Surveyed Preservice Teachers Reveal Skills Acquired From 1:1 Environment

Judy Ann Henning
University of Nebraska at Kearney
Bryan Artman
University of Nebraska at Kearney
Rebecca Nelson
University of Nebraska at Kearney
Jordan Dille
University of Nebraska at Kearney
Chelsea Feusner
University of Nebraska at Kearney

Abstract

Are high school students ready for their postgraduate education or a career that may not have been invented yet? As teachers focus on career prep and the necessary future-ready skills in the classroom, teachers are using technology to hone skills necessary for students' future success. Success in higher education or career pursuits requires students to develop a combination of technology through student-centered, project-based learning around the 4Cs (critical thinking/problem solving, communication, collaboration, and creativity/innovation). The literature on technology skills and 4C skills has historically focused on one set of skills or the other in isolation. This research addresses this gap in the literature by comparing the acquisition of the two skill sets to each other in the same (1:1 technology) environment. This is a mixed methods study using survey data collected from pre-service teachers in an education course. The study aims to understand what technology and 4C skills pre-service teachers who graduated from a 1:1 technology high school possess. The findings of this study showed that the respondents are more prepared and comfortable using their 4C skills than their technology skills. The potential implications of technology and 4C skills deficiencies and strengths on future teaching practices are discussed. technology) environment.

Keywords: *1:1 instructional technology; career readiness, teacher perception, P21 framework, 4Cs, student-centered learning, project-based learning*

When considering instructional technology's role in education and its importance in our schools, one only needs to start with the investment schools and districts are making. United States schools were expected to spend $27.6 billion (about $85 per person in the US) on educational technology in 2021 (Nagel, 2021). According to EdTech Evidence Exchange, U.S. public schools were spending $26-$41 billion (about $130 per person in the US) per year on educational technology before the COVID-19 pandemic (Bamforth, 2021). As schools locked down and went to virtual learning during the pandemic, it only makes sense that school technology expenditures increased even more.

A report by the Education Technology and Smart Classroom Global Market Trajectory and Analysis predicted that global education tech expenditures will reach $195.7 billion (about $600 per person in the US) in 2026. If schools are investing their limited resources in such significance, there must be a reason why they believe in its ability to benefit students (CISION PR Newswire, 2022).

Literature Review

In 2021, approximately 90% of secondary schools in the U.S. were 1:1 computing environments, with school districts purchasing a device for each student. That same year, 84% of elementary schools also provided a device for each student (Bushweller, 2022). U.S. school districts are embracing 1:1 computing in their schools and using educational funds to leverage technology with a goal of increasing student academic achievement (Sauers & McLeod, 2018).

Instructional technology can be used to address the digital divide and re-imagine learning experiences for students (U.S. Department of Education Office of Educational Technology, 2017). Opportunities include providing virtual learning options when physical options are not available and taking the learning outside of the school building (i.e., museums, virtual field trips, etc.). The literature shows multiple ways in which instructional technology can benefit schools and students. Several studies show that the integration of instructional technology tools has led to increased student motivation and engagement (Olson et al., 2015; Urrea, 2010; Mouza, 2008; Bebell & Kay, 2010). Instructional technology integration has also been shown to increase individualized and student-centered learning and instruction (Dunleavy et al., 2007; Hallman, 2019). Students in technology-infused classrooms are also shown to be less reliant on the teacher for assistance (Clariana, 2009).

The integration of instructional technology in classrooms has been linked to increased instructional flexibility as well as more small group and collaborative work (Shapley et al., 2011; Bebell & Kay, 2010). Instructional technology integration has also been shown

to create more meaningful instructional moments and deeper learning (Mouza, 2008; Maninger & Holden, 2009). Research also shows that instructional technology has also been used to make remote learning more manageable and to help close achievement gaps.

Student computer access facilitates personalized project-based learning, a successful teaching strategy. The 4Cs include critical thinking/problem solving, communication, collaboration, and creativity/innovation (D'Addario, 2022). Project-based learning allows educators to incorporate projects focusing on the 4Cs to teach students the digital skills needed to thrive in a global society (Trilling & Fadel, 2009). Project-based learning hones the 4Cs and encourages students to create knowledge rather than just consume it. These projects allow students to take ownership of their learning as they tackle relevant topics found in the real world. "Therefore the 21st century requires that students acquire the 4Cs (communication, collaboration, critical thinking and creativity) on how to engage with the information and not just receive it" (Tunjera & Chigona, 2020, p. 126).

