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Research Article

Adding Relevancy to STEM Interest Through Adventure Education: A Mixed Methods Study

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ABSTRACT

The purpose of this mixed methods concurrent triangulation study was to assess the vocational relevancy of adventure STEM for sixth grade students attending the Science Adventure School (SAS), a residential, informal education program focused on delivering adventure STEM education to low-income, rural students. Specifically, this study sought to research any changes in STEM attitudes, including science interest (Eccles, 2007; Gilmartin et al., 2007) and science career interest (Sadler et al., 2011) as a result of participating in SAS. In the quantitative phase of the study, curriculum relevancy and STEM attitudes were assessed with a pre- and post- adventure STEM experience survey. The qualitative portion of the study consisted of semi-structured in-person interviews with 14 students and eight teachers shortly after their SAS experience to gain additional insights into the results of the statistical analysis and identify how students and teachers see the relevancy of adventure STEM curriculum. This study's findings add to the body of adventure STEM literature and lends support to the positive benefits of engaging youth in adventure STEM programming.

Keywords: STEM education, adventure education, informal education, outdoor learning

INTRODUCTION

Students in the United States are falling behind the rest of the world in terms of interest in STEM (science, technology, engineering, and mathematics) related fields and in their ability to study and work in these fields, which may lead to an inability to fill vacancies in a growing job market (ACT, 2017). At the same time, they have been performing at lower levels in STEM subjects (Daugherty, 2013), and their interest levels in STEM remain stagnant (ACT, 2017). Educators, policy makers, and business leaders are concerned that there will not be enough STEM graduates to fill vacancies in a growing job market (Hanushek et al., 2012). Despite a lack of students pursuing careers in the STEM, STEM curriculum is not lacking in the classroom. Policy makers and business leaders have been pushing for more STEM based educational opportunities in schools since the 1990's (Breiner et al., 2012), and these have steadily risen in response to their efforts. So, if there are plenty of STEM opportunities available to them, why do students remain uninterested in these classes?

STEM Education

In recent years, STEM educational approaches have become a popular trend in the United States to bolster the country's workforce with college graduates who can compete internationally and bring innovation to businesses and companies. The definition of STEM education incorporates both the subjects that instructors are expected to teach and the methods that they use to teach STEM curricula. STEM education refers to 'teaching and learning in the fields of science, technology, engineering, and mathematics' (Gonzalez & Kuenzi, 2012, p. 1). According to Breiner et al. (2012, p. 3), STEM education also involves 'the replacement of traditional lecture-based teaching strategies with more inquiry and project-based approaches.' For the purpose of this paper, the two definitions will be combined to include all four subject areas of STEM and experiential-based teaching methodologies. While there is some debate as to the overall combination of the four areas (Daugherty, 2013), a unified definition of STEM can include each area applied either alone or in conjunction with another area, regardless of how well they are integrated.

The benefits of pursuing a post-secondary STEM degree are numerous. STEM graduates can expect higher wages across their lifetimes and may be less likely to experience unemployment. STEM workers earned 29% more than non-STEM workers in 2015, and they continue to make more than non-STEM graduates even when they choose a non-STEM occupation (Noonan, 2017). Additionally, STEM workers are half as likely to be unemployed as non-STEM workers (Noonan, 2017). STEM curricula can also increase learning and enjoyment of the subject, as lessons and projects are often student-designed and student-driven, which can in turn lead to higher GPAs and retention rates (Gilmer, 2007; Halpern et al., 2007).

Since choosing a STEM degree has many benefits, it may seem counterintuitive for so many students to choose other degrees. Research shows that students' chief complaint about science class is that it is boring (Hossain & Robinson, 2012; Turner et al., 2010). They dislike memorizing facts and equations, and writing long technical reports (Osborne et al., 2003; Owen et al., 2008). They also perceive science subjects as too difficult or unwelcoming (Turner et al., 2010). By the time many students reach middle school, they have already decided against pursuing STEM classes that are not required by their schools (Jenkins & Nelson, 2005; Osborne et al., 2003). Students who perceive school as boring or irrelevant are less motivated to learn (McInerney & McInerney, 2000). Interestingly, there is a distinction between interest in STEM as an idea and interest in STEM as it is taught in schools. Students see value in STEM as a concept and feel that STEM is good for society, but they view the STEM taught in their classes as uninteresting and irrelevant (Sjoberg & Schreiner, 2005). Thus, the problem of students' disinterest in pursuing STEM careers may not be in the subject itself, but in how it is taught.

Relevance

The concept of relevance may prove useful in understanding why students are experiencing lower levels of STEM interest. Relevance goes beyond interest and addresses the individual, societal and vocational needs of the students on an intrinsic and extrinsic level (Stuckey et al., 2013). Students who find that their course material has an obvious impact upon their lives may be more likely to see science curriculum as important or useful. Positive attitudes can influence behavior (Fishbein, 1966), so a positive attitude toward science may lead to greater engagement with the subject. Engagement is 'broadly a positive and proactive term that captures students' quality of participation, investment, commitment, and identification with school and school-related activities to enhance students' performance' (Alrashidi et al., 2016, p. 42). Engagement has also been shown to predict student performance in school (Alrashidi et al., 2016; Dogan, 2015; Fredericks et al., 2004). Thus, it follows that academic relevance has the potential to influence attitudes about the subject being taught, which can influence academic engagement, which may, in turn, lead to better performance in that subject.

While educators have worked to make content more relevant to students than in the past, many young learners still fail to see relevancy in their schoolwork. This is particularly true for science education. Starting around the age of nine, positive student attitudes toward science show a steady decline (Osborne et al., 2003). Students do not find the material in class applicable to their personal lives or communities (Hofstein et al., 2010). Thus, making science education more relevant is crucial to increasing the personal interests of STEM students. When students recognize that studying science can help them grow, benefit their home communities, and be a viable career option, everyone benefits.

Adventure Education

Adventure education, defined as an educational experience that takes place in conjunction with outdoor activities (Priest & Gass, 2017), may be uniquely suited to increase the relevance of STEM education, because it is grounded in hands-on, practical experience (Miner & Boldt, 2002; Ringholz, 2000), which is something children report as being their favorite part of science lessons (Murphy, 2003). Adventure education theory comes from a constructivist perspective that is often lacking in traditional classrooms. Additionally, because most experiences in adventure education take place outside, they are often immediately novel and appealing to students (Walsh & Golins, 1976).

When combined with STEM education, adventure education can provide a more relevant vehicle for STEM learning than many classroom experiences. For example, many students have experienced riding a bike. In an adventure STEM lesson focused on bikes, students learn about the physics that relates to riding a bike and how their muscles influence its ability to start and stop. They then have the opportunity to manipulate the bike's movement as they ride. This lesson takes something that they are already accustomed to seeing, teaches them how it works with STEM principles, and allows them to experiment. These meaningful and personal connections are at the heart of relevance (Ham, 2016).

