AT HOME OR IN PERSON? A COMPARISON OF INFORMAL LEARNING ENVIRONMENTS FOR SECONDARY STUDENTS

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ABSTRACT

Due to the sudden onset of the COVID-19 pandemic, the comparison of online versus traditional face-to-face (FTF) environments has now come under review. The research of online informal learning spaces for K–12 education in particular is underdeveloped and requires more investigation. The purpose for this paper is to report an analysis of the differences in students' career interest after an online and a FTF STEM camp. One group (n = 45) of participants attended a one-week STEM camp online while another group (n = 62) attended a one-week STEM camp in person. In this mixed methods study, pre and posttest scores of a STEM career interest survey were analyzed and semistructured interviews were conducted. For the quantitative portion, p-values from paired-sample t-tests are reported as well as Cohen's d effect sizes. Interviews were coded using the constant comparative method and were analyzed using thematic analysis.

The quantitative results indicate that both the online and FTF camps may improve different aspects of a student's career interest. The qualitative results consist of four main themes: social connections, learning and teaching, preference, and opportunities. Aspects of an informal learning environment may work in person but may not translate to an online environment. Therefore, improvements should be made based on the specific learning environment, not on the general product of a course.

Keywords: informal learning, online learning, STEM camp, STEM education

INTRODUCTION

The sudden onset of the COVID-19 pandemic caused an immediate need to move formal schooling and other learning experiences to a virtual setting. This dynamic shift in learning from 100% face-to-face (FTF) to, in some circumstances, completely online has forced teachers and other educators to deliver learning material over technical platforms, which presents new challenges to students, parents, and educators. Although these challenges have prompted educators to rethink pedagogical and delivery methods, new technological advancements such as Google Suites, learning management systems, and Zoom, have made it easier for educational experiences to be delivered online. Additionally, informal online learning has allowed access to educational resources for students who may not have the opportunity to attend FTF informal learning opportunities, such as science, technology, engineering, and mathematics (STEM) camps. Given the rising demand for online teaching and learning methods, the goal of this study is to compare the changes in STEM career interest and the perceptions of STEM professionals among students who attended an in-person STEM camp as compared to those who attended an online STEM camp. I will also report from a student's perspective the advantages and disadvantages of an online, informal learning environment compared to an in-person, informal learning experience.

These findings can improve informal education (both online and FTF) and contribute to the current body of research focused on STEM education.

BACKGROUND

Learning can occur in a myriad of settings, including, but not limited to, informal and formal environments. The qualities and characteristics of a learning environment are important because a learning environment can have a significant impact on student learning, regardless of student ability, as measured by standardized test scores (Brooks, 2011). A formal learning environment can be described as a structured setting with a rigid curriculum governed by a set of explicit expectations or rules. These types of environments were developed without considering students' attitudes or needs and formal environments rarely meet the demands of students and society (Mahajan, 2017). Informal learning environments allow students to develop skills at their own pace and experience "school" as it presents itself in real-world situations. In so doing, informal environments promote self-directed learning through trial and error and self-reflection (Watkins & Marsick, 1992). Furthermore, informal learning allows for the implementation of the latest technology and encourages the development of 21st-century skills, such as creative thinking, collaboration, and leadership (Khanaposhtani et al., 2018). For the purpose of this paper, an informal learning environment is defined as any educational experience that occurs outside of the traditional, FTF classroom setting. In this study specifically, students engaged in an informal learning environment through participation in a one-week STEM camp, and I observed how the components of an online informal learning environment compared to those of an FTF camp.

The comparison of informal and formal environments through a cognitive and social lens provides insight into students' perceptions of learning and how the learning environment affects education. In terms of student achievement, secondary students involved in more active learning settings, such as those provided in informal learning environments, outperform students who learn in more traditional environments (Brooks, 2011). Students' perceptions of learning in the two environments, however, is debated, and research mostly focuses on postsecondary education and teacher professional development. For example, Levenberg & Caspi (2010) found that teachers perceived their learning during professional development to be more effective in formal settings, whereas another study found that educators perceived their professional learning to be better in informal settings (Burns et al., 2005). Investigating the perceptions of learning among K–12 students when comparing formal and informal learning environments has yet to be reported.