Trilling and Fadel (2009) explain that critical thinking/problem solving develops expert thinking skills, communication/collaboration develops complex communication skills, and creativity/innovation develops applied imagination and invention skills. "These skills are the keys to unlocking a lifetime of learning and creative work . . . The 21st century global economy is also requiring higher levels of imagination, creativity, and innovation to continually invent new and better services and products for the global marketplace" (Trilling & Fadel, 2009, p. 49). Teachers integrate technology and digital skills in the curriculum to ensure students are successful in education, career, and a global society.

Twenty-first-century skills, including the 4Cs, are important to make students ready for careers that may not currently exist. Richard Riley, former U.S. Secretary of Education (1993-2001) said, *"*We are currently preparing students for jobs that don't yet exist…using technologies that haven't been invented…in order to solve problems we don't even know are problems yet" (Bednar, 2022, para 1). By teaching digital skills through the 4Cs, students can be career ready. "Career readiness means equipping students with a nuance set of skills that can prepare them for the unknown" (Buckle, n.d., para. 6).

Educators should never use technology for the sake of using technology. "Teaching with technology goes beyond mere acceptance of digital tools but should be purposefully applied in their daily practices to achieve teaching and learning goals" (Tondeur et al., 2020, p. 127). An educator preparing students for a job that has not been invented must know more than how to navigate an application. Students must be

able to apply knowledge of that application to relevant real-world problems. By actively engaging in technology through student-centered projects, students can acquire the skills needed to know how the same application can be used to problem-solve in other areas. “The 21st century communication encourages a shift from the traditional teacher-centered to digital learner-centered strategies in order to develop the 4Cs” (Tunjera & Chigona, 2020, p. 132).

Beginning in 2004, a qualitative longitudinal Canadian study explored the development and retention of the digital skills in middle school students who experienced 1:1 middle-level technology in 2004 (Leger & Freiman, 2016). After ten years, students were interviewed about their technological skills and how their tech savviness impacted their success in education and career. The interviews reveal students “are competent in information and communication technology skills (and) seem better able to solve problems in the technologically rich environment” (Leger & Freiman, 2016, p. 58).

These interviews show students felt confident and empowered by their tech prowess. For example, “The world of computers is an ever-changing one, so adaptability is an important trait to have if you want to survive in an increasing digital workplace” (Leger & Freiman, 2016 p. 63). Students in the study felt confident in their digital literacy skills so they could be resourceful and knew how to adjust to the changes in technology. Students acquired three specific digital skills identified in the Canadian study. “These digital skills are technological resourcefulness, digital self-efficacy (empowerment), and open-mindedness toward technology” (Leger & Freiman, 2016 p. 64). The proficiency of these digital skills varied with each of the student study participants.

Theoretical Framework

The theoretical background for this study was based on the Partnership for 21st Century Learning (P21) framework. In 2002, the Partnership for 21 Century Skills was founded as a nonprofit organization that included a coalition of business leaders, policymakers and educational leaders discussing the importance of establishing future-ready P21 technology skills in today’s students (Battelle for Kids, n.d., para. 1). This group was later changed to Partnership for 21st Century Learning. This framework is “A unified vision for learning to ensure students success in a world where change is constant and learning never stops” (Battelle for Kids, 2019, para. 1). This framework identifies the key innovation and learning skills as creativity, critical thinking, communication, and collaboration, also known as the 4Cs. Using technology to provide students with the 4Cs is essential in making students successful in the 21st century.

The theoretical basis for the P21 framework is a construct that students must be given the proper opportunities to prepare them for careers and success in the workplace

(Remake Learning, 2016). Students gain these skills by “engaging in activities that promote creativity, critical thinking, communication, and collaboration-the P21’s research based 4Cs. Many of these opportunities for integrating core knowledge and critical thinking skills stem from technological literacy and related areas like media literacy" (Remake Learning, 2016, para. 5).

In schools, a 1:1 environment for technology is when all students are provided with their own mobile computing devices. “One-to-one refers to one computer for every student” (Great School Partnerships, 2013 para 1). The purpose of this is to contribute to the limited but growing body of research on the impact of a 1:1 technology environment’s impact on students' preparedness with the 4Cs. Thus, the guiding research question of this study is: Are pre-service teachers who graduated from a 1:1 technology environment more prepared in their career-ready technology skills or in their 4C skills?