STEM Attitudes

By making STEM curriculum more relevant to students, it may become possible to increase positive attitudes toward their STEM classes, which may increase persistence in STEM (Osborne et al., 2003). Attitudes are:

1. affective, relating to how people feel about things or other people, and
2. evaluative, meaning that they determine the degree to which people see something as good or bad (Gawronski, 2007).

Attitudes are also important because they can play a role in changing behavior (Fishbein, 1966).

STEM interest and career interest

Interest is an overarching construct found in STEM attitudes, with identity and self-efficacy as additional constructs or subconstructs. STEM interest can refer to several dimensions. This study focuses on subject interest, which refers to a student's curiosity in learning about the STEM subject, and career interest, which refers to a student's desire to pursue a job in the STEM fields (Sadler et al., 2011). Though they are linked, it is important to distinguish the two, as a student who enjoys learning about STEM may not want to become a professional in the field, and vice versa. STEM interest may be key components of increasing students' academic interest in the subject. STEM interest can be defined to include 'a combination of students' self-perceptions and interest in science and science-related work' (Gilmartin et al., 2007, p. 982). Any interest that a student has in a particular subject, STEM included, increases the likelihood that they will pursue and persist in a related career choice (Eccles, 2007).

Table 1. Demographic information of participating students

	Intervention sample	Control sample
Number of students	344	53
Gender		
Male	47.6%	48.1%
Female	51.6%	51.9%
Other	.8%	
Race and ethnicity		
White or Caucasian	74.4%	86.5%
Black or African American	4.1%	
Hispanic or Latino	2%	
Asian	1.2%	
Native Indian or Indigenous American Indian	.8%	
Two or more races	10.6%	3.8%
Other	3.3%	1.9%
Prefer not to provide	3.7%	7.7%

Interest, combined with career aspirations, informs the value that the person places on a career path in relation to the costs which they may have to incur to pursue and retain the career (Eccles, 2007).

Research indicates that many students show more interest in learning about STEM subjects than they do in taking STEM classes. Osborne et al. (2003) posit that this may be because contemporary science curriculum focuses on scientific discoveries from the past rather than on how science addresses issues from the present. Science in the classroom often seems disconnected from modern culture and is presented as something that should be studied for its own sake (Ebenezer & Zoller, 1993), rather than for its potential to effect change. The lack of perceived relevance, and therefore interest in taking STEM classes, is also likely contributing to why students may not choose to pursue STEM. Even though many students see the concept of STEM as interesting, they are still not interested in pursuing STEM careers (Abels, 2015; Jenkins & Pell, 2006). Taken together, for students to want to work in STEM fields, they must see STEM courses as relevant as well as interesting to study.

METHODS

Research Design

This study was a mixed methods quasi-experimental study designed to both assess change in STEM attitude constructs and gain a better understanding of how students perceive the relevancy of the adventure STEM curriculum. A mixed methods framework was chosen because of its pragmatic approach that seeks to combine the best of both quantitative and qualitative approaches into a flexible design (Maxcy, 2003). By using both approaches, it becomes possible to compensate for weaknesses in one methodology with strengths of the other (Johnsonet al., 2007).

Specifically, this study utilized a concurrent triangulation design, which is used for cross-validation within a single structure (Terrell, 2012), increases validity, and reduces method and researcher bias (Greene et al., 1989). In this methodology, both qualitative and quantitative data are collected in the same phase of research, analyzed separately, and then integrated during the interpretation phase of the study (Terrell, 2012).

To quantitatively examine the relationship between adventure STEM curriculum and relevancy, a non-randomized quasi-experimental design with a both a treatment and control group was used. For the qualitative portion of this study, a phenomenological approach was chosen. As Van Manen (2016) describes, phenomenology is the reflection of the lived human experience. Phenomenological research seeks to describe what all participants have in common as they experience a phenomenon (Creswell et al., 2003) and distill those experiences down to the universal essence of their interaction with the phenomenon (Van Manen, 2006).

Sample

Sixth-grade students and their teachers were chosen for this study as literature indicates that science interest markedly declines in middle school (Jenkins & Nelson, 2005; Osborne et al., 2003). Eleven schools from four counties took part in the study. The treatment group sample size of the quantitative portion of this study consisted of 344 students while the control group consisted of 53 students from the same schools as the treatment group.

The sample size of the qualitative portion of the study consisted of 14 students and eight teachers. The number of interviewed participants was consistent with the recommendation that five to 25 individuals be interviewed in phenomenological studies (Polkinghorne, 1989). Students came from the same schools as the treatment population, and interviewed students also completed the survey. Teachers came from the same school systems as the students (**Table 1**).

Participant Recruitment

Using a census approach, all sixth-grade students and teachers from the schools who attended SAS had an opportunity to participate in this study. For the quantitative survey portion of the study, convenience sampling was used (Onwuegbuzie & Collins, 2007) due to concern regarding limited numbers of student participants in the program.

Student participants of the qualitative interview portion of the study were purposefully selected from each school (Onwuegbuzie & Collins, 2007). Teachers were asked to recommend students who would be comfortable speaking and being recorded. They were also told that students did not need to like science or be strong academic performers in an attempt to avoid interviewing only students with strong positive science attitudes. Students were chosen from each school to ensure a better understanding of population school systems.

Teacher participants in the qualitative portion were a convenience sample. As a limited number of teachers attended SAS, it was deemed best to approach all potential interview subjects with the goal of obtaining enough interview data. All teachers who attended SAS had an opportunity to participate.

Setting

SAS was hosted at a 14,000-acre Boy Scouts of America facility located in southern West Virginia. The facility can host as many as 40,000 individuals overnight, and provide activities which include mountain biking, BMX biking, skateboarding, archery, rifle and shotgun shooting, zip-lining, canopy tours, swimming, scuba, challenge course, rock climbing, and rappelling. There are also interpretive trails, a wetlands boardwalk and a sustainability treehouse, which showcases the local ecosystem and sustainable technology.

Students attended SAS from September through October for four days of programming. Students and teachers attended camp for free through funding provided by private donors. They camped onsite in tents for three nights and received meals from the dining facility. Campsites were split evenly by gender with three-four students of the same gender assigned to one tent. Each group of 14 students was assigned two instructors to accompany them throughout their time at the camp and serve as discussion facilitators and resources for support. One teacher from the students' schools was assigned to each group to assist instructors and provide continuity for teachers.

Students interacted with two kinds of staff daily: their assigned group facilitators and environmental and STEM education instructors. Both groups of staff took part in a week-long training prior to the beginning of SAS with emphasis on content delivery and group discussion facilitation. While there was some overlap in training, facilitator training focused most heavily focused on managing interpersonal relations, delivering group discussions, promoting individual and group growth, and creating an enjoyable camp experience. Environmental education and STEM education instructors' training revolved around delivering STEM or environmental education lessons related to their areas of focus.