Comparing Online Learning Environments with FTF Environments

The use of technology in education has given rise to a new era of learning, and the COVID-19 pandemic has forced society to utilize such technology and reimagine education at a rapid pace. The dichotomy between online and FTF education has resulted in distinct factors that can and should be examined for effectiveness, particularly in K–12 education. Similar to the comparison of informal versus formal education, the perception of learning between the two environments has been debated. In one study, students reported higher levels of learning in an online format (Levenberg & Caspi, 2010), but another study reported that students favored FTF learning (Parlamis & Mitchell, 2014). Regardless of learning environment preference, studies have found that students in online settings performed at the same rate and just as well (in terms of grades) as learners in an FTF environment (Callister & Love, 2016; Parlamis & Mitchell, 2014). This conclusion is not held in consensus among researchers, however.

Performance variations between the two learning environments are also not definitive. Students in online learning environments on average perform better in terms of student learning outcomes than students in FTF environments (Means et al., 2010; Means et al., 2014). However, in terms of interactive performances, students from FTF environments have been found to perform better (Callister & Love, 2016). Although these results may or may not favor one learning environment over the other, it is also important to consider that most of the available research has only studied these conditions in higher education and teacher education; little research has been done with online versus FTF learning in grades K–12. Additionally, modern education has not faced the ramifications of a pandemic such as COVID-19

before. Thus, the motivation to study completely online education for grades K–12 is in its infancy. The comparison of online versus FTF learning environments warrants further research, especially in the field of STEM education.

The comparison of online and FTF learning environments must move past learning outcomes and discuss social interactions. In general, students see high value in interactions that occur online, although they place greater value on interactions that happen in FTF environments (Chakowa, 2018; Ke & Kwak, 2013; Tan, 2013). Because virtual communication is often less organic than FTF interactions, the content of online conversations needs to be meaningful and connect to the student on a personal level (Schwier & Seaton, 2013). These conversations include both student-to-student interactions as well as student-to-teacher interactions. Although overall academic performance may not vary between FTF and online learning, students from one online environment reported lower levels of collaboration and personal knowledge of and interaction with students and teachers (Parlamis & Mitchell, 2014). Moreover, minority students, who generally perceive student-teacher interactions more positively than their peers, have reported that online learning is less socially fulfilling than FTF interactions (Ke & Kwak, 2013). There seems to be a vital disconnect in human interaction that occurs in online learning environments.

This is not to say that online learning is entirely without benefit to social learning experiences. In fact, learners who participated in an online learning environment engaged in interactions that focused more on their own construction of knowledge or for individual social purposes rather than ones aimed at creating a community of learners (Ke & Kwak, 2013). Still, if online learning is to foster the important opportunities for collaboration that FTF environments provide, instructors of virtual education must make smart pedagogical decisions regarding the social environment of an online classroom.

Furthermore, although FTF classrooms may provide more opportunities for hands-on learning and collaboration among students, online learning may provide its own set of benefits. For example, online learning can accommodate various learners as long as the programs are developed through informed decisions that match the technology to the students' needs (Brown, 2000; Ke & Kwak, 2013). Additionally, learning through web-based programs respects the concept of multiple intelligences, as it "leverages the small efforts of the many with the large efforts of the few" (Brown, 2000, p. 12). Online learning can also become more effective than FTF learning by giving students more control over what they are learning by providing groups with support mechanisms, such as guiding questions, and by promoting self-reflection, self-regulation, and self-monitoring (Means et al., 2010). With the development of effective learning strategies for online learning environments currently in high demand, further pedagogical advancements are sure to be made. Today's students are more technologically literate than ever before and can perform several tasks simultaneously (such as searching for music while talking on a cell phone and receiving GPS instructions), which allows them to multitask with the use of technology (Brown, 2000). Online education should build upon these skills and provide motivation for students that will transfer to the formal learning environment.

STEM Camps as Informal Learning Environments

Informal learning environments, such as STEM camps, provide a purpose and context for formal STEM learning. First, the collaborative learning environment of STEM camps encourages students to develop and enhance their 21st-century skills, such as leadership, creativity, problem solving, and technology literacy (Khanaposhtani et al., 2018). Previously, STEM camps have been used to increase students' STEM knowledge (Hirsch et al., 2017) and heighten students' perception (Vela et al., 2020), attitude (Roberts et al., 2018), and self-efficacy (Kwon et al., 2019) of the individual STEM fields and STEM careers. These changes can be attributed to several factors, including the interaction between students and STEM professionals that takes place in STEM camps (Maiorca et al., 2020; Roberts et al., 2018; Vela et al., 2020). Additionally, students' career interest may be heightened through participation in a STEM camp because it gives them a context for and provides hands-on experiences with STEM fields, which allow students to have better understanding of the true nature of a STEM career (Asiabanpour et al., 2010; Hirsh et al., 2017). Although outcomes of FTF STEM camps have been and continue to

be studied, online STEM camps have not been observed for the above measures nor have studies of online STEM camps focused on students' perceptions of the online learning environment compared to an FTF STEM camp.

