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Underrepresented High Schoolers' Interests, Engagement, and Experiences in an Information and Communications Technology Summer Workshop: A Three-Year Study

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Underrepresented High Schoolers' Interests, Engagement, and Experiences in an Information and Communications Technology Summer Workshop: A Three-Year Study

ABSTRACT

In this paper we describe our investigation of underrepresented high school students' interests, engagement, and experiences in design-based Information & Communications Technology (ICT) summer workshop activities; with the goal of identifying activities, aspects, and/or elements of the program that can be tailored or improved upon to attract, engage, educate, and retain high schoolers who have historically been underrepresented in ICT. Our primary research question is "which activities are most engaging for students typically underrepresented in ICT careers and programs," and we additionally report on underrepresented students' experiences and psychosocial changes across the summer workshops. A total of 139 high school students (of which 98 identified as being underrepresented female and/or racially minoritized students) participated in the ICT workshops hosted across three consecutive summers at a large, public, urban university in the Midwestern region of the United States. Employing a mixed methods design, our quantitative results and qualitative findings suggest that underrepresented students in our sample found the summer workshops' group projects and hands-on courses to be the most engaging activities. Implications of our results/findings are further discussed.

Keywords High School Students; Engagement; Interest; Design-Based Learning

INTRODUCTION

A report from the U.S Bureau of Labor Statistics projects Information and Communication Technology (ICT) related jobs to be among the occupations with the highest growth rates from 2012 to 2022 (U.S. Bureau of Labor Statistics, 2015). Efforts to encourage and prepare school and college aged students in the U.S. for ICT and computer science (CS) related careers have been bolstered by such initiatives as the National Science Foundation's Innovative Technology Experiences for Students and Teachers (ITEST) (see Knezek, Christensen, and Tyler-Wood, 2011) and Computer Science for All programs (Ladner & Israel, 2016); and a key aspect embedded in many of these initiatives is to enhance and improve opportunities for historically underrepresented women and racially minoritized persons in ICT/CS education and the ICT/CS workforce (see also Reider, Knestis, & Malyn-Smith, 2016; Wardle, 2003). In spite of projected ICT/CS job growth and initiatives to enhance ICT/CS opportunities for high schoolers and college students considering science, technology, engineering, and math (STEM) occupations, the underrepresentation of women and racially minoritized persons in ICT/CS persists (see Scott & Martin, 2012). This is in part attributed to the lack of meaningful access to high-level STEM opportunities (Lynch et al., 2017) and/or the lack of identity or sense of belongingness historically underrepresented people have with ICT/CS (Lee, Alston, & Khan, 2015; see also Beyer, 2014).

To respond creatively to complex challenges and innovative changes in technology, companies and industries are desiring a more diverse and more highly educated ICT workforce (Bass, Dahl, & Panahandeh, 2016). Programs, curricula, and workshops geared towards enhancing historically underrepresented students' interest, motivation, engagement, and retention in ICT and STEM related fields have included what are commonly referred to as project-based, problem-based, inquiry-based, or design based afterschool/summer programs (see Duran et al., 2014; Bass, Dahl, & Panahandeh, 2016; Selcen Guzey et al., 2017; Beckett et al., 2016; Connors-Kellgren, Parker, Blustein, & Barnett, 2016; Vallett, Lamb, & Annetta, 2018), many with components or elements that help address and reduce potential psychosocial barriers to underrepresented students' engagement in STEM activities.

In this paper we describe our investigation of underrepresented students' interests, engagement, and experiences in design-based ICT summer workshop activities; with the goal of identifying activities, aspects, and/or elements of the program that can be tailored or improved upon to attract, engage, educate, and retain high schoolers who have historically been underrepresented in ICT. Our primary research question explored which activities engaged students typically underrepresented in ICT careers and programs, and we additionally report on underrepresented students' experiences and psychosocial changes across the summer workshops. Taken holistically, our results/findings can be used to inform the structure, timing, and recruitment strategies for other future ICT high school programs.

Theoretical Framework

Design-Based Learning/Activities. Our Design-Based Information Technologies Learning Experiences (DITLE) program was inspired by inquiry-based/design-based/project-based programs that provided students opportunities to design, develop, and carry out authentic projects of their own making. Doppelt et al. (2008) quote,

> Inquiry is a multifaceted activity that involves making observations; posing questions; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results. (National Research Council, 1996, p. 23).

The amalgamation of cognitive inquiry, authentic projects, and ICT content/problems/resources propelled and informed the structure of the DITLE program, which consisted of ICT Summer Workshops that took place over three consecutive summers, with each workshop being three weeks long. High school students, particularly historically underrepresented female and racially minoritized students from a large, public, urban school district in the Midwestern region of the U.S. were recruited to participate in the summer workshops. Each workshop session consisted of four activities spread across each day; including keynote speakers, instructor-led courses, hands-on courses, and group projects.

Keynote speakers were invited daily to speak to and/or engage students in topics including the availability and growth of ICT professions, cybersecurity threats, applying to college and scholarships in ICT, and even improvisational techniques (to help students become more comfortable interacting with others and responding to ever-changing situations). Although some of the students at participating schools came into the workshops with prior knowledge of and experience with computer devices, coding/programming languages, and media platforms, the keynote speaker events were followed by instructor-led courses that introduced students to ICT content. Students were not expected to have prior knowledge of ICT content; were provided with graduated exercises to meet different levels of experience; were grouped to solve problems and changed roles in the groups to gain experience with each area of the project; and were given time to work on physical computing devices such as Raspberry Pi projects in hands-on courses, before ending their day working on their group projects. Both the hands-on courses and group projects were experiential activities and involved authentic hands-on problem solving with computer devices. However, it was the group projects that aligned most with the spirit of Design-Based Learning, whereby student groups would design, create, and carry out projects of their own making. In groups of four to six, students were tasked with: 1) developing a project that tackled an ICT problem; 2) conducting research on the problem and potential solutions; 3) designing and creating a solution to the problem; and 4) giving a presentation on their project in front of peers, instructors, and invited family members on the final day of the workshop.

Previous studies on inquiry/design/project-based ICT programs, report changes in students' attitudes toward ICT/STEM, engagement in STEM activities, and ICT competence/achievement. Duran et al. (2014) described collaborative design-based afterschool ICT workshops for underrepresented high school students that consisted of hands-on activities, opportunities to identify areas of interest within STEM fields, interactions with STEM leaders and educators, and opportunities for students with shared STEM interests to work in small groups. Overall, Duran et al. reported improved attitudes towards technology, ICT/STEM career aspirations, and understanding of technology use in STEM related fields. Beckett et al. (2016) described multiple project-based high school STEM projects where students would learn in depth about a scientific problem, solutions to the problem, and presenting results at the end of their projects with the tools/equipment they used to solve the problem. Student activity feedback indicated that underrepresented students' engagement was enhanced by the project activities.