Treatment

In comparison with one standard week of school, a week of camp consisted of four days of programming. Students' arrival time at camp depended on the distance traveled, but most schools generally arrived around midmorning on Tuesdays. Once they arrived, students immediately split up into groups, stowed their belongings in their tents, and then participated in a site orientation, introductory icebreakers, and a scavenger hunt session. Over the course of the four days, students participated in a variety of adventure STEM activities including science behind the sport (SBTS) rock climbing, SBTS ziplining, and SBTS archery (West Virginia University, 2020). They also took part in environmental education activities related to topics such as phenology and freshwater ecology, as well as positive youth development based discussions.

All activities included content lessons with time spent doing the activity and applying the material in the moment. During their rock climbing class, they learned about the physics principles involved with climbing equipment and their body movements while climbing, as well as rock geology and its relation to climbing. Through zip-lining, they explored the forces exerted on them while zip-lining and estimated their zip-lining speeds, and learned more about forest ecology at each zip platform. In archery class, the students learned about the scientific principles behind a bow and the arrow's flight. Phenology lessons focused on identifying seasonal changes in the landscape. Finally, students also participated in freshwater ecology activities, where they learned about the effects of pollution in water systems as they conducted a macroinvertebrate inventory in a stream that leads into the property's lake. Each evening the students had free choice activity time. Activities varied based on instructor interest but including things like fishing, tea drinking, slack lining, and a geology escape room. On Tuesday and Wednesday evening they also had focused discussions on fears related to transitioning to middle school and on positive self-talk. The night before leaving camp, the students participated in a celebratory campfire night. Prior to leaving on Friday, each class had an opportunity to complete the "big zip", a particularly tall and long zip line, and participated in a bead ceremony, which allowed them to recognize each other's strengths and accomplishments in the preceding days.

Measures

Survey instrument

Students were given a sixteen-item 5-point Likert-type survey instrument to assess STEM attitudes, specifically STEM interest, STEM career interest, and STEM career knowledge. As the SAS camp's curriculum falls most heavily in the science domain of STEM, instruments using the term 'science' were prioritized over items focusing on other STEM domains.

The *science opinion survey* used in the survey comes from Gibson and Chase's (2002) work with the attitudes of middle school students toward science. This instrument was used to evaluate the constructs of *STEM interest* and *STEM career interest*. The *science opinion survey* consists of 30 statements and was originally created for the national assessment of education progress to assess subject areas across the United States (Gibson & Chase, 2002), and it was written to accommodate middle school reading levels. In order to maintain survey brevity for the students, full scales were not used, but three to four items for each construct were chosen. Individual items were chosen based on their relevancy to SAS. Although it was not an item from Gibson and Chase's (2002) research, students were also asked to name three potential STEM careers to evaluate whether their knowledge of STEM career options changed after spending time at the SAS.

The survey instrument was designed with the needs of children in mind. The survey was kept as short as possible, with items from middle school-based surveys that include age-appropriate language and sentence structure (Christensen, 2017). As Likert scales can sometimes be more difficult for youth, the survey ranking system used words instead of numbers (Mellor & Moore, 2013).

Interview protocol

Fourteen semi-structured, in-person interviews were conducted with students immediately following SAS. The interview protocol for students drew from two previous studies. The first was Hughes et al.'s (2013) study, which looked at the formation of STEM identity in middle school students attending informal science programs. Though the study focused on science identity, many of its questions were well suited for being adapted to other constructs. The second study looked at STEM-based outcomes (Sahin et al., 2014) in 10 students with the goal of understanding student experience and learning in after-school STEM programs. As with the previous study, differing contexts required that questions be adapted to better fit the research goals of this current study.

Teachers' interviews were less focused on specific STEM constructs. This was because teachers had only been with students for a short time before attending SAS, or in some instances, were not one of the students' main teachers. It would not be realistic for teachers to be able to assess changes in specific constructs without having deeper baseline knowledge of their students. Instead, teachers were asked more general questions with the goal of connecting their insights to constructs during the data analysis process of coding. Their interview protocol was also informed by Hughes et al.'s (2013) study.

Data collection

The quantitative portion of the study was conducted over the course of two months. Students who chose to participate were given a survey while at their schools on the Monday before they attended camp. All treatment surveys were administered digitally using Qualtrics software (Snow & Mann, 2013) through desktop computers, laptops, or tablets. All control group surveys were administered via paper survey. As student reliability in completing surveys cannot always be assumed, using two separate survey media was done deliberately to guarantee that the two samples surveys could not inadvertently become mixed. The same survey was re-administered post-camp. In most cases, this meant that students took the post-survey a week after taking the pre-survey.

The qualitative component of this study had two phases. The student interviews took place concurrently with the post-survey administration. Upon arrival at the school, the researcher solicited suggestions from teachers for interview participants and students were interviewed after completing their surveys. Teacher interviews took place after student data collection was completed approximately a month after camp ended. Interviews took place via telephone, and teachers were contact via email after their respective interview was transcribed for member checking (Shenton, 2004).

Data analysis

Once data was cleaned, statistical package for social science (SPSS) software was used to compare the mean pre- and post-survey difference of each construct by individual student through the use of a paired t-test analysis (Hsu & Lachenbruch, 2005). A frequency analysis was used to compute demographic information. Cronbach's alpha was calculated for each construct's survey item to estimate internal consistency of responses in multi-item scales (Vaske et al., 2017).

Qualitative data analysis included the information from students and teachers, though each sample was analyzed individually. Conventional content analysis was used to identity relevant pieces of data for further analysis (Bowen, 2009; Hsieh & Shannon, 2005). This technique is an established method for looking at text-based data (Thorne, 1994) on a phenomenon where literature is limited (Hsieh & Shannon, 2005). A priori codes were established before analysis began (Saldaña, 2016), as they are necessary to integrate data in concurrent triangulation study designs (Greene et al., 1989). In this study, a priori codes consisted of the STEM constructs assessed by the survey questionnaire. Codes were also allowed to emerge as a result of the coding process (Saldaña, 2016).

Student and teacher interviews were examined separately. Data analysis for each began by reading the data repeatedly to fully immerse the researcher in the data (Bowen, 2009; Hsieh & Shannon, 2005). Transcripts were then read word-for-word to capture key thoughts and concepts. (Hsieh & Shannon, 2005). These impressions were analyzed to generate codes associated with each key piece of text (Hsieh & Shannon, 2005). Next, Dedoose software was used to code transcripts with both a priori and emergent codes (Taylor & Treacy, 2013). Codes were categorized based on their relationships and linkages to other codes, and categories were clustered into meaningful themes (Hsieh & Shannon, 2005). Subthemes were generated as they emerged and organized into a hierarchical structure with the corresponding exemplary text (Hsieh & Shannon, 2005). Data analysis was considered complete upon emergence of a consistent picture of how students and teachers viewed the curriculum (Bowen, 2009). Themes were then compared for frequency of appearance across the corresponding pool of student or teacher interviews.