Theoretical Framework

The theoretical framework that guides this study is situated in the nexus of Vygotsky's (1934/1962) Social Learning theory, Albert Bandura's (1986, 2001) Social Cognitive theory, and John Dewey's (1916, 1938) theory of progressive education and experiential learning. This amalgamation creates a central theme of student-centered learning within the influences of society. Students learn in a myriad of ways, including through social interaction and communication with their peers and teachers (Vygotsky, 1934/1962) and through interaction with their environment by completing hands-on activities (Dewey, 1916). Specifically, social cognitive theory stresses the importance of the interaction between a student's behavior and their environment (Bandura, 1986, 2001). Additionally, tacit knowing (knowing "how") is developed through practice and the skill building and shared understanding that emerges when students work together (Brown, 2000). This type of learning through collaboration among classmates is already employed in FTF STEM camps and is currently becoming more popular in online environments. If online learning can meet the social learning needs of students, then online education as a whole can become more equitable and effective.

In general, the purpose of education is to provide students with information and tools to be successful in life (Dewey, 1916). Therefore, education and how students learn must change according to the needs of society. Presently, society calls for more online learning, and educators must therefore adapt to this need. Online informal learning environments extend this progression to meet the present technological needs of society. Even when formal schooling returns to mostly FTF interactions, the knowledge gained during the time of complete virtual learning can aid in developing online educational programs to supplement and extend formal education.

Students' Perceptions and Self-Efficacy

How students perceive their surroundings in a learning environment ultimately influences their attitudes and self-efficacy towards academic content. A learning environment is classified as the overall atmosphere in which learning occurs and incorporates both the physical space and the human(s) within it (Fraser, 1998). The physical space itself has a potential positive effect on student learning (Brooks, 2011; Brooks & Solheim, 2014). Furthermore, there exists a positive relationship between students' perceptions of the learning environment and their self-efficacy; when students have a clear vision of their task and see opportunities to actively participate in their learning (both direct implications of the learning environment), they experience higher self-efficacy (Galos & Aldridge, 2021). Students' perceptions of the classroom environment positively affect their achievement and attitudes towards science in particular (Cohn & Fraser, 2016; Fraser, 1994). The same positive relationship can be extended to students' self-efficacy in science (Khine et al., 2020) and overall academic self-efficacy (Dorman, 2001). Because of this evidence, examining students' perceptions of online environments is warranted.

METHOD

This mixed methods study is focused on the comparison of an FTF STEM camp and an online STEM camp, specifically regarding the role the educational environments and interactions with STEM professionals had in increasing students' STEM career interest. An explanatory sequential design was chosen for this study because the qualitative data was collected after the quantitative data in order to explain the quantitative results of the students' interest in STEM careers (Creswell & Plano Clark, 2018). In this study, I used STEM career interest survey data to test the theories of social learning and how they influence high school and middle school students' STEM career interest, perceptions of STEM professionals, and perceptions of the learning environment. The convergence of the quantitative data (career interest survey pretest and posttest scores) and qualitative data (interview responses) provided insight into the impact different types of informal learning environments had on students' perceptions of STEM professionals and interest in STEM careers. Through this mixed methods research study, I aimed to answer the following research questions:

1. To what extent do FTF STEM camps and online STEM camps affect student STEM career interest?
2. How do students' perceptions of the learning environment explain the differences in career interest survey scores between an FTF and an online camp?

Participants

I wanted to determine if participation in a one-week STEM camp could improve the STEM career interest of secondary students. For the quasi-experimental (quantitative) section of this study, I analyzed students' (n = 45) pretest and posttest scores in the online version of the camp and students' (n = 62) pretest and posttest scores from the FTF version of the camp. The demographics for these participants can be found in Table 1. Four students who participated in both versions of the STEM camps (online and FTF) were interviewed for the qualitative component of this study. Two participants are female and two are male. One female student had completed the 9th grade, and the other female student had completed the 10th grade. One of the male participants had completed the 7th grade, and the other male student had finished the 9th grade.