Engagement. Subscribing to a multidimensional framework of engagement, we use Ben-Eliyahu et al.'s (2018) definition of engagement, which is the "intensity of productive involvement in an activity;" with conceptualizations for affective, behavioral, and cognitive dimensions of engagement (see Archambault et al., 2009; Fredericks, 2004). Affective engagement refers to one's feelings, interests, perceptions, and attitudes towards school; cognitive engagement refers to psychological investment (i.e. attention and concentration) and use of metacognitive self-regulatory learning strategies; and behavioral engagement refers to one's conduct and/or participation in activities. In the present study, particular attention is dedicated towards assessing underrepresented students' cognitive and affective engagement in the Summer Workshop activities, since high behavioral engagement was assumed by students' attendance and participation in the daily workshop activities.

The Present Study

The primary research question for this study was "which activities are most engaging for students typically underrepresented in ICT careers and programs?" Although previous literature concerning ICT/STEM Design-Based Learning workshops report on their effectiveness in enhancing [indices of] student engagement (see Beckett et al., 2016; Duran et al., 2014), we believe it important to investigate underrepresented students' engagement in our Summer Workshop activities to help inform us of which activities can be tailored and enhanced to attract and retain underrepresented students in future ICT opportunities. For this study, we measured both perceived cognitive engagement and interest (an indicator of affective engagement) for each of the summer workshops' four activities, and across the three weeks of the summer workshops. Although simplistically stated and descriptive in nature, our primary research question is addressed in several ways including 1) analyzing underrepresented students' perceived cognitive engagement and interest by activity; 2) their overall ratings and cognitive engagement with technology for the entire summer workshop; and 3) changes and relationships between psychosocial characteristics and indices of engagement. We believe our results/findings have potentially informative implications for others wishing to launch and carry-out ICT/STEM programs for underrepresented students. Based on the results of previous studies involving ICT/STEM Design-Based Learning programs, we expect that students will rate Group Project activities favorably on measures and responses of perceived affective and cognitive engagement; however, we refrain from making any formal hypotheses, as the other three summer workshop activities can also be rated favorably.

METHODS

We employed a multi-year (cross-sectional), multi-method/mixed methods concurrent design. Unlike a sequential mixed methods design, where the goal would be to integrate the quantitative and qualitative data, concurrent designs describe the simultaneous collection of qualitative and quantitative data and giving the researcher(s) the flexibility to use one source of data to cross-validate and/or provide a supporting role to the second source of data (Creswell, 2015). In our study, we administered and collected surveys with both closed-ended and open-ended items, as well as conducted interviews with students throughout the three consecutive years of our summer workshops. Quantitative data was analyzed as a means of identifying trends, degree, and differences in engagement by year and activity; whereas the qualitative data provided richer and more contextual descriptions of students' experiences and what they found interesting/engaging. Descriptive, correlational, and inferential statistical analyses were employed using the quantitative data. Qualitative data from both the surveys and interviews were organized and analyzed together for all three years of the summer workshops, with an emergent thematic/topic coding approach.

Participants and Setting

Each of the summer workshops were designed and prepared to host a total of 60 high school students per year from six large, public, urban high schools in the Midwestern region of the United States.

School liaisons at each of the participating schools were asked to actively recruit 10 students interested in ICT to apply and participate in the inaugural workshop. School liaisons were also informed that preference would be given to historically underrepresented sophomores and juniors with favorable letter grades (“B’s” and “A’s”) in mathematics; although all applicants would be considered. A total of 38 high school students (13 females; 25 males) applied and participated in the inaugural summer workshop with varying representation from each of the participating schools. Four of the six school liaisons were each able to recruit a handful of students, whereas the other two liaisons (both at schools with established ICT/CS clubs) were able to recruit a larger number of students. Since 10 students could not be recruited from each of the participating schools, more student participants were admitted from the two schools with the larger recruiting pools. Of the 38 Year one participating students, 14 were White/Caucasian, 18 were Black/African-American, and six were categorized as “Other” specifying mixed-ethnicities, Hispanic, and/or Asian/Pacific-Islander. Approximately 60% were sophomores, 30% were juniors, and 10% were freshmen. Years two and three of the summer workshops yielded greater number of applicants/enrollees (49 and 52, respectively), with applications coming in from non-participating schools with students who had heard about the summer workshops from others.

Year two participants consisted of 17 females, 29 males, and three no gender reported; with 16 freshmen, 17 sophomores, and 11 juniors; and consisting of 17 Black/African-American, 15 White/Caucasian, and 14 categorized as “Other.” Year three participants consisted of 21 females, 27 males, and four no gender reported; with 24 freshmen, 10 sophomores, and 13 juniors; and consisting of 20 Black/African-American, 11 White/Caucasian, and 17 categorized as “Other.” A total of 139 high school students participated in the three summer workshops.

All three of the workshops took place over a three-week period (Monday through Friday, from 9am-4pm) in the month of June of each year. Workshops were held on the campus of a large, public, urban, research university in the Midwestern region of the United States. Though the university was within driving distance for each school, bus/carpool transportation was organized and offered to students from participating schools. Students from the furthest school outside of a direct city bus line were offered a school shuttle ride from their high school. Students from the other schools were offered a 30 day city bus pass for transportation directly to the university. Some students opted to have parents transport them each day. Due to differences in bus schedules and parent work schedules, students arrived as early as 7:45am and left as late as 5:00pm. Due to the early arrival by many students, breakfast, supervision, and entertainment became a priority and provided in the mornings. Each workshop consisted of four activities, including keynote speakers, instructor-led courses, hands-on courses, and group projects. With exception to some keynote speaker events, most of the other activities took place in either a computer lab space and/or a technology-oriented classroom designed for group work and video/computer capabilities. Keynote speaker events were quite diverse and hosted in diverse settings on the university's campus. Always taking place in the morning, some speakers gave a presentation in a lecture hall on topics ranging from cybersecurity to financial advice for majoring in IT in college, while some speakers engaged students in "improv" comedy sketches outdoors, instructional design acting workshops in a large conference room, and IT Student Mentor Panel in an outdoor classroom. Following keynote speaker events were the instructor-led courses and hands-on courses that included lessons on

- object oriented programming using Java;
- web programming using HTML5 with Javascript and CSS;
- mobile programming for Android;
- networking concepts including creating a network diagram, creating a patch cable;
- cyber security concepts including Linux commands and online safety;
- digital media including Photoshop; and
- Microsoft Office applications.

Breaks and lunches were dispersed throughout each day, ending with group projects.

Scheduling and duration of Groups Projects varied however across the three years of the workshops, as team-building strategies were adjusted from year-to-year based on student feedback. The group projects were what inspired the summer workshops from their initial conception, where students would work in small groups to design, develop, and implement a working IT solution. Each group would have a mentor (IT teaching assistants) to aid in the organization of information and materials, yet only the students would present their work as groups on the final day of the workshop. In Year one, group projects were held at the end of each day, however, feedback from students indicated that students would have preferred more time to get to know their peers and identify shared interests in IT solutions before working in groups. Therefore, in Year two, more time and attention was dedicated towards team-building and increasing social interactions among students. Although students expressed appreciating increased social interactions in Year two, many expressed the desire to have more time to work on their group projects after they learned the core IT skills. Thus, in Year three, the first two weeks of the Summer Workshop was dedicated mostly to the Instructor-Led and hands-on courses, so that the last week of the summer workshop could almost entirely be dedicated to the group projects (although keynote speaker events still took place in the morning daily throughout the Year three workshop). During the first two weeks, the instruction was structured for partner and small group hands-on activities so the students stayed engaged while learning the core IT concepts. When the students started the group project, they had the core IT skills to complete more complex and complete IT solutions.