Coding followed Saldaña's (2016) approach, with the researcher performing the bulk of the coding, and associated assistants providing collaborative coding throughout the process for the purpose of providing a "crowd sourcing reality check" (p. 38) to ensure that codes authentically represented the data. A quantitative intercoder agreement approach was considered, but ultimately rejected due to the interpretive process of qualitative research and instead in-depth discussion with group consensus was selected as being truer to the discipline (Saldaña, 2016). As the next step in the coding process, two researchers independent of the project reviewed the data. They made their own notes and generated their own codes and themes, before the group met to discuss findings (Saldaña, 2016). Discussion continued until all involved had reached a consensus on the codes and themes. (Saldaña, 2016).

Data integration

After findings for were each were finalized, the results were compared during the interpretation phase of the study to search for similarities and differences between the two datasets (Terrel, 2012). Specifically, the results of each survey construct were compared with the instances where the same construct emerged or did not emerge from interview data.

Table 2. Summary of paired t-test for treatment group

Construct	Item	PM	PsM	MC	SD	t	S (2-tailed)
STEM interest	Science lessons are fun.	4.31	4.35	+.04	.985	-.647	.518
	I would like to learn more about science.	4.28	4.17	-.11	1.186	1.505	.134
	Science is one of the most interesting school subjects.	4.02	4.06	+.04	1.089	-.644	.520
STEM career interest	When I leave school, I would like to work with people who make discoveries in science.	3.47	3.53	+.06	1.340	-.714	.476
	A job as a scientist would be interesting.	3.93	3.90	-.03	1.148	.389	.698
	I would like to be a scientist when I leave school.	**2.93**	**3.21**	**+.28**	**1.300**	**-3.433**	**.001**
STEM career knowledge	**Name three potential STEM careers.**	**3.08**	**3.32**	**+.24**	**1.025**	**-3.732**	**.000**

Note. PM: Pre mean; PsM: Post mean; MC: Mean change; SD: Standard deviation; S: Significance at α=.05, df=245. Response scale of 1-5, for all except STEM career knowledge with higher numbers corresponding to higher level of agreement. Bolded text denotes significant items

Limitations

As with any study, some limitations were inevitable. The smaller sample size of the control group had its own associated limitations (Price & Murnan, 2004). Because camp took place near the beginning of the school year, schools were often rushed to complete field trip-related paperwork resulting in a large portion of the original control group being eliminated due to missing parental consent forms. Small sample size likely influenced the control group's survey responses, as analysis revealed the two samples were dissimilar, potentially lowering the trustworthiness of the study's results (Price & Murnan, 2004).

The contrasting survey scores could have also been influenced by the non-random nature of participant selection. As was also a limitation in Hughes et al.'s (2013) study, the teachers who attended SAS were self-selected and allowed to choose the students that attended SAS, which may have influenced the experimental population by favoring students with stronger academics or those who already had positive attitudes or interest in science. A final potential explanation of differing survey score results could be the students' knowledge of their camp attendance. SAS attendance may have influenced experimental group students to interpret the survey more positively, while control group students could have interpreted it more negatively (Price & Murnan, 2004).

Additionally, prior experience with STEM was not assessed with the survey sample and prior experience with outdoor activities was not assessed with either quantitative or qualitative samples. Students' unknown previous experience participating in these types of activities, either with their families or in school or club contexts, limits the degree of change that can be inferred.

One of the most significant potential limitations is the unknown relationship between the SAS experience and the students' return to their classrooms. This study assumes that there was a transference of learning from SAS to the classroom, and that students who participated in SAS connected their learning at SAS to their school environments. However, as Brown (2010) points out in his work examining transference, this may not have happened. In the same way that students associate their classroom science with boredom, they may associate SAS with a fieldtrip type of experience that is engaging and amusing, but ultimately separate from their classrooms (Brown, 2010). This may lead to more ephemeral attitude changes toward STEM.

QUANTITATIVE RESULTS

Student Surveys

Of the group of 393 sixth-grade students from eleven schools who attended the SAS, 344 students were surveyed, yielding a completion rate of 87.5%. Of the 344 surveys administered, 98 were eliminated due to incomplete or inconsistent results or the absence of the student from either the pre- or post-survey, leaving a total of 246 completed surveys and a final overall response rate of 62.6%. 74 sixth-grade students from six schools who did not attend SAS were surveyed to establish a control group. Of these surveys, 22 were eliminated due to incomplete or inconsistent results or the absence of the student from either the pre- or post-survey, which left a total of 53 completed surveys and a final response rate of 71.6%.

Based on data from the 246 completed surveys in the experimental group, there were significant increases in one item from the science career interest scale, and in the science career knowledge item (**Table 2**). There were no significant changes from pre-test to post-test found for the 53 paired surveys from the control group (**Table 3**).

However, pre-test scores of the control group were lower than those of the experimental group indicating a potential limitation within the data. Concurrently, while administering surveys and conducting interviews, multiple teachers reported that students who attended the program had been selected by schools based on internal criteria, creating doubt as whether the two samples were similar.

An individual t-test was run to compare the two samples' pre-test scores. Results revealed a significant difference between the experimental and control groups on all but one construct. Additionally, an ANCOVA test using pre-test scores as the covariate was also run. Over half the items showed statistically significant difference between the experimental and control groups. These results coupled with prior analysis and teacher reports add support to the idea that there was a potential pre-existing difference between experimental and control groups related to selection for participation (**Table 4**).