Setting

All participants attended a one-week STEM camp designed to increase their interest in the STEM fields. For the quantitative part of this study, one cohort (n = 62) attended the FTF version of the camp, and the other group (n = 45) attended a comparable, synchronous online version of the camp. For the qualitative portion of the study, all four participants were first enrolled in the one-week FTF STEM camp followed by the one-week online STEM camp. For three of the participants, the two camps occurred during two consecutive summers. The fourth participant attended the FTF camp three years prior to the online camp. Interviews occurred within three weeks of completing the online version of the camp. Both camps were similar in structure regarding STEM curriculum and classes and incorporated panel sessions and activities from STEM professionals. The FTF camp included approximately five hours of STEM-related classes, on-site visits to STEM labs, in-person chemistry and physics shows, in-person panel sessions with

TABLE 1. DEMOGRAPHIC INFORMATION OF CAMP PARTICIPANTS

Characteristic	Online Camp (n=45)		FTF Camp (n=62)	
	n	%	n	%
Gender				
Female	17	38%	26	42%
Male	27	60%	36	58%
Chose not to respond	1	2%	0	0%
Grade				
6	0	0%	1	2%
7	6	14%	12	19%
8	4	9%	5	8%
9	4	9%	14	23%
10	11	24%	16	26%
11	15	33%	6	10%
12	5	11%	8	13%
Race/Ethnicity				
Asian	5	11%	8	13%
Black or African American	2	4%	1	2%
Hispanic or Latino	12	27%	13	21%
White	25	56%	37	60%
Other	1	2%	3	5%

STEM professionals, evening social activities, and a residential stay at a large university. The virtual camp was delivered entirely through an online platform and incorporated approximately five hours of STEM classes, one panel session (including a chemistry show), and a social activity each day. Both camps were designed with the intention of increasing students' perceptions of the STEM fields and their STEM career interests.

Instruments and Procedure

Precamp and postcamp surveys were used as a method of collecting the quantitative data for this study. All students (for both the online and the FTF camp) completed the Career Interest Survey developed by Kier et al. (2014). This survey was developed specifically to measure a student's interest in a STEM career and has been reported to be psychometrically sound by the developers (Kier et al., 2014). This survey was administered before camp began and after camp concluded. Participants completed the survey using an online system both times. The results were not anonymous, as they needed to be paired for comparison. The following questions from the Career Interest Survey were used in this paper:

Question 1: I have a role model for a STEM career.

Question 2: I would feel comfortable talking to people who work in STEM careers.

Question 3: I am interested in careers that use STEM.

Each question was scored from 0 (strongly disagree) to 100 (strongly agree). The three questions were chosen because they provide an indication of a student's overall STEM career interest.

The qualitative portion of this study required the use of semistructured interviews. Interview questions were derived from prior research regarding learning environments and were designed to be open ended, a research technique supported by Jacob and Furgerson (2012). The four participants were interviewed within three weeks of the conclusion of the second (online) STEM camp. During the interview, clarifying questions were asked by the interviewer, and the students had the opportunity to expand upon their ideas during this time. I conducted the interviews via Zoom, transcribed them using the Zoom transcription feature, and corrected transcription errors. I coded the interviews with the help of one other researcher familiar with thematic analysis. Each of us coded all four of the interviews and derived themes from these codes. We then discussed the emergent themes until 100% agreement was reached, which validated the results through intercoder agreement (Miles et al., 2014).

Data Analysis

For the quantitative portion of the study, I analyzed the data using STATA 16 and Microsoft Excel 16. To measure the reliability of the survey, Cronbach's alpha was calculated for the three questions measuring the students' career interest. Because I wanted to compare pretest and posttest scores from the Career Interest Survey, six paired-sample t-tests were conducted, and the p values (and corresponding confidence intervals) and Cohen's d effect sizes (and corresponding confidence intervals) were reported for the comparison of pretest and posttest scores. The difference in pretest and posttest scores were not univariate normal, but the sample size was sufficiently large ($N > 30$). The a priori alpha level was set at .05. A post hoc power analysis was conducted using g*Power 3.1 to accommodate for the inflation of a Type II error due to small sample size. The quantitative results will be discussed alone and then together with the qualitative results.

For the qualitative component, the interviews were transcribed and analyzed using thematic analysis (Braun & Clarke, 2006). This method allows for flexible comparison between interviews through analysis of patterns within the data (Braun & Clarke, 2006). Finally, the results of the qualitative and quantitative portions of the study will be analyzed together to determine the effects of an online STEM camp compared to an FTF STEM camp.