Instrumentation

Interest & Engagement. We employed Archambault et al.'s (2009) School Engagement measure to assess the affective, behavioral, and cognitive engagement of students, tailoring the cognitive engagement items for the technology context students found themselves in for the summer workshops, in place of French language arts, which was originally applied in Archambault et al.'s work. For the cognitive engagement scale, where students were asked to rate on a 1-7 Likert scale from "Strongly Disagree" to "Strongly Agree," the original item "how much time are you ready to put into French?" was changed to "I am ready to put a lot of time learning about technology." A total of four items were altered or created to assess students' cognitive engagement in technology, including the item "I want to learn more than what we learned in the technology program." Archambault et al.'s four items for assessing students' cognitive engagement in mathematics remained unchanged. The affective engagement scale utilized the same 1-7 Likert scale of “Strongly Disagree” to “Strongly Agree,” with seven items like “what we learn in class is interesting.” Finally, four items on a 1-4 Likert scale (Never = 1, Rarely = 2, Sometimes = 3, and Quite Often = 4), were used to assess behavioral engagement with items like “missed school without a valid reason.” These four behavioral engagement items are negatively worded, and therefore reverse coded so that higher means could be interpreted as higher [adaptive] behavioral engagement. Achambault et al. report Cronbach alpha scores of .88, .83, and .65 respectively for the cognitive, affective, and behavioral engagement scales; whereas we obtained alpha coefficients of .93, .90, and .70 for this study. Archambault et al.’s (2009) School Engagement measure was administered to access students’ general engagement for school; however, more direct items were employed to assess students’ perceived cognitive engagement and interest by activity.

Perceived cognitive engagement and interest by activity were assessed using items inspired from Duncan and McKeachie’s (2005) Motivated Strategies for Learning Questionnaire (MSLQ; see also Pintrich, Smith, Garcia, McKeachie, & Hancock, 2004), and Johnson & Sinatra’s (2013) perceived cognitive engagement item. This was done to keep weekly surveys short, and we did not want to exhaust participants from filling out longer measures weekly and by activity. To assess interest, an indicator of affective engagement, by activity we asked students weekly to rate statements on a scale of 1-7 (whereoneindicates the statement is “Not at all true of me” and seven indicated “Very true of me”), “I found the ideas, content, and topics that were presented by the keynote speakers to be very interesting.” Similarly, to assess perceived cognitive engagement by activity, students were asked to rate statements like “I felt engaged during the Group Project events this week.” Items for interest and perceived cognitive engagement were respectively summed and averaged by activity to produce a mean score for each. Across the three weeks and three years of the Summer Workshop, Cronbach reliability coefficients for interest by activity fell within the acceptable range from .68 - .80, and similarly for perceived cognitive engagement by activity ranging from .67 - .76.

Attitudes, Aspirations, and Experiences. Although not pertinent to our primary research question, additional measures for ICT Attitudes and College/Career Aspirations, Persistence, Self-

Concept, Self-Determined Needs, demographics, ICT Knowledge, and overall rating of the summer workshop were administered at the beginning and end of the workshops. This was done to describe, evaluate, and compare psychosocial changes in students across their participation in the workshops. To assess ICT Attitudes and College/Career Aspirations, Ardies, De Maeyer, and Gijbels' (2013) Pupils Attitude Towards Technology (PATT) scales were tailored to fit our summer workshop context. In addition to career aspiration items like "I will probably choose a job in technology," attitudinal subscales within PATT include interest in technology, technology as an activity for both girls and boys, consequences of technology, technology is difficult, and tediousness towards technology.

Literature on the psychosocial characteristics of STEM students, suggest relationships between STEM achievement and students' self-concept as a "STEM person," persistence in the face of STEM challenges, and Self-Determined needs, especially for underrepresented populations (see Linnenbrink-Garcia et al., 2018; Finley-Van Nostrand & Pollenz, 2017; Flynn, 2016; Leon, Nunez, & Liew, 2015). Fleming's (2007) Personal and Academic Self-Concept Inventory (PASCI) was adapted and employed to assess students' self-concept, with subscales for self-regard, social acceptance, academic ability, verbal ability, math ability, parental acceptance, and social anxiety [renamed "social comfort" in the present study to better indicate students' comfort in social interactions]. Persistence items from Martin's (2015) Motivation and Engagement Scale (MES) were tailored and utilized. And Van den Broeck et al.'s (2010) measure for the three Self-Determined needs of autonomy, relatedness, and competence was tailored and administered to fit our ICT workshop context.

Demographic information was collected from workshop applications that were collected by school liaisons or at workshop orientations that took place prior to the workshops. Students reported their year in school, gender, age, and ethnicity. Based on students' responses for gender and ethnicity, a dichotomized "representation" variable for "represented" (White/Caucasian males, $n = 33$) and "underrepresented" (racially minoritized and/or female, $n = 98$) students was created (with eight of the 139 participants not reporting their gender and/or ethnicity), so that the mean scores for underrepresented students could be assessed separately from represented students. For ICT Knowledge, a 10-item multiple/choice pretest and posttest were created, with items derived from an introductory college-level ICT course. Finally, at the end of the last survey administered each year, students were asked "Overall, I would rate this summer program as . . .," with 5 = Excellent, 4 = Good, 3 = Average, 2 = Fair, and 1= Poor.

Open-Ended/Interview Questions. In each of the summer workshops, students were given opportunities to provide more qualitative feedback about their experiences through responses to open-ended survey items and interviews. An interview protocol was employed consisting of 16 open-ended items. Although interview questions included "are you interested in participating in an [ICT] internship following this program," the interview items most pertinent to our primary research question included "please describe the most interesting things you are taking away from this workshop" and "please describe what you like best about this workshop." Similarly, on the final survey of each of the summer workshops, students were asked to provide responses to open-ended items such as "what suggestions do you have to improve this summer program," and the survey item that got at interest (or affective engagement), was "what did you like most about this summer program?"

Data Collection and Analysis

In accordance with the procedures approved in an Institutional Review Board (IRB) protocol, parental/guardian informed consent was obtained along with assent from participating students during orientation meetings that took place approximately one month prior to the start of the summer workshops. A total of four surveys were administered and collected across each of the three-week long workshops. The first survey, administered in the morning on the first day of the summer workshop, consisted of the ICT Knowledge pretest, demographic questions (if not provided previously in students' applications for the summer workshop), and measures of Self-Concept and ICT Attitudes & College/Career Aspirations. The second survey was administered on the Friday of the first week of the summer workshop and consisted of interest and perceived cognitive engagement items by activity, along with a measure for Self-Determined Needs. The third survey again consisted of interest and perceived cognitive engagement items by activity. And the fourth and final surveys were administered right before students' final day project presentations, consisting of all of the aforementioned items/measures, including those for persistence. Quantitative data was organized, coded, and/or calculated using SPSS 21. "Year of participation" categories were also created so that students could be compared by year. Descriptive, correlational, and inferential statistical analyses were conducted and reported below.