Cronbach's alpha statistic was run for both the pre- and post- survey results of the test group with post-test alpha values higher than pre-test. It is generally accepted that a Cronbach's alpha in the range of .65 -.80 is adequate (Vaske, 2008) though more specifically alphas greater than or equal to .9 are excellent, .8-.9 is good, .8-.7 is acceptable, .6-.7 are questionable, and .5-.6 are poor (Glen, 2014). Acceptable pre-

Table 3. Summary of paired t-test for control group

Construct	Item	PM	PsM	MC	SD	t	S (2-tailed)
STEM interest	Science lessons are fun.	3.71	3.75	+.04	1.357	-.204	.839
	I would like to learn more about science.	3.62	3.56	-.06	.826	.503	.617
	Science is one of the most interesting school subjects.	3.31	3.15	-.16	1.211	.916	.364
STEM career interest	When I leave school, I would like to work with people who make discoveries in science.	2.83	2.98	+.15	1.319	-.841	.404
	A job as a scientist would be interesting.	3.46	3.35	-.11	1.132	.735	.466
	I would like to be a scientist when I leave school.	2.21	2.46	+.25	1.493	-1.207	.233
STEM career knowledge	Name three potential STEM careers.	3.08	2.83	-.25	.968	1.863	.068

Note. PM: Pre mean; PsM: Post mean; MC: Mean change; SD: Standard deviation; S: Significance at α=.05, df=51. Response scale of 1-5, for all except STEM career knowledge with higher numbers corresponding to higher level of agreement

Table 4. Summary of ANCOVA analysis using pre-score as covariate

Construct	Item	TIII-SS	df	MS	f	S
STEM interest	**Science lessons are fun.**	**2.977**	**1**	**2.977**	**4.585**	**.033**
	I would like to learn more about science.	.917	1	.917	.944	.332
	Science is one of the most interesting school subjects.	**3.418**	**1**	**3.418**	**4.448**	**.036**
STEM career interest	When I leave school, I would like to work with people who make discoveries in science.	4.284	1	4.284	3.449	.062
	A job as a scientist would be interesting.	.616	1	.616	.646	.422
	I would like to be a scientist when I leave school.	**12.363**	**1**	**12.363**	**10.7**	**.001**
STEM career knowledge	**Name three potential STEM careers.**	**2.556**	**1**	**2.556**	**3.926**	**.048**

Note. TIII-SS: Type III sumof squares; MS: Mean square; S: Significance at α=.05. Response scale of 1-5, for all except STEM career knowledge with higher numbers corresponding to higher level of agreement

Table 5. Student themes with significant codes

Theme	Code name	Child code	Code definition	%	Representative quote
Elementary school STEM experience	Experiments in class		Student refers to doing experiments or a specific experiment memory in elementary school	71	I figured out how to make a pickle glow. I did that as one of my science fairs. We hooked up a bunch of electricity to it and then it made it glow.
Changing science attitudes	Change in STEM opinion	Science is 'bigger'	Student expresses that science includes more component or aspects than they previously believed	50	That there is a lot more in science to do than I thought there would be.
	STEM knowledge		Person indicates that students has learned more about an aspect of STEM or has learned more STEM content knowledge	86	We learned a lot. We learned about watts and electrical currents. We learned how to zipline safely. What the science is behind ziplining.
	STEM interest		Person makes reference to students being interested in STEM	43	The science school made [science] more fun to learn about.
	STEM career interest		Person makes reference to students being interested in a STEM career	86	One [career interest] is to study to try and become an inventor and the other is a physicist.
	Relevance		Person expresses that what is learned or taught at SAS is relevant to a student's life including, personal/interpersonal, vocation and social dimensions	76	You were actually doing it and it was a lot easier to understand when you were actually doing it.

test values were found for STEM interest (.78) and STEM career interest (.745). All post-test alpha values for STEM interest (.832) and STEM career interest (.822) were good.

QUALITATIVE RESULTS

Student Interviews and Themes

14 students were interviewed about their thoughts on SAS. Nine students identified as female and five students identified as male. Half (50%) of these students reported having at least one parent working in a STEM field, and 79% indicated that they had some degree of interest in STEM before coming to the SAS. Thematic categories that emerged from the interviews are defined and illustrated with representative quotes in Table 5, where % is percent of students mentioning code idea.

Changing STEM attitudes

Overall, most students reported an increase in positive attitudes toward STEM, particularly in short-term outcomes such as STEM career knowledge. Twelve students felt that they knew more about STEM and had a better knowledge of how the STEM principles they were introduced to at the SAS worked. Eleven students felt that STEM related to their daily lives in general, which two students felt that STEM would be useful at school. Additionally, 12 students were interested in pursuing a STEM career in the future after their experience at SAS.

Table 6. Teacher themes with significant codes

Theme	Code name	Child code	Code definition	%	Representative quote
Science Adventure School learning environment	Relevance		Person expresses that what is learned or taught at SAS is relevant to a student's life including, personal/interpersonal, vocation and social dimensions	88	We couldn't do any of that without science. So I think that was also really powerful for them to see… 'If I want to do stuff like this, then I actually have to know some physics.'
Changing science attitudes	Change in STEM opinion	Science is 'bigger'	Person expresses that science includes more component or aspects than was previously believed	63	I think, broadly speaking, they might view it, as not only something you can do in the classroom, but that is done by everyday people, outside of the classroom.
	STEM interest		Person makes reference to students' being interested in STEM, either generally, or in reference to a specific aspect of their lives such as sports, classes, etc.	75	I think [SAS has] definitely helped them try to open their mind to new ideas and also try to just be more curious in general, honestly, which is what science is all about.
	Willingness to try new things		Person references students as being more willing to try new things.	50	I do know that when we immediately came back, they did see those changes as far as just a little more confident and willing to try things.
	STEM knowledge		Person indicates that students have learned more about an aspect of STEM or has learned more STEM content knowledge	25	They got to do the science lesson and then do the actual activity and it helped them to understand the science behind it

Teacher Interview Themes

Eight teachers from six different schools were interviewed about their thoughts on SAS. Six teachers identified as female and two teachers identified as male. Three teachers had zero to five years of teaching experience, and the other five had eleven or more years of teaching experience. Six teachers taught STEM subjects and two taught non-STEM subjects. Teachers were asked about the teaching methods used in their classrooms, and they self-identified their preferred methods. Two teachers taught using more traditional methods, and three used experiential methods, and three used a blend of both. The thematic categories that emerged from the interviews are defined and illustrated with representative quotes in **Table 6**, where % is percent of teachers mentioning code idea.

Changing STEM attitudes

Teachers had not yet been working with their current students for an extended period of time before coming to SAS, so all were hesitant to note changes in science attitude based purely on time at spent at the program. However, some teachers did make observations that could indicate change in STEM attitudes. Four teachers noticed an increase in comfort answering questions in the classroom. Five also reported that their students seem to have a greater understanding of the concept of science as something bigger than their textbooks. Six teachers noted that their students seemed highly interested in science after returning from the SAS. Students also became more curious after SAS, with four teachers noting that their students were more willing to try new things.

DISCUSSION

Findings from this study seek to build on previous research and close the gaps between adventure education and STEM education with the guiding research questions. Though results indicate that there is some support for increasing relevancy as a result of SAS, it is important to consider the relationship between survey and interview data and the concept of relevancy and its indicator STEM constructs, to gain a thorough understanding of potential implications for practice.

STEM Interest

STEM interest survey items showed no significant changes from pre- to post-survey, which contrasts somewhat with results from the student and teacher interviews. A minority of six interviewed students did indicate a positive change in STEM interest, but most did not. However, as 11 of the 14 students indicated a prior interest in science before attending SAS, it is likely that most maintained their interest through the program, rather than experienced an increased interest or a change from disinterest to interest. Six of the eight teachers indicated that they felt their students were showing more interest in class as a result of their attendance at SAS.