RESULTS

Research Question 1: To what extent do FTF STEM camps and online STEM camps affect student STEM career interest?

One of the prerequisites to answering the first research question is to examine the psychometric property of reliability. Reliability is important to report because it can influence the value of the effect size (Thompson, 2002). Scores over .6 but less than

or equal to 1.0 fall within the recommended range (George & Mallery, 2003). Cronbach's alpha, a measure of internal consistency, was first calculated to measure the reliability of the career interest questions. The alpha level for the pretest was .5, and the value for the posttest was .5. The low values of both the pretest and the posttest indicate that the students had similar interest in STEM careers with little spread, and more so for the posttest. However, because the posttest reliability did fall above the recommended value, corrections do not need to be made to the results.

Before statistical tests were conducted, I calculated pretest and posttest means and standard deviations. Descriptive statistics for the survey questions can be found in Table 2. The pretest means favored the FTF camp for Question 1 by two points and Question 2 by eight points, indicating that students who attended the FTF option came into camp with a higher likelihood of already having a STEM role model and were more comfortable talking to people in STEM careers than students who attended the online option. The online camp had a higher mean for Question 3, but only by 0.8. This indicates that students who attended the online option came into camp with a higher career interest than the students in the FTF camp. Posttest mean scores favored the FTF camp for Questions 1 and 3, indicating that students left the FTF camp with a higher likelihood of having a STEM role model and a higher career interest. The posttest means for Question 2 only differed by 0.1, favoring the online camp. This indicates that students from both camps left camp with similar levels of comfort talking to STEM professionals.

To better understand the statistical significance of the results, I conducted a paired-sample t-test. The p-values, Cohen's d effect sizes, and confidence intervals for the three questions can be found in Table 3. Results from the paired-sample t-test indicated a statistically significant effect for Question 1 in the FTF camp ($p = .003$) and Question 2 for the online camp ($p = .048$). The FTF camp did not produce statistically significant results for Question 2 ($p = .730$) and Question 3 ($p = .368$). The online camp did not produce statistically significant results for Questions 1 and 3 ($p = .148$, $p = .450$, respectively). These results indicate that the FTF camp significantly improved students' likelihood of having a STEM role model and the online camp significantly improved students' comfortability in talking to STEM professionals. Neither camp significantly improved students' career interest.

Although statistical significance may help answer Research Question 1, effect sizes were also calculated to measure the practical significance.

TABLE 2. DESCRIPTIVE STATISTICS FOR STEM PERSONNEL

	Question 1				Question 2				Question 3			
	Pre		Post		Pre		Post		Pre		Post	
		SD		SD		SD		SD		SD		SD
Online	62.0	35.6	69.1	33.3	77.6	22.6	85.4	18.4	91.6	14.8	89.7	20.0
FTF	64.7	34.3	75.7	33.7	85.9	17.3	85.3	19.7	90.8	17.9	92.7	14.9

TABLE 3. T-TEST RESULTS FOR STEM CAREER INTEREST

	p value	95% Confidence Interval	Cohen's d	95% Confidence Interval
Question 1				
Online	.148	−16.67, 2.58	0.20	−0.21, 0.62
FTF	.003*	−18.25, −3.78	0.32	−0.03, 0.68
Question 2				
Online	.048*	−15.43, −0.08	0.38	−0.04, 0.79
FTF	.730	−2.85, 4.04	−0.03	−0.38, 0.32
Question 3				
Online	.450	−3.25, 7.20	−0.11	−0.53, 0.30
FTF	.368	−6.36, 2.39	0.12	−0.23, 0.47

Note. *$p < 0.05$

Cohen's d revealed an effect size favoring the posttest for both the online and FTF camps for Question 1 (d = .20, d = 0.32, respectively). Both of these values indicate a noticeable improvement for students having a role model in a STEM career. For Question 2, the effect size for the online camp favored the posttest (d = 0.38), but the effect size for the FTF camp favored the pretest (d = −0.03). This indicates that the online camp improved students' comfortability in talking to STEM professionals while the FTF camp regressed this measure. The effect sizes for Question 3 favored the pretest for the online camp (d = −0.11) and favored the posttest for the FTF camp (d = 0.12), indicating that the FTF camp overall improved students' interest in STEM careers whereas the online camp did not. These results indicate that both online and FTF camps may improve different aspects of a student's STEM career interest.