A total of 22 interviews were conducted across the three years of the summer workshops; six interviews in Year one, six interviews in Year two, and 10 interviews in Year three. Interview participants were purposefully selected from each of the six participating schools, and meant to include historically underrepresented students. A greater number of interviews were conducted in Year three due to some confusion about the status of some of the participants' signed parental consent forms; however it was later confirmed that all had signed and submitted parental consent forms. Year one interviewees consisted of three females and three males, with four identifying as being from a racially minoritized group. Year two consisted of two females and four males, with four identifying as being from a racially minoritized group. Year three consisted of five females and five males, with five identifying as being from a racially minoritized group. Although interviewees were selected and notified of their selection at the start of their summer workshops, the interviews themselves were scheduled and conducted in the third and final week of the workshops. The timing of the interviews was done intentionally, so that all interviewees would have enough time and experience with the workshop activities. All interviews were recorded and transcribed, and copied into SPSS 21 and NVivo 11. Both the coding key for our qualitative data and highlighted quotes are reported below.

RESULTS/FINDINGS

Due to the robustness of our multi-year mixed methods concurrent design, we present our results and findings in three subsections to simplify and organize information pertinent to both our primary research question and the descriptions of students' experiences and psychosocial changes across the workshops. Specifically, we begin with a subsection that provides greater details about our Year one, Year two, and Year three student samples' pretest ICT Knowledge and school contexts. We then present the results and findings in the second subsection addressing our primary research question "which activities are most engaging for students typically underrepresented in ICT careers and programs?" In this second subsection we compare students' perceived cognitive engagement and interest by activity, along with students' qualitative responses. And finally, we end with a subsection describing other relevant student experiences and feedback in the summer workshops beyond our primary research question concerning engagement and interest; reporting changes in students' self-concept, persistence, and self-determined needs, to name a few. We chose to present our results and findings in this way, as opposed to separate subsections for quantitative and qualitative analyses, because data was collected simultaneously in our concurrent mixed methods design, as opposed to being collected and analyzed separately for a sequential mixed methods design. Priority was given to our quantitative data to identify statistically significant relationships and differences by activity and by year; and where our qualitative data played more of a supportive role.

ICT Knowledge & School Contexts

Before identifying which activities underrepresented students found most engaging, we believe it is important to first understand our student samples by year of participation in the summer workshops; especially because Year one students had entered into their summer workshop with varying levels of ICT exposure. In recruiting students for our inaugural Year one workshop, school liaisons at two of the six participating schools had an easier time identifying students who would be interested in participating in an ICT summer workshop because their schools had existing ICT/CS clubs with active teachers heading the clubs. The other four schools at the time this study started did not have active or existing ICT/CS clubs. In addition to the differences in ICT/CS club opportunities, the four schools without ICT/CS clubs were predominantly Black/African-American in their student populations. This does not mean that the two schools with clubs were not ethnically diverse; rather the bulk of the White/Caucasian participating students in the Year one workshop primarily came from these two schools, and the bulk of the Black/African-American participating students came for the other four schools.

Comparing Year one students' ICT Knowledge pretest scores (maximum score of 10) by school (though the sample is too small to appropriately interpret statistical significance), students from the two schools with ICT/CS clubs yielded mean scores of 4.4 and 4.7, whereas students from the four schools without clubs yielded mean scores of 2.0, 2.5, 2.6, and 3.8. An independent samples t-test, where students were dichotomized as White/Caucasian and Non-White/Caucasian, a statistical difference in pretest ICT Knowledge scores is observed, $t(35) = 2.78$, $p = .009$, where White/Caucasian students yielded higher scores ($M = 4.86$, $SD = 1.7$) than Non-White/Caucasian students ($M = 3.26$, $SD = 1.68$). These results are indicative of student differences in knowledge and exposure of ICT prior to their participation in the inaugural workshop. Ethnic differences however in pretest ICT Knowledge scores were not observed for Year two or Year three students.

Mean pretest ICT Knowledge scores were statistically higher for all Year two and Year three students than Year one students as evidenced by a one-way ANOVA, $F(2,113) = 19.9$, $p < .005$, $\eta^2 = .26$, where Year three students yielded the highest mean ($M = 5.96$, $SD = 1.59$), followed by Year two students ($M = 5.7$, $SD = 1.23$), and finally Year one students ($M = 3.8$, SD 1.84). We believe that these differences can be attributed to several factors including: 1) schools that did not initially have ICT-related clubs in Year one launching and establishing such clubs before the Year two workshops; 2) school liaisons increased awareness and efforts to recruit interested students to the Year two and Year three workshops; and 3) increased students' awareness of the summer workshops in Year two and Year three, perhaps by word-of-mouth and/or information provided by teachers and liaisons at ICT-related school clubs.

Two paired-samples t-tests were conducted to analyze whether ICT Knowledge had changed across the three-week long workshops for the overall sample, and for underrepresented students specifically. And significant increases in ICT Knowledge are observed for both the overall sample, $t(97) = -3.64$, $p < .005$, and underrepresented students specifically, $t(66) = -2.99$, $p = .004$; where the overall sample began the summer workshops with a mean of 5.25 ($SD = 1.92$) and finished with a mean of 5.82

(*SD* = 2.29) and underrepresented students began with a mean of 5.08 (*SD* = 2.08) and finished with a mean of 5.65 (*SD* = 2.41). Running a repeated-measures MANOVA for underrepresented students' beginning and ending scores for Archambault et al.'s (2009) School Engagement subscales, we do observe a difference, Wilks' Lambda = .833, $F(4, 65) = 3.253$, $p = .017$, $\eta^2 = .167$; with a statistically significant change observed in affective engagement in class/school work, $F = 6.973$, $p = .010$, $\eta^2 = .093$, where students began their workshops with a mean score of 4.55 (*SD* = 1.48) and ended with a mean score of 4.83 (*SD* = 1.37) (See Table 1).

Table 1. Paired-samples t-tests for ICT Knowledge and tests of within-subjects contrasts for School Engagement.

	N	*M*	*SD*	*t*	*df*	*F*	*p*	η^2
Overall Sample								
Pretest ICT Knowledge	98	5.25	1.93					
Posttest ICT Knowledge	98	5.82	2.29	-3.64	97		.001	
Underrepresented Students								
Pretest ICT Knowledge	67	5.08	2.08					
Posttest ICT Knowledge	67	5.65	2.41	-2.99	66		.004	
Behavioral Engagement (Pre)	69	3.58	0.46					
Behavioral Engagement (Post)	69	3.52	0.49			1.57	.214	.023
Affective Engagement (Pre)	69	4.55	1.48					
Affective Engagement (Post)	69	4.83	1.37			6.97	.010	.093
Cognitive Engagement Math (Pre)	69	5.30	1.43					
Cognitive Engagement Math (Post)	69	5.31	1.56			.005	.944	.000
Cognitive Engagement Technology (Pre)	69	5.49	1.23					
Cognitive Engagement Technology (Post)	69	5.30	1.58			1.47	.229	.021

(Pre) indicates initial responses; (Post) indicates final responses.