Though difficult to verify without further study, there are several potential reasons for discrepancies in STEM interest change. It could be that students perceived science at SAS and science in their schools differently, making it difficult to translate from one context to the other, as with Dewey's (1939) theory of continuity. Results from this research indicate that students found SAS to be an enjoyable experience (Ainley & Ainley, 2011), while they generally found science in their schools to be less enjoyable (Osborne et al., 2003). Because students already have a preconceived negative connotation to learning science in their school settings, STEM interest may not translate well from SAS to the classroom.

It is also possible that students do not become more interested in science at all as a result of their SAS experience, or that they arrive with relatively high levels of STEM interest which is not significantly impacted by the experience, as indicated by the pre- and post-survey. This latter hypothesis may be further supported by the selection process used to bring students to SAS. SAS allows teachers to select the students who will attend. As it was SAS's first full operating year, quotas were put in place for most schools, limiting schools to a small subset of students able to attend. It is possible that teachers selected students with a higher interest in science to attend, which would account for no significant change.

Teacher interviews could be interpreted in several ways. Teacher observation of students in their classrooms may be a more objective assessment of STEM interest than self-reported data from the students' surveys, because they may have a more accurate gauge of science interest in their classroom (Fredericks & McColskey, 2012). Conversely, teachers could be equating science interest with another construct like STEM self-efficacy. When witnessing a student successfully performing STEM activities, they may perceive the student's achievement as interest.

Ultimately, the contrast among sources of data for the STEM interest construct makes it difficult to reconcile. Additional research focused specifically on the construct of science interest would be needed to fully understand these results.

STEM Career Interest

An increase in STEM career interest is somewhat supported by the student surveys and student interviews. There was a significant positive increase in one of the three survey statements, 'I would like to be a scientist when I leave school.' Strengthening this finding, 12 of the 14 students interviewed indicated that they would be interested in pursuing a STEM career in the future.

This construct is likely to be closely linked to, and influenced by, other constructs (Hughes et al., 2013; Riedinger, 2011). If self-efficacy, interest, career knowledge, identity, and value rise, students are likely to be able to feel that they can pursue a career in STEM. Self-efficacy raises their ability to feel they will be successful at STEM activities (Eccles, 2007; Rittmayer & Beier, 2009), interest relates to a desire to participate in STEM (Eccles, 2007; Gilmartin et al., 2007), identity helps them to feel like they are already a scientist or capable of being a scientist (Carlone & Johnson, 2007; Herrera & Hurtado, 2011), and STEM value increases the importance of STEM to them (Ainley & Ainley, 2011; Sjøberg & Schreiner, 2005). Hypothetically, it would follow that as these factors rise, so too would an interest in pursuing STEM as a career. Future research would be needed to fully understand construct linkages in an adventure STEM setting.

While not one of the survey constructs, many students reported an increased sense of enjoyment while undertaking STEM activities at SAS. As Ainley and Ainley's (2011) and Hughes et al.'s (2013) studies show, the idea that a career in STEM can be enjoyable may have made the potential of a career in STEM more appealing.

STEM Career Knowledge

Student surveys along with student and teacher interviews showed evidence of increasing STEM career knowledge. While at SAS, instructors showed or described multiple ways of conducting science and gave examples of current scientists and their specialties. This exposure to additional kinds of potential STEM careers likely influenced students' career knowledge (Hughes et al., 2013).

In interviews, students also repeatedly described coming to see science as 'bigger' after their participation in SAS. Through the students' descriptions, it became apparent that describing their views of science as 'bigger' meant that they were aware of more possibilities within the realm of STEM, a thought echoing Young and Glanfield's (1998) emphasis on linking science to broader social and cultural contexts. This included greater knowledge both of the variety of science disciplines and sub-disciplines and of potential career options. Several teachers also reported that their students seemed to see the concept of science as broader than before. This echoes Bell et al.'s (2003) and Hughes et al.'s (2013) findings that students came to a wider understanding of STEM careers after exposure to practical STEM experiences. Teachers also believed that their students no longer saw science as something confined to the classroom (Young & Glanfield, 1998). When given fewer limits and more space to explore the concept of science, it appears that students are open to greater knowledge of science career options and the possibilities they contain. Though additional research is needed in this area, it does appear that the closer connection (Ham, 2016; Stuckey et al., 2013) to STEM material provided by adventure STEM education can translate to more a more positive regard towards STEM.

Implications for Practice

The results of this study have implications for formal and informal science educators. Though limitations do not make these findings universally applicable, they still provide support for the importance of relevancy in relation to curriculum and adventure STEM education as a method of increasing positive STEM attitudes in youth.

Results indicate that SAS may be more relevant to students than their classroom curricula because students learn through activities that are associated with immediately being able to put learning into practice (Riedinger, 2015). This makes the learning tangible. Enjoyment also affects relevancy, as positive emotions influence connection to learning (Ainley & Ainley, 2011; Ham, 2016), and students reported enjoyment while participating in SAS activities. While most teachers will lack the resources to undertake adventure activities in their classroom, they may be able to incorporate more hands-on activities related to tangible elements of students' lives to influence positive STEM attitudes.

This study also provides support for the idea that adventure STEM education can provide benefits similar to other informal STEM learning contexts. Multiple studies (Barab & Hay, 2001; Hughes et al., 2013; Riedinger, 2015) show that informal science experiences can have a positive effect on youth. As adventure STEM education is a relative new phenomenon, there have been few studies highlighting the discipline's ability to generate similar positive effects. This study's findings add to the body of adventure STEM literature generally, and specifically lend support to the positive benefits of engaging youth in adventure STEM programming.

CONCLUSION

Adventure STEM education represents a blossoming opportunity to foster connections with youth before their attitudes toward STEM turn from curiosity to disinterest. This study builds on prior research in adventure education and STEM education and begins to bridge the gaps between the two fields, with results of this study indicating that SAS provides many opportunities for youth to grow and explore STEM. However, there is much more to explore in this burgeoning field and additional study is needed to better understand the complex relationships among adventure STEM education, STEM attitudes, and curricula relevancy. Adventure STEM education is a new field, but it shows great promise as an ameliorant in the struggle to make academic lesson interesting and meaningful to students. It deserves the time and attention of researchers to evaluate its efficacy and help to improve the discipline for its own sake and for the sake of students everywhere.

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REFERENCES

Abels, S. (2015). Scaffolding inquiry-based science and chemistry education in inclusive classrooms. In N. L. Yates (Ed.), *New developments in science education research* (pp. 77-96). Nova Science Publishers, Inc.

