolis, IN: National FFA Organization.

Nichnadowicz, J. (2004). The union county 4-H summer science program: An effective method for increasing low-income youth's interest in science. *Journal of Extension* [Online], 42(3) Article 3IAW4. Retrieved from http://www.joe.org/joe/2004june/iw4.php

Nugent, G., Barker, B., Welch, G., Grandgenett, N., Wu, C., & Nelson, C. (2015). A model of factors contributing to STEM learning and career orientation. *International Journal of Science Education.* Advance online publication. doi: 10.1080/09500693.2015.1017863

Ponzio, R. (2006). Welcome to 4-H SERIES. In R. Enfeld & J. George (Eds.), It came from planted Earth (pp. i-v). University of California Division of Agriculture and Natural Resources. Retrieved from http://www.ca4h.org/!les/13928.pdf

Ponzio, R., Junge, S., Manglallan, S., Smith, M. (2000). 4-H youth experiences in science project. Davis, CA: #e Regents of the University of California. Retrieved from http://ucanr.org/sites/UC4-H/!les/20005.pdf

Potvin, P., & Hasni, A. (2014). Interest, motivation and attitude towards science and technology at K-12 levels: A systematic review of 12 years of educational research. *Studies in Science Education, 50*(1), 85-129. doi: 10.1080/03057267.2014.881626

Radhakrishna, R. B., Everhart, L., & Sinasky, M. (2006). Attitudes of 4-H participants about 4-H competitive events. *Journal of Extension*, *44*(6), Article 6RIB3. Retrieved from http://www.joe.org/joe/2006december/rb3.php

Renninger, K. A., Ewen, L., & Lasher, A. K. (2002). Individual interest as context in expository text and mathematical word problems. *Learning and Instruction*. 12(4), 467-491. doi:10.1016/S0959-4752(01)00012-3

Renninger, K. A., & Hidi, S. (2011). Revisiting the conceptualization, measurement, and generation of interest. *Educational Psychologist*, 46(3), 168-184.

Rice, L., Barth, J. M., Guadagno, R. E., Smith, G. P. A., & McCallum, D. M. (2012). The role of social support in students' perceived abilities and attitudes toward math and science. *Journal of Adolescence*. doi:10.1007/s10964-012-9801-8

Roberts, A. (2012, May/June). A justification for STEM education. *Technology and Engineering Teacher*, 72(8), TTTE1-5.

Rotherham, A. J. (2011, May 26). The next great resource shortage: U.S. Scientists. *Time U.S.* Retrieved from http://www.time.com/time/nation/article/0,8599,2074024,00.html

Rothwell, J. (2013). *The hidden STEM economy*. Washington DC: Metropolitan Policy Program at Brookings.

STEM Food and Ag Council. (2014). *STEM annual report 2014*. Retrieved from Iowa Lieutenant Governor's website: https://ltgovernor.iowa.gov/wp-content/uploads/2014/10/STEM_Final_Small.pdf

Subotnik, R.F., Tai, R.H., & Rickoff, R. (2010). Specialized public high schools of science, mathematics, and technology and the STEM pipeline: what do we know now and what will we know in 5 years? *Roeper Review*, 32(1), 7-16.

Swarat, S., Ortony, A., & Revelle, W. (2012). Activity matters: Understanding student interest in school science. *Journal of research in science teaching, 49*(4), 515-537. doi:10.1002/tea.21010

Tai, R., Liu, C.Q., Maltese, A.V., & Fan, X. (2006). Planning early for careers in science. *Science*, 312, 1143-4. doi:10.1126/science.1128690

Tarpley, M. (2011). Discover scientific method research poster contest. Texas 4-H Youth Development. Retrieved from http:// texas4-h.tamu.edu/library/!les/project_4h_science_poster_guide_11

Teodorescu, T., & Binder, C. (2004). Getting to the bottom line: Competence is what matters. *Performance Improvement* 43(8), 8–12. doi:10.1002/pfi.4140430805

Threeton, M., & Pellock, C. (2010). An examination of the relationship between SkillsUSA student contest preparation and academics. *Journal of Career and Technical Education*, 25(2), 94-108.

Warner, R. (2013). *Applied statistics: From bivariate through multivariate techniques.* Thousand Oakes, CA: Sage.

Weinburgh, M. & Steele, D. (2000). The modified attitudes toward science inventory: Developing an instrument to be used with fifth grade urban students. *Journal of Women and Minorities in Science and Engineering, 6,* 87-94. doi:10.1615/JWomenMinorScienEng.v6.i1.50

Williamson, R., & Smoak, E. (1999). Creating a down-to-earth approach to teaching science, math and technology. *Journal of Extension* [Online], 37(3) Article 3IAW3. Retrieved from http://www.joe.org/joe/1999june/iw3.php