Most Engaging Activities

Our primary research question for this study was "which activities are most engaging for students typically underrepresented in ICT careers and programs?" We first attempt to answer this question by identifying which activities yielded the highest mean score for perceived cognitive engagement and interest, just for underrepresented students. Overall, the activity with the highest mean score for interest was the hands-on courses (*M* = 5.61, *SD* = 1.14) followed by group projects (*M* = 5.43, *SD* = 1.33), yet the activity with the highest mean score for perceived cognitive engagement was group projects (*M* = 5.54, *SD* = 1.32) followed by the hands-on courses (*M* = 5.44, *SD* = 1.25) (See Table 2). Results of a MANOVA, where underrepresented and represented students' mean scores for perceived cognitive engagement and interest by activity were compared, indicated no overall statistical difference, Wilks' Lambda = .863, $F(8, 89) = 1.76$, $p = .094$, $\eta^2 = .137$; however pairwise comparisons, indicate a small but significant difference between the two student groups in their interest for instructor-led courses, $F(1, 96) = 4.02$, $p = .048$, η^2=.04, where underrepresented students reported greater interest (*M* = 5.31, *SD* = 1.18), than represented students (*M* = 4.68, *SD* = 1.91); as well as a significant difference between the two student groups in their perceived cognitive engagement for group projects, $F(1, 96) = 5.03$, $p = .027$, η^2=.05, where underrepresented students reported greater perceived cognitive engagement (*M* = 5.52, *SD* = 1.34), than represented students (*M* = 4.73, *SD* = 1.94).

An emergent thematic/topic coding approach was used to analyze underrepresented students' open-ended responses to the survey question "what did you like most about this summer program." A total of 21 codes were identified in the first analysis, with codes for "*learning*," "*peers*," "*hands-on*," "*keynotes*," and "*technology*" being among the most frequent. References to group projects, classmate interactions, and/or friends, were coded as "*peers*." Although the instructor-led courses could not specifically be teased out or directly identified in students' responses, aspects of the instructor-led courses like "learning about binary" did appear in students' responses; however, were simply coded as "*learning*" since that was the term that specifically came before other terms related to the instructor-led courses. When an instructor's name was specified in the response, the code "*instructor*" was used.

Codes were then grouped into seven themes, including *learning*, *peers*, *hands-on*, *keynotes*, *instructors*, *personal growth*, and *peripheral elements*. *Peers* and *hands-on* (both coded 24 times), were the most prevalent themes, where *peers* included quotes like "I liked the group project," "meeting new people," and "making new friends;" and *hands-on* being specifically mentioned by name. These two themes were closely followed by the theme for *learning*, (coded 23 times), including quotes like "learning about the different aspects of IT," "learning about coding," "learning about binary," and "learning about hexadecimal." Specific *keynotes* were mentioned five times, as well as *instructors'* names mentioned five times, with one student expressing that they appreciated "listening to speakers who overcame the same obstacles [as me]". *Personal growth* was coded six times and pertained to responses that expressed how the summer workshops were a good opportunity to use their creativity or grow confidence in talking to others (i.e. public speaking). Finally, four codes were grouped into the theme for *peripheral elements*, which included responses about liking the food that was served during the workshops and the chance to just spend time on a college campus. We believe that the themes for *peers* and *hands-on* support our quantitative findings of both the group projects and hands-on courses being deemed the most engaging/interesting activities by underrepresented students. Although the theme for *learning* was close in frequency count to *peers* and *hands-on*, the *learning* theme was an amalgamation of aspects of the instructor-led courses and students simply expressing that they liked "learning." As for specific elements of the group projects and hands-on courses that students found interesting, "taking apart computers," Javascript, coding [languages], networking, programming raspberry pi's, and Wi-Fi heat mapping were frequently referenced by students when describing interesting hands-on activities they enjoyed gaining practice with or applying. Details about group projects varied, oftentimes being very specific to one's own group project, however, the opportunity to socialize/interact with peers, feelings of being a contributing team member, and practicing for the final group presentation were generally mentioned frequently as being enjoyable. Popular topics at the center of many group projects included cybersecurity, animation, integrating social media platforms, phone applications that use location tracking, and developing devices to help individuals with physical or audio/visual impairments.

Underrepresented students' interview responses (n = 15) primarily reflected similar sentiments expressed in the open-ended survey item responses. The item "please describe the most interesting things you are taking away from this workshop," were analyzed using the same thematic/topic coding approach employed with analyzing students' open-ended survey responses. The same themes were identified, where *hands-on* (n = 6) and *peers* (n = 5) were the most frequent response themes, followed by *learning* (n = 3), *personal growth* (n = 2) and *keynotes* (n = 1). Several of the *peers* themed responses were quite striking in that they elaborated on why students found their group projects and/or peer interactions to be so interesting. Several of these students expressed sentiments along the lines of "[my peer interactions are] opportunities for me to teach others." Perhaps the most striking of responses came from a Black/African-American female student, who said:

> [This program] reassured me that I'm not the only black girl who likes technology, in seeing many different faces . . . And I've really made friends who are the same color as me, finally for a change . . . I've seen more people rise up and not be afraid of loving technology, something that's, in the past has been seen as nerdy or uncool; and now it's turning into something cool and useful at the same time.

Collectively, comments from across students' responses to open-ended survey questions and interviews alluded to a sense of belongingness, a sense of autonomy "freedom" in making choices, seeing ICT as a possible career option, making something that can be used by others, applying gained knowledge and skills, and the interactive nature of activities as reasons for finding hands-on courses and group projects to be engaging. Although the instructor-led courses and keynote speakers were not as frequently spoken about as being interactive, compared to the hands-on courses and group project activities, it should be noted that many students appreciated learning about new and different ICT materials in the instructor-led courses that they later applied and enjoyed during the hands-on and group project activities; and similarly appreciated learning about career paths and diversity in ICT from keynote speakers. Some general comments from students worth noting include: "I liked the diversity, and meeting new people," "the summer program exposed us to many aspects of technology and different paths one could follow in a technology career," "something that's particularly interesting [is] the fact that I'm able to like create an application," and the "most interesting thing is, they introduced me to raspberry pi, and with that, I can take it and run with it [to create something useful]."