ACT. (2017). *STEM education in the U.S.: Where we are and what we can do*. https://www.act.org/content/dam/act/unsecured/documents/STEM/2017/STEM-Education-in-the-US-2017.pdf

Ainley, M., & Ainley, J. (2011). Student engagement with science in early adolescece: The contribution of enjoyment to students' continuing interest in learning about sciences, *Contemporary Educational Psychology*, *36*(1), 4-12. https://doi.org/10.1016/j.cedpsych.2010.08.001

Alrashidi, O., Phan, H. P., & Ngu, B. H. (2016). Academic engagement: An overview of its definitions, dimensions, and major conceptualisations. *International Education Studies*, *9*(12), 41-52. https://doi.org/10.5539/ies.v9n12p41

Barab, S. A., & Hay, K. E. (2001). Doing science at the elbows of experts: Issues related to the science apprenticeship camp. *Journal of Research in Science Teaching*, *38*(1), 70-102. https://doi.org/10.1002/1098-2736(200101)38:1<70::AID-TEA5>3.0.CO;2-L

Bell, R. L., Blair, L. M., Crawford, B. A., & Lederman, N. G. (2003). Just do it? Impact of a science apprenticeship program on high school students' understandings of the nature of science and scientific inquiry. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *40*(5), 487-509. https://doi.org/10.1002/tea.10086

Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal*, *9*(2), 27-40. https://doi.org/10.3316/QRJ0902027

Breiner, J. M., Harkness, S. S., Johnson, C. C., & Koehler, C. M. (2012). What is STEM? A discussion about conceptions of STEM in education and partnerships. *School Science and Mathematics*, *112*(1), 3-11. https://doi.org/10.1111/j.1949-8594.2011.00109.x

Brown, M. (2010). Transfer: Outdoor adventure education's Achilles heel? Changing participation as a viable option. *Journal of Outdoor and Environmental Education*, *14*(1), 13-22. https://doi.org/10.1007/BF03400892

Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching*, *44*(8), 1187-1218. https://doi.org/10.1002/tea.20237

Creswell, J. W., Plano Clark, V. L., Gutmann, M. L., & Hanson, W. E. (2003). Advanced mixed methods research designs. In A. Tashakkori, & C. Teddlie (Eds.), *Handbook of mixed methods in social and behavioral research* (pp. 209-240). SAGE.

Daugherty, M. K. (2013). The prospect of an 'A' in STEM education. *Journal of STEM Education: Innovations and Research*, *14*(2), 10-15.

Dewey, J. (1939). *Experiential education*. Collier.

Dogan, U. (2015). Student engagement, academic self-efficacy, and academic motivation as predictors of academic performance. *The Anthropologist*, *20*(3), 553-561. https://doi.org/10.1080/09720073.2015.11891759

Ebenezer, J. V., & Zoller, U. (1993). Grade 10 students' perceptions of and attitudes toward science teaching and school science. *Journal of Research in Science Teaching*, *30*(2), 175-186. https://doi.org/10.1002/tea.3660300205

Eccles, J. S. (2007). Where are all the women? Gender differences in participation in physical science and engineering. In S. J. Ceci, & W. M. Williams (Eds.), *Why aren't more women in science? Top researchers debate the evidence* (pp. 199-210). American Psychological Association. https://doi.org/10.1037/11546-016

Fishbein, M. (1966). The relationships between beliefs, attitudes and behavior. In Feldman, S. (Ed.) *Cognitive consistency, motivational antecedents and behavioral consequents*. Academic Press, Inc. https://doi.org/10.1016/B978-1-4832-2828-0.50012-X

Gawronski, B. (2007). Attitudes can be measured! But what is an attitude? *Social Cognition*, *25*(5), 573-581. https://doi.org/10.1521/soco.2007.25.5.573

Gibson, H. L., & Chase, C. (2002). Longitudinal impact of an inquiry-based science program on middle school students' attitudes toward science. *Science Education*, *86*(5), 693-705. https://doi.org/10.1002/sce.10039

Gilmartin, S., Denson, N., Li, E., Bryant, A., & Aschbacher, P. (2007). Gender ratios in high school science departments: The effect of percent female faculty on multiple dimensions of students' science identities. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *44*(7), 980-1009. https://doi.org/10.1002/tea.20179

Gilmer, T. C. (2007). An understanding of the improved grades, retention and graduation rates of STEM majors at the Academic Investment in Math and Science (AIMS) Program of Bowling Green State University (BGSU). *Journal of STEM Education: Innovations and Research*, *8*(1&2), 11-21.

Glen, S. (2014). *Cronbach's alpha: Simple definition, use and interpretation*.https://www.statisticshowto.com/cronbachs-alpha-spss/

Gonzalez, H. B., & Kuenzi, J. J. (2012). *Science, technology, engineering, and mathematics (STEM) education: A primer*. http://www.stemedcoalition.org/wp-content/uploads/2010/05/STEM-Education-Primer.pdf

Greene, J. C., Caracelli, V. J., & Graham, W. F. (1989). Toward a conceptual framework for mixed-method evaluation designs. *Educational Evaluation and Policy Analysis*, *11*(3), 255-274. https://doi.org/10.3102/01623737011003255

Halpern, D. F., Benbow, C. P., Geary, D. C., Gur, R. C., Hyde, J. S., & Gernsbacher, M. A. (2007). The science of sex differences in science and mathematics. *Psychological Science in the Public Interest*, *8*(1), 1-51. https://doi.org/10.1111/j.1529-1006.2007.00032.x

Ham, S. (2016). *Interpretation: Making a difference on purpose.* Fulcrum Publishing.

Hanushek, E. A., Peterson, P. E., & Woessmann, L. (2012) *Achievement growth: International and U.S. state trends in student performance*. https://files.eric.ed.gov/fulltext/ED534652.pdf

Herrera, F. A., & Hurtado, S. (2011). *Maintaining initial interests: Developing science, technology, engineering, and mathematics (STEM) career aspirations among underrepresented racial minority students.* https://www.heri.ucla.edu/nih/downloads/AERA%202011%20-%20Herrera%20and%20Hurtado%20-%20Maintaining%20Initial%20Interests.pdf

Hofstein, A., Eilks, I., & Bybee, R. (2010). Societal issues and their importance for contemporary science education. *Contemporary Science Education, 9*, 1459-1483. https://doi.org/10.1007/s10763-010-9273-9

Hossain, M., & Robinson, M. (2012). *How to motivate US students to pursue STEM (science, technology, engineering and mathematics) careers*. https://files.eric.ed.gov/fulltext/ED533548.pdf

Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research*, *15*(9), 1277-1288. https://doi.org/10.1177/1049732305276687

Hsu, H., & Lachenbruch, P. A. (2005). Paired t test. *Encyclopedia of Biostatistics*. https://doi.org/10.1002/9781118445112.stat05929