Finally, a post hoc power analysis was conducted (see Table 4). The low values are likely due to small sample size. This also indicates an inflation of a Type II error for Questions 1 and 3 from the online camp and for Questions 2 and 3 from the FTF camp. This error inflation is considered in conjunction with the statistically nonsignificant findings found in Table 3. The change in scores from Question 1 for the online camp and Question 3 for the FTF camp were not statistically significant, but they did produce positive effect sizes and had low power, indicating a large likelihood of a false negative.

TABLE 4. POWER ANALYSIS FOR CAREER INTEREST QUESTIONS

	Power ($1-\beta$)	
	Online	FTF
Question 1	.27	.72
Question 2	.70	.06
Question 3	.12	.16

Research Question 2: How do students' perceptions of the learning environment explain the differences in career interest survey scores between an FTF and an online camp?

Interview questions were coded and organized into four main themes: social connections, learning and teaching, additional opportunities, and preference. These themes emerged from patterns in the students' responses under the specific lens of the second research question, which asked how students' perceptions of the learning environment can explain the difference in student career interest in each of the camps. Specifically, we wanted to find an explanation to why the camps' scores may have differed in each of the three survey questions.

Social Connections

Social connections was the most common element found among the interviews. A sample of responses regarding the social aspects of camp from each participant can be found in Table 5. Three of the four students (Students A, C, and D) commented on how it was easier to connect with people in person compared to the online environment. Two of the four participants (Student A and Student D) commented on the interactions between the students and the teacher; both mentioned preferring in-person interactions with the teachers. Students C and D both had positive comments about social interactions that took place online. All four participants indicated that they preferred connections made in an FTF environment.

Learning and Teaching

The second most prominent theme among students' responses was the differences in the learning opportunities between the two camps regarding the quality and amount of instruction (see Table 6). Although Student A did not think there was a difference between the quality of the instructors, they commented it was easier to be more engaged at the in-person camp. Students A, B, and D all made a comment about the difficulties of the individual interactions with the teacher regarding asking questions in the online environment. Students B and C both commented on the difficulties of working in a group online. Students C and D both believed that learning online places a limit on how much they could learn. In general, the four participants preferred the learning opportunities at the FTF camp compared to the online camp.

Additional Opportunities

Although most of the interviews focused on the social or learning components of camp, each of the four participants also commented on the additional opportunities provided by the FTF camp. The responses from the participants can be found in Table 7. Three of the four participants mentioned

TABLE 5. RESPONSES FOR SOCIAL CONNECTIONS

Student A	"It's like, it's easier to connect with people if you can see them face to face and if you're seeing them like an actual person. So, you gain, like, more connections I guess if you have a residential camp than online." "It's not just, like, the subject matter."
Student B	(in reference to the FTF camp) "In my opinion, we get to meet more people."
Student C	(in reference to the FTF camp) "I really liked the afternoon activities … It was fun to, like, just, like, interact with people who weren't even in your class." (in reference to the online camp) "I still talk to my team members a lot for it being online. So I, like, got to know my team members and especially because I was at, like, all the afternoon things—that was also pretty fun to interact with people who were there, and the camp director …"
Student D	(in reference to the online camp) "It was more of getting into different rooms with your personal group and figuring things out with them and learning how to do things with the group, away from everyone else, so you can kind of, like, meet new people. And then you could collaborate with them to see what their ideas were; you can get new ideas." (in reference to the FTF camp) "You get to talk to the instructor more … you get to collaborate more with your group, and you get to learn new ideas … I like just the interaction with everyone being able to touch everything, being able to see everything physically, and especially at the end of the camp when we had the show and tell basically, kind of like the presentations." "When you're online … a lot of people can talk, but this is harder to hear, you have less flexibility to really get to know and talk to the instructors and get to know what we're actually doing." "Now when it comes to the social aspect, in my opinion, obviously, meeting new people in person. Better than meeting them online. … Since we have individual, like, group leaders. We got to learn some from them too. And, and the online camp, obviously we don't have those … I think it's really good to be able to interact with the group leader, because they know things that sometimes you don't know, so you can ask them questions too."