Relevant Experiences & Feedback

Due to our multi-year (cross-sectional), multi-method/mixed methods concurrent design, a wealth of data was collected from the summer workshops across the three years that enriches our interpretations of the primary research findings, and informs our understanding of and future directions with the workshops. Continuing to analyze the data and responses of underrepresented students, a paired-samples t-test and several repeated measures MANOVA's were performed with measures administered at the start and end of the workshops (see Table 3). Overall, no significant differences are observed for underrepresented students from the start to the end of the Summer Workshops in attitudes, Wilks' Lambda = .952, $F(5, 67) = .681$, $p = .639$, $\eta^2 = .048$; self-concept, Wilks' Lambda = .877, $F(7, 61) = 1.22$, $p = .305$, $\eta^2 = .123$; self-determined needs, Wilks' Lambda = .928, $F(3, 44) = 1.14$, $p = ..343$, $\eta^2 = .072$; or persistence $t(77) = -1.48$, $p = .142$. However, in a test of within-subjects contrasts for the PASCI (Fleming, 2007) self-concept subscale for social comfort, a statistically significant change is observed, $F(1, 67) = 4.86$, $p = .031$, $\eta^2 = .068$, where underrepresented students began the workshops with lower mean scores on social comfort ($M = 3.91$, $SD = 1.56$) and ended the summer workshops with higher mean scores on social comfort ($M = 4.25$, $SD = 1.40$); suggesting some support of the qualitative theme of Peer interactions as an enjoyable aspect of the workshops.

Among the notable correlations for underrepresented students, between the variables perceived cognitive engagement and interest by activity, posttest ICT Knowledge, attitude subscales from PATT, general school engagement scales, and persistence, include the positive significant relationships between Group Project perceived cognitive engagement and positive attitudes towards technological career aspirations ($r = .508$, $p < .005$); as well as between Group Project interest and positive attitudes towards technological career aspirations ($r = .502$, $p < .005$). Both Group Project perceived cognitive engagement and interest had the strongest relationships with Archambault's subscale for cognitive engagement towards technology, (r = .496, p < .005) and (r =.484, p < .005) respectively. See Table 4.

In response to the final quantitative survey item "Overall, I would rate this summer program as . . .," there was no statistical differences by year, $F(2,78) = 3.08$, $p = .052$, $\eta^2 = .075$, in spite of the increasing trend from Year one (M = 3.96, SD = .76) to Year two (M = 4.23, SD = .61) to Year three (M = 4.41, SD .79). Although not statistically significant, the values themselves and positive trending direction are perceived favorably by the workshop personnel. When asked "what suggestions do you have to improve this summer program," the most common responses pertained to either the need for more time (24% of responses) to complete group projects and/or rearranging the schedule of activities (40% of responses) so more time can be dedicated to Hands-On activities for example. Actual suggestions as to what activities or content should be given more or less time varied wildly. For those who expressed wanting more time to complete group projects, some proposed extending the summer workshops by another week.

DISCUSSION

We employed a mixed methods concurrent design, to address our primary research question "which activities are most engaging for students typically underrepresented in ICT careers and programs?" Generally, our quantitative and qualitative data support one another in pointing to both group projects and hands-on courses as being the most affectively and cognitively engaging activities by underrepresented students. Additionally, these findings support previous literature expressing that collaborative inquiry- and design-based activities can be engaging (Doppelt et al., 2008).

Although group projects were a major focus in the conceptualization of the DITLE summer workshops, the authentic and interactive elements of the hands-on courses were perceived by underrepresented students in as favorable a light. This is not to say however that the keynote speakers and instructor-led courses were unfavorable, as a proportion of our entire sample and underrepresented sample expressed how informative and inspirational some of the keynote speakers were in communicating the challenges they had to overcome to succeed in ICT and the encouragement they received from their instructor-led course mentors and instructors.

In addition to finding group projects and hands-on courses as being the most engaging workshop activities, we believe our additional results and findings concerning increased social comfort, and desired changes to the summer workshop schedules to be insightful and useful. With these results and findings, we believe that the workshops were effective in exposing all students, and especially underrepresented students, to ICT content and activities in a socially supportive way. Furthermore, students' feedback on the scheduling and duration of the workshops and activities energizes the DITLE team and personnel to reconsider strategies for providing students adequate time to complete their group projects.

Limitations and Future Directions

There were several limitations in our study, including our limited sample and the school contexts from which students were entering the summer workshops. As mentioned earlier, at the time in which the summer workshops began, only two of the six participating schools had ICT/CS clubs that had exposed students to ICT/CS content and activities. The lack of ICT/CS clubs at the other four schools also meant that liaisons had a more difficult time recruiting interested students to the summer workshops, especially in Year one. These circumstances limit the generalizability of our findings. Simultaneously, it should also be noted that our recruitment and samples were not so atypical to discount our results/findings either, as many urban school districts across the U.S. may be limited in their ICT/CS club offerings. Future research may consider assessing larger samples of students from similar school contexts (i.e. those with ICT/CS clubs or those without ICT/CS clubs). Additionally, larger samples would be ideal for future studies to evaluate the external validity of our finding of a relationship between Group Project cognitive engagement and technological career aspirations.

Another limitation to our study is in our research design. Although we are proud to have employed a mixed methods concurrent design, our research was nonexperimental and not longitudinal, limiting our ability to generate causal conclusions or long-term predictions. This study involved minors from multiple schools in an urban school district, many of whom self-selected into the summer workshops (especially in Years two and three) (see Vallett, Lamb, & Annetta, 2018). Although there are ethical and logistical considerations to take into account, future studies could consider research designs in which students within the same school district could be randomly assigned to different workshop conditions (i.e. comparing students who stay in one group for all workshop activities to those who have to interact with different students for Hands-On and Group Project activities). Additionally, future studies can consider longitudinal designs to assess whether students who expressed high ICT/CS career aspirations during the workshops actually pursue ICT/CS college majors or employment. Finally, a third limitation to our study was the possibility of a testing effect, where students may have performed better on the ICT Knowledge measure at the end of the summer workshop simply because they were familiar with the questions, having seen the ICT Knowledge items at the start of the summer workshop; limiting the internal validity of our finding of increased scores in ICT Knowledge. Future research may consider longer and more varied ICT achievement measures.

Implications

Logistical and Methodological Implications. Methodologically, our collection of quantitative and qualitative data was advantageous in that it allowed us to discover more nuanced and contextual findings that would not have been possible had we just collected quantitative data, or just qualitative data. For example, we would not have been able to identify statistical differences in students' pretest ICT Knowledge had we not collected quantitative data. Similarly, it is likely that we would have had an incomplete or limited understanding of students' desire to have more time to complete group projects, had we not collected qualitative data. With the collection and analyses of quantitative and qualitative data enriching our findings, we encourage future research concerning ICT/CS programs to consider mixed methods designs. We believe our study demonstrates that a mixed methods concurrent design, as well as the measures we employed, can be applied in future research with high school aged samples.

Logistically, it is important to report on the challenges in recruiting and working with adolescents from a large, public, urban school district. The schools in our study varied in their ICT/CS club offerings and student demographics, which likely contributed to the statistical differences we observed in Year one students' pretest ICT knowledge. Additional logistical challenges included organizing bus schedules so that students could attend the summer workshops; obtaining institutional approval to host minors in the summer workshops on a college campus; maintaining and organizing signed parental consent forms; and monitoring foods and students' food allergies throughout the summer workshops. These tasks were all atypical responsibilities that the DITLE research team and university staff/faculty had to work with, however, they are necessary logistical issues that any future ICT/CS research with high school aged samples on college campuses would have to take into consideration. Successful handling of these logistics contributed to the minimization of missing data in our study, as failure to organize bus schedules, consent forms, or not attending to students' food allergies could have resulted in more student absences or attrition from the workshops. Further discussion about the timing and length of workshop activities can be found below.