Hughes, R. M., Nzekwe, B., & Molyneaux, K. J. (2013). The single sex debate for girls in science: A comparison between two informal science programs on middle school students' STEM identity formation. *Research in Science Education*, *43*(5), 1979-2007. https://doi.org/10.1007/s11165-012-9345-7

Jenkins, E. W., & Nelson, N. W. (2005). Important but not for me: Students' attitudes towards secondary school science in England. *Research in Science & Technological Education*, *23*(1), 41-57. https://doi.org/10.1080/02635140500068435

Jenkins, E. W., & Pell, G. (2006). *The relevance of science education project (ROSE) in England: A summary of findings*. http://www.leeds.ac.uk/educol/documents/152736.htm

Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a definition of mixed methods research. *Journal of Mixed Methods Research*, *1*(2), 112-133. https://doi.org/10.1177/1558689806298224

Maxcy, S. J. (2003). Pragmatic threads in mixed methods research in the social sciences: The search for multiple modes of inquiry and the end of the philosophy of formalism. In A. Tashakkori, & C. Teddlie (Eds.), *Handbook of mixed methods in social and behavioral research* (pp. 51-89). SAGE.

McInerney, D. M., & McInerney, V. (2000). *A longitudinal qualitative study of school motivation and achievement*. https://files.eric.ed.gov/fulltext/ED441815.pdf

Mellor, D., & Moore, K. A. (2013). The use of Likert scales with children. *Journal of Pediatric Psychology*, *39*(3), 369-379. https://doi.org/10.1093/jpepsy/jst079

Miner, J. L., & Boldt, J. R. (2002). *Outward bound USA: Crew not passengers*. Mountaineers Books.

Murphy, C. (2003). *Literature review in primary science and ICT*. https://www.nfer.ac.uk/publications/futl73/futl73.pdf

Noonan, R. (2017). *STEM jobs: 2017 update*. https://www.commerce.gov/sites/commerce.gov/files/migrated/reports/stem-jobs-2017-update.pdf

Onwuegbuzie, A. J., & Collins, K. M. (2007). A typology of mixed methods sampling designs in social science research. *The Qualitative Report*, *12*(2), 281-316. https://doi.org/10.46743/2160-3715/2007.1638

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education*, *25*(9), 1049-1079. https://doi.org/10.1080/0950069032000032199

Owen, S., Dickson, D., Stanisstreet, M., & Boyes, E. (2008). Teaching physics: Students' attitudes towards different learning activities. *Research in Science & Technological Education*, *26*(2), 113-128. https://doi.org/10.1080/02635140802036734

Polkinghorne, D. E. (1989). Phenomenological research methods. In R. S. Valle, & S. Halling (Eds.), *Existential-phenomenological perspectives in psychology* (pp. 41-60). Springer. https://doi.org/10.1007/978-1-4615-6989-3_3

Price, J. H., & Murnan, J. (2004). Research limitations and the necessity of reporting them. *American Journal of Health Education*, *35*(2), 66-67. https://doi.org/10.1080/19325037.2004.10603611

Priest, S., & Gass, M. (2017). *Effective leadership in adventure programming*. Human Kinetics.

Riedinger, K. (2015). Identity development of youth during participation at an Informal Science Education Camp. *International Journal of Environmental and Science Education*, *10*(3), 453-475.

Riedinger, K. A. (2011). *Identity development of middle school students as learners of science at an informal science education camp* [Unpublished doctoral dissertation]. University of Maryland.

Ringholz, R. (2000). *On belay: The life of legendary mountaineer Paul Petzoldt*. Mountaineers Books.

Rittmayer, M. A., & Beier, M. E. (2009). Self-efficacy in STEM. In B. Bogue, & E. Cady (Eds.), *Applying research to practice (ARP) resources* (pp. 2-12). CASEE.

Sadler, P. M., Sonnert, G., Hazari, Z., & Tai, R. (2012). Stability and volatility of STEM career interest in high school: A gender study. *Science Education*, *96*(3), 411-427. https://doi.org/10.1002/sce.21007

Sahin, A., Ayar, M. C., & Adiguzel, T. (2014). STEM related after-school program activities and associated outcomes on student learning. *Educational Sciences: Theory and Practice*, *14*(1), 309-322. https://doi.org/10.12738/estp.2014.1.1876

Saldaña, J. (2016). *The coding manual for qualitative researchers*. SAGE.

Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information*, *22*(2), 63-75. https://doi.org/10.3233/EFI-2004-22201

Sjøberg, S., & Schreiner, C. (2005). How do learners in different cultures relate to science and technology? Results and perspectives from the project ROSE (the Relevance of Science Education). *Asia-Pacific Forum on Science Learning and Teaching, 6*(2), 1-17.

Snow, J., & Mann, M. (2013). *Qualtrics survey software: handbook for research professionals*. Qualtrics Labs, Inc.

Stuckey, M., Hofstein, A., Mamlok-Naaman, R., & Eilks, I. (2013). The meaning of 'relevance' in science education and its implications for the science curriculum. *Studies in Science Education*, *49*(1), 1-34. https://doi.org/10.1080/03057267.2013.802463

Taylor, S., & Treacy, A. (2013). Just Dedoose it! Making mixed methods data analysis manageable. In *Proceedings of the Annual Meeting of the Northern Rocky Mountain Educational Research Association.* Jackson Hole, WY, USA.

Terrell, S. R. (2012). Mixed-methods research methodologies. *The Qualitative Report*, *17*(1), 254-280. https://doi.org/10.46743/2160-3715/2012.1819

Thorne, S. (1994). Secondary analysis in qualitative research: Issues and implications. *Critical Issues in Qualitative Research Methods, 18*(1), 263-279.

Turner, S., Ireson, G., & Twidle, J. (2010). Enthusiasm, relevance and creativity: Could these teaching qualities stop us alienating pupils from science? *School Science Review. 91*(337), 51-57.

Van Manen, M. (2016). *Phenomenology of practice: Meaning-giving methods in phenomenological research and writing*. Routledge. https://doi.org/10.4324/9781315422657

Vaske, J. J. (2008). *Survey research and analysis: Applications in parks, recreation and human dimensions.* Venture.

Vaske, J. J., Beaman, J., & Sponarski, C. C. (2017). Rethinking internal consistency in Cronbach's alpha. *Leisure Sciences*, *39*(2), 163-173. https://doi.org/10.1080/01490400.2015.1127189

Walsh, V., & Golins, G. (1976). *The exploration of the outward bound process*.

West Virginia University. (2020). *The science behind the sport.* https://sciencebehindthesport.wvu.edu/

Young, M., & Glanfield, K. (1998). Science in post-compulsory education: Towards a framework for a curriculum of the future. *Studies in Science Education, 32*, 1-20. https://doi.org/10.1080/03057269808560125