TABLE 6. RESPONSES FOR LEARNING AND TEACHING

Student A	(when comparing the FTF and online camp) "I think the quality and instruction were, like, the same. We still got, like, quality instructors and quality classroom time and learning." "I just, I feel like if I'm in the online class and I don't see my teachers, I'm not as engaged … learning is harder. It's harder to ask questions. Like, in class, a teacher can, like, gauge how well the class is responding to, like, new subjects by, like, whether people look confused, whether people, like, slowly getting it or not. But online, you don't really have that."
Student B	"What I didn't like about the virtual one was that was kind of hard to decide on a model, work on a model together because of the distance." "In school we usually had—If we found a question we had to, like, look it up or email our teacher or wait for the Google call to happen."
Student C	(in reference to the online camp) "It was kind of, it was different for sure because, like, when, when our team members needed help, we shared our screen and then, like, basically everybody else in the meeting was, like, kind of forced to listen to that because we can't turn off our volume because then we're going to, like, not be back when we need to be back." "I learn more at, like, at place—there at camp … everything takes, like, a slower pace when you're, when you're in online … it was kind of weird to do group projects online."
Student D	(in reference to the FTF camp) "You get a lot of hands-on learning, and you know what to do, because you can ask multiple questions. You can ask certain things that you can't ask online." "So when it comes to the quality of instruction … when you're in person, you get to individually ask the questions and you can go up to them. But when you're online, it's harder to get that individual interaction." "Yeah, it's just online learning … you don't really learn most of the stuff you need to learn. It's really dimmed down. For us learning online, we didn't get half the stuff we needed." "When you're in person, you get to experience it hands on and you get to experience everything there."

touring the campus or other STEM laboratories. Student D mentioned "life experience" as a component of the FTF camp. This comment was tied to a similar comment that was placed in the learning and teaching theme noting that the hands-on learning in the FTF camp provided an additional component to the learning experience that the online camp lacked. The discussion of these additional opportunities provides evidence that the FTF camp provides more opportunities for students to be immersed in the STEM fields.

Preference

Each student explicitly stated their preferred learning environment during their interview (see Table 8). All four students were univocal in that they preferred learning in person. Three of the four students commented that their decision was based on the learning and social opportunities available at the FTF camp. Although Student C did not explicitly state this reasoning for this preference, this student made comments that fell into the other thematic categories to support the idea that they also preferred the in-person learning due to the social aspects offered in the FTF camp. It is important to note that although each of the students preferred the FTF camp experience, they all stated that they liked the online camp as well.

DISCUSSION

The purpose for this study was to examine the differences between an FTF STEM camp and an online STEM camp in terms of students' perceptions of the learning environment and each camps' effects on students' perceptions of STEM personnel and their career interest. Although previous studies indicated that the in-person interactions of a STEM camp provide the foundation to improve students' attitudes and interests towards STEM and STEM careers (Maiorca et al., 2020; Roberts et al., 2018; Vela et al., 2020), such studies have not examined the effects of an online STEM camp. In the present study, the results of the paired-sample t-test and corresponding effect sizes indicate the influence of a STEM camp on a student's career interest, and the qualitative results help explain how the environment may affect students' interest in a STEM career.

The results of the qualitative analysis help explain the improvement of scores for the first survey question inquiring about students having a role model for a STEM career. The positive effect size values indicate that the student-teacher interactions that occurred in both camps positively impacted students regarding their opinion of STEM professionals, with results favoring the FTF camp. The interview answers under the theme of social connections supports this change in that two of the students mentioned that it was easier to make

TABLE 7. RESPONSES FOR ADDITIONAL OPPORTUNITIES

Student A	(in reference to the FTF camp) "I really like the evening activities and all that. I just, I remember going to the rodeo and then going to the game arcade place, and that was all really fun. The dorms are really nice. I think I took, like, the fidget spinner class. And then we also traveled to, like, the different biology labs and everything, and then we walked around, and it was all very inclusive ... We did, like, more things. Like, we were able to tour the campus or, like, go see different facilities. I think we, like, to see like the atom splitter thing, the cyclotron, and that was really cool."
Student B	(talking about opportunities at the FTF camp) "Going to the vet school, to the bird place."
Student C	(in reference to the FTF camp) " ... you got to know what, like, a college looks like. I never really been to one. So that was cool, to see what it looks like and how, like, yeah, layout and everything."
Student D	(in reference to the FTF camp) "You get to experience the life experience, not the online experience."