Psychosocial and Practical Implications. Given the age group of our student samples, many, if not all, were grappling with psychosocial changes in their identity, [peer or intimate] relationships, and perhaps taking on new responsibilities inside and outside of their home environments (i.e. chores, babysitting siblings, part-time jobs, driving, etc.). It is important for ICT/CS faculty in higher education settings to keep the aforementioned psychosocial changes being experienced by high school students in mind, as high school students are developmentally different from the college-aged students they may be more familiar interacting with or teaching. Additionally, across the summer workshops, many of the group project presentations had ties to students' personal lives, interests, and experiences, including protecting, securing, and/or combining social media platforms and devices, or developing sensory devices for those with physical or audio/visual impairments. One female student who was inspired by the movie Mr. Holland's Opus, expressed her strong altruistic desire to help those with audio/visual impairments "see sound or maybe even feel sound again." This implication of connecting curriculum and instruction with things that are personally relevant to learners, aligns with recommended teaching practices that promote deep learning (see American Psychological Association, Coalition for Psychology in Schools and Education, 2015; Harackiewicz, Smith, & Prinski, 2016).

Practically speaking, our results and findings again support our conclusion that underrepresented students found both the group projects and hands-on courses to be engaging. Both activities reflected design-based learning practices, where students worked in authentic ways to question, research, design, and carry out solutions. Belland, Kim, and Hannafin (2013) however caution those interested in applying inquiry/problem/design-based activities by expressing that such activities alone do not ensure adaptive engagement, motivation, or success on tasks; further stating that students will benefit from problem-based learning activities when paired with sufficient guidance, scaffolding, and motivational supports. And we believe that our summer workshop instructors (who were present for not only instructor-led courses, but throughout the summer workshop activities), and perhaps even keynote speakers provided the motivational supports and guidance needed to adaptively engage in the hands-on courses and group projects. Another practical implication of our results and findings comes from students expressing that the workshops can be improved by extending the time dedicated to group projects. Although there are logistical concerns (i.e. time and cost of instructors and resources), extending the workshop by another week for students to complete group projects can potentially benefit students. The additional time can promote distributed practice, increasing opportunities to become more proficient on a learning task; and students' self-efficacy can be enhanced with the mastery experience of completing the group projects, which could strengthen students' persistence in the face of challenges, identity with ICT/CS, and subsequent engagement in future ICT/CS activities (see Ormrod, 2016; Butz & Usher, 2015).

Applications and Revelations from DITLE Personnel. Informed by our results and findings across the DITLE program, faculty and administrators at the higher education institution that hosted the ICT workshops have and continue to apply strategies for growing ICT opportunities, recruitment, admissions, career advancement, and student diversity. Although beyond the scope of our primary research question, university faculty and administrators believe that what separated the DITLE program from other ICT summer workshops in the region, were the relationships that were built between the university's ICT personnel and local high schools, especially the school liaisons. Inspired by the Year one results that revealed differences in students' ICT knowledge, school liaisons who worked at schools that lacked ICT/CS clubs took actions to launch and establish ICT/CS clubs; exposing prospective workshop students to ICT/CS content and informing them of local opportunities and events (i.e. robotics competitions, internships, and programs like DITLE). We attribute the absence of ICT knowledge differences in Years two and three, to the establishment of ICT/CS clubs at all partner schools; which has only strengthened relationships with the university's ICT faculty and administration, as well as the sharing of resources and ICT materials between the university and partner high schools.

In observing the creativity, energies, problem-solving successes, and project achievements of high schoolers from diverse backgrounds throughout the DITLE program, the university's ICT administrators expressed that they "realized that our admissions requirement [heavily based on standardized test scores] is a significant barrier to students who would excel in hands-on and project-based activities but not so much on traditional [measures/tests of academic achievement] . . . We started to [reconceptualize] our admissions requirements to open the door to these students who possess the key skills for success in ICT." This revelation further inspired the university's ICT administrators to partner with more local high schools to build ICT courses and experiences into students' high school years, that would give students opportunities and course credits that they could speak to in their college applications and articulate their hands-on and project-based experiences that would indicate their potential for success in a hands-on and project-based oriented ICT major. Further efforts by the university's ICT administrators have been made to reshape the ICT curriculum to be more project-based, and to train ICT faculty and instructors on engaging both high school and college-aged students. In addition to partnering with local high schools, the university's ICT administrators were also inspired to partner with local industries to create internships for students, based on our study's probing interview question concerning and indicating students' interest in participating in ICT internships. Collectively, these efforts to reshape and reconceptualize admissions and the ICT curriculum and instruction, move away from the traditional lecture-based approaches to college-level programs and towards more experiential and applied learning opportunities.

Beyond the partnerships that have grown out of the DITLE program, aspects that one of the program's key managers and facilitators expressed as being major contributors to historically underrepresented students' sense of belonginess during the ICT workshops were having a "space on a college campus that they could call their own," some of the diversity, equity, and inclusion exercises that keynote speakers engaged students in, and the inclusion and participation of diverse instructors and teaching assistants in the DITLE program. The summer ICT workshop activities predominantly took place in computer labs and/or technology-oriented classrooms on a large, public, urban college campus, where students could work in their groups and work with materials safely and consistently on a daily basis. The sentiment of "feeling like I'm already going to college," was expressed by multiple students in this study's surveys and interviews, as well as through conversations among students, instructors, and teaching assistants. We believe that in addition to the building of ICT clubs and courses in local high schools, college curriculum that incorporates more hands-on and project-based activities, and partnerships with local industries, that building diversity, accessibility, equity, and inclusion into the infrastructure, personnel, and practices of ICT programs can contribute to heightened engagement in ICT opportunities and experiences among historically underrepresented female and racially minoritized students.

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Table 1. Paired-samples t-tests for ICT Knowledge and tests of within-subjects contrasts for School Engagement.

	N	*M*	*SD*	*t*	*df*	*F*	*p*	η^2
Overall Sample								
Pretest ICT Knowledge	98	5.25	1.93					
Posttest ICT Knowledge	98	5.82	2.29	-3.64	97		.001	
Underrepresented Students								
Pretest ICT Knowledge	67	5.08	2.08					
Posttest ICT Knowledge	67	5.65	2.41	-2.99	66		.004	
Behavioral Engagement (Pre)	69	3.58	0.46					
Behavioral Engagement (Post)	69	3.52	0.49			1.57	.214	.023
Affective Engagement (Pre)	69	4.55	1.48					
Affective Engagement (Post)	69	4.83	1.37			6.97	.010	.093
Cognitive Engagement Math (Pre)	69	5.30	1.43					
Cognitive Engagement Math (Post)	69	5.31	1.56			.005	.944	.000
Cognitive Engagement Technology (Pre)	69	5.49	1.23					
Cognitive Engagement Technology (Post)	69	5.30	1.58			1.47	.229	.021

(Pre) indicates initial responses; (Post) indicates final responses.