TABLE 8. RESPONSES FOR PREFERENCE

Student A	(in reference to the online camp) " ... the evening activities were fun, but just not the same as like residential ... I really prefer the residential camp ... I just like the whole, like, being able to meet new people and, like, have more experiences that I get in the residential camp."
Student B	"They're both good, but the only issue with the virtual camp is that it's hard to work on a model together ... I prefer to learn in person, since I find it easier to understand."
Student C	"I would choose the in-person camp."
Student D	"I would definitely recommend the residential camp because you get to meet new people in person, you get to have hands-on learning, you get to be there."

connections with teachers in person. Additionally, under the theme learning and teaching, three students indicated that it was easier to ask questions and interact with the teacher in an FTF environment. These results support the findings of other research regarding the preference of FTF social interactions between students and teachers (Parlamis & Mitchell, 2014).

There is a divergence of results regarding students' comfortability in talking to STEM professionals between the quantitative and qualitative results. The effect size measures indicate that only the online camp made students feel more comfortable talking to people in STEM careers. However, each of the four interview participants indicated a preference for learning and interacting FTF. This result echoes those found in previous research (i.e., Chakowa, 2018; Ke & Kwak, 2013; Tan, 2013). Although these four participants represent a small subset of the students who attended the STEM camps, it is an interesting find that the online camp improved scores more in this area. This may indicate that students' comfortability in talking to STEM professionals is separate from their perceptions of the learning environment regarding social interactions or learning aspects. It may also be helpful to mention that, with the growing popularity in social media and the increase of online interactions, this generation of students may be more comfortable communicating online than in person. As such, in this regard, it is not surprising that the online camp showed an increase in scores while the FTF camp showed a decrease.

Conversely, scores increased only for the FTF camp for Question 3, leading to the conclusion that only the FTF camp improved students' interest in STEM careers. All four students indicated a preference for the FTF camp over the online camp, with all four commenting on the additional opportunities afforded by the FTF environment. Students who were able to attend camp in person had the opportunity to visit various STEM labs, informally visit with STEM professionals and college students, and work hands on and in groups for most of the activities. Although the online camp incorporated similar classes and panel sessions, the expanse of the opportunities the FTF camp offered was different, and their in-person nature may have had a greater impact on participants. It is very possible that these opportunities explain the increase in the career interest scores among students and their preference for the FTF camp.

Although the FTF camp appears to have an advantage over the online camp regarding students' STEM career interest, the results and implications of the online camp, which still produced noticeable effects on students' career interest in STEM, should not be overlooked. Firstly, online camps provide an accessible environment to students who may be hindered by economic, social, or physical barriers and so function as a rare opportunity for such students to experience factors that may increase their interest in STEM careers. Additionally, because students appear to be more comfortable speaking to STEM professionals through technological platforms, online resources should be developed and further studied to produce more measurable effects on students' STEM career interest.

The results of this study expand upon prior research of informal learning environments, social learning, and STEM camps for secondary students. It reaffirmed that STEM camps as informal learning environments can increase students' STEM knowledge (Hirsch et al., 2017) as well as their perceptions (Vela et al., 2020), attitudes (Roberts et al., 2018), and self-efficacy (Kwon et al., 2019) towards the individual STEM fields and STEM careers. These changes can be attributed to several factors, including the interaction between students and STEM professionals (Maiorca et al., 2020; Roberts et al., 2018; Vela et al., 2020) and hands-on experiences that allow students to have a better understanding of the true nature of a STEM career (Asiabanpour et al., 2010; Hirsh et al., 2017).

Although the outcomes of FTF STEM camps have been and continue to be studied, the effects of an online STEM camp on students' career interest had not been observed. The results from this study aid in developing and improving informal learning environments, both online and in person. Further, it highlights that aspects of an informal learning environment may work in person but may not translate to an online environment. Therefore, instead of comparing online camps to FTF camps as "better" or "worse," educators should examine the aspects of each environment that have the greatest impact on student interest, and improvements should be made based on the specific learning environment, not on the general product of a course.

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APPENDIX

INTERVIEW QUESTIONS

1. What were some of your favorite aspects of camp online?
2. Compare and contrast the on-campus camp and the virtual one. What were some of your favorite aspects of each? Was there anything that you didn't like?
3. Explain some of the main differences you noticed between the online camp and the residential camp. Focus on two aspects: social and quality of the instruction.
4. Given the choice between the online camp and the residential camp, which one would you recommend to your friends and why?
5. In general, do you prefer to learn online or traditionally (in person)?
6. If a camp was offered again online next year, would you consider attending?
7. Would you consider attending another on-campus camp?
8. If BOTH were offered, which one would you choose?