Table 2. Means, standard deviations, and quotes for underrepresented students by activity.

Activity/Variable	***M***	***SD***	**Quotes**
Keynote - Interest	5.16	1.29	"How the Keynote Speakers talked about their own experiences [even with failure] in the field they work in or personal experiences they've had."
Keynote – Perceived Cognitive Engagement	4.98	1.39	
Instructor-Led Interest	5.23	1.26	"I like the professors a lot . . . like they encourage you."
Instructor-Led Perceived Cognitive Engagement	5.23	1.30	
Hands-On Interest	5.61	1.14	"Taking apart a computer and putting it back together."
Hands-On Perceived Cognitive Engagement	5.44	1.25	
Group-Project Interest	5.43	1.33	"Just the people. It just brings satisfaction showing someone how to do something new. Opportunities for me to teach others."
Group-Project Perceived Cognitive Engagement	5.53	1.32	

Note: Quotes were identified from both interviews and surveys of underrepresented students.

Table 3. Within-subjects contrasts for attitudes, self-concept, and self-determined needs; and paired-samples t-test for persistence of underrepresented students.

	N	*M*	*SD*	*t*	*df*	*F*	*p*	η^2
Career Aspirations for Technology (pre)	72	4.02	.78					
Career Aspirations for Technology (post)	72	3.97	.96			.230	.633	.003
Technology Interest (pre)	72	4.03	.63					
Technology Interest (post)	72	3.99	.70			.586	.447	.008
Tediousness of Technology (pre)	72	1.79	.71					
Tediousness of Technology (post)	72	1.94	.90			2.72	.103	.037
Consequences of Technology (pre)	72	4.14	.57					
Consequences of Technology (post)	72	4.13	.71			.046	.831	.001
Difficulty of Technology (pre)	72	2.09	.78					
Difficulty of Technology (post)	72	2.26	.88			2.09	.152	.029
PASCI Self-Regard (pre)	68	4.99	1.40					
PASCI Self-Regard (post)	68	5.10	1.36			.675	.414	.010
PASCI Social Acceptance (pre)	68	4.15	1.57					
PASCI Social Acceptance (post)	68	4.27	1.67			.302	.584	.004
PASCI Academic Ability (pre)	68	4.76	1.66					
PASCI Academic Ability (post)	68	4.70	1.31			.137	.713	.002
PASCI Math Ability (pre)	68	4.92	1.53					
PASCI Math Ability (post)	68	4.95	1.46			.072	.789	.001
PASCI Verbal Ability (pre)	68	4.81	1.11					
PASCI Verbal Ability (post)	68	4.97	1.18			1.51	.222	.022
PASCI Parental Acceptance (pre)	68	5.01	1.40					
PASCI Parental Acceptance (post)	68	5.00	1.55			.001	.974	.000
PASCI Social Comfort (pre)	68	3.91	1.56					
PASCI Social Comfort (post)	68	4.25	1.40			4.86	.031	.068
Autonomy (pre)	47	4.88	.99					
Autonomy (post)	47	4.97	1.05			.401	.530	.009
Competence (pre)	47	4.96	1.23					
Competence (post)	47	5.21	1.22			2.68	.108	.055
Relatedness (pre)	47	4.98	1.44					
Relatedness (post)	47	5.17	1.40			1.19	.281	.025
MES Persistence (pre)	78	5.32	1.24					
MES Persistence (post)	78	5.51	1.29	-1.48	77		.142	

(Pre) indicates initial responses; (Post) indicates final responses.

Note: Career Aspirations for technology was measured by a single item derived from Duran et al. (2013). The subscale name "Social Comfort" was used in place of Fleming's (2007) "Social Anxiety," because we believe "Social Comfort" better describes the items like "Do you usually feel comfortable and at ease meeting new people?"

Table 4. Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11
1. Keynote – Intrinsic	1										
2. Keynote – Engagement	.82**	1									
3. Instructor-Led – Intrinsic	.69**	.59**	1								
4. Instructor-Led – Engagement	.75**	.64**	.93**	1							
5. Hands-On – Intrinsic	.52**	.474*	.366	.351	1						
6. Hands-On – Engagement	.59**	.51**	.399*	.50**	.85**	1					
7. Group – Intrinsic	.490*	.51**	.74**	.71**	.270	.406*	1				
8. Group - Engagement	.396*	.445*	.61**	.65**	.143	.356	.88**	1			
9. Posttest ICT Knowledge	-.116	-.024	-.093	-.085	-.081	-.017	-.097	.037	1		
10. Career Aspirations (Post)	.197	.029	.049	.145	.269	.338	.192	.360	.086	1	
11. Technology Interest (Post)	.335	.215	.112	.228	.50**	.54**	.222	.308	.149	.61**	1
12. Tediousness of Technology (Post)	-.068	.072	.166	.110	-.194	-.202	.113	-.069	.094	-.5**	-.6**
13. Consequences of Technology(Post)	.134	.013	.109	.181	.148	.275	.014	.113	.098	.51**	.420*
14. Difficulty of Technology (Post)	-.363	-.360	-.147	-.282	-.301	-.42*	-.024	-.041	-.082	-.131	-.303
15. Affective Engagement (Post)	-.142	.028	.063	-.032	-.118	-.184	-.215	-.128	-.264	.190	.045
16. Behavioral Engagement (Post)	.62**	.53**	.55**	.54**	-.006	.093	.244	.182	.070	-.147	.028
17. Cognitive Engagement for Math (Post)	.218	.258	.187	.240	.079	.176	.314	.445*	.083	.65**	.415*
18. Cognitive Engagement for Technology (Post)	.189	.245	.063	.179	.070	.242	.228	.429*	.146	.66**	.53**
19. MES Persistence (Post)	.284	.175	.121	.099	.075	.033	-.039	.184	.015	.55**	.360

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

Table 4. Correlation Matrix (continued)

	12	13	14	15	16	17	18	19
1. Keynote – Intrinsic								
2. Keynote – Engagement								
3. Instructor-Led – Intrinsic								
4. Instructor-Led – Engagement								
5. Hands-On – Intrinsic								
6. Hands-On – Engagement								
7. Group – Intrinsic								
8. Group - Engagement								
9. Posttest ICT Knowledge								
10. Career Aspirations (Post)								
11. Technology Interest (Post)								
12. Tediousness of Technology (Post)	1							
13. Consequences of Technology(Post)	-.219	1						
14. Difficulty of Technology (Post)	.057	-.069	1					
15. Affective Engagement (Post)	-.301	.123	-.135	1				
16. Behavioral Engagement (Post)	.111	-.112	-.131	.210	1			
17. Cognitive Engagement for Math (Post)	-.314	.51**	-.088	.338	.034	1		
18. Cognitive Engagement for Technology (Post)	-.39*	.478*	-.101	.368	-.008	.67**	1	
19. MES Persistence (Post)	-.47*	.183*	-.029	.73**	.308	.57**	.59**	1

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)