Methodology

This research builds upon a previous article (Artman et al, 2022) published in a 2022 issue of *Issues and Trends in Instructional Technology.* It adds further knowledge to the subject matter, specifically when addressing the research question. For this mixed method research project, a confidential Likert Scale survey was created (1- Very Low, 5- Very High) to evaluate technology and career readiness skills. The survey consisted of 30 Likert Scale questions, plus 6 background questions and 2 qualifying questions. The 2 qualifying questions eliminated potential participants who did not attend a 1:1 middle school or high school or who had already taken a college-level course on instructional technology, as we were interested in examining pre-service teachers who were technological novices. For this research project, the qualifying questions, one background question, and 15 career readiness skill questions were analyzed. The survey was conducted after IRB approval was received. Respondents completed the survey during two separate semesters (fall 2020 and spring 2021) of TE100 Teaching in a Democratic Society, an introductory teaching course, at a regional public Midwestern university.

After gaining instructor approval, students in TE100 were invited to participate in the study either face-to-face or via email. Participation was anonymous and voluntary; students could choose to participate or not without consequence or reward. After qualifying questions and incomplete surveys, the final N for the project was 89. Data were collected on 15 questions related to career readiness technology skills and the 4Cs of education (communication, collaboration, critical thinking, and creativity). Responding students were also asked to rate the extent to which they felt instructional technology was an integral part of their educational experience.

The introductory education pre-service course was selected because the students in the course were most likely to have the most recent high school and middle school experience with 1:1 technology. Due to the course's introductory level, students were also less likely to have taken college-level instructional technology coursework which would have eliminated them as potential participants. Subjects were provided online access to the survey via a Qualtrics link, and data was downloaded and secured by a two-factor authentication system. Analysis for correlation was conducted on student survey responses.

Findings

Correlation was calculated using SPSS among 15 questions on pre-service teachers' comfort level in using the 4Cs (critical thinking/problem solving, communication, collaboration, and creativity/innovation) and the background question. Once completed, the correlation was compared to the previous study (Artman et al., 2022) on the student's comfort level with technology skills.

Results

Table 1. Table 1 summarizes the characteristics of the data set including range, mean, and standard deviation of the 15 technology and career readiness skills questions and the background question.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Please rate your comfort/ability level collaborating with classmates on an academic project using technology tools.	89	2	5	3.93	.77
Please rate your comfort level/ability collaborating with classmates using technology tools to communicate instead of being in the same location.	89	2	5	3.88	.86
Please rate your comfort level/ability to create a presentation (PowerPoint, Google Slides, video, etc.) to present to your classmates.	89	3	5	4.42	.69
Please rate your comfort level presenting in front of a class or a group or your peers.	89	1	5	3.45	1.12
Please rate your ability to express your ideas fully, clearly, and professionally in an online setting.	89	2	5	3.80	.81
Please rate your comfort level/ability to find creative solutions to real life problems.	89	2	5	3.80	.77
Please rate your ability to express yourself using media (artwork, images, video, music, etc.)	89	1	5	3.44	.94

created using online or digital tools.					
Please rate how much you agree with this statement: My middle school/high school teachers used instructional technology tools and/or internet resources to encourage collaboration between classmates.	89	2	5	3.78	.94
Please rate how much you agree with this statement: My middle school/high school teachers used instructional technology tools and/or internet resources to encourage communication between students and teachers.	89	1	5	3.83	1.04
Please rate how much you agree with this statement: My middle school/high school teachers used instructional technology tools and/or internet resources to enhance communication skills in their students.	88	1	5	3.57	.99
Please rate how much you agree with this statement: My middle school/high school teachers used instructional technology tools and/or internet resources to encourage creativity in their students.	89	1	5	3.63	1.04
Please rate how much you agree with this statement: My middle	89	1	5	3.65	.98

school/high school teachers used instructional technology tools and/or internet resources to enhance critical thinking skills in their students.					
Please rate how much you agree with this statement: My middle school/high school teachers used instructional technology tools and/or internet resources to help me view problems from different points of view/perspectives.	89	1	5	3.67	.93
Please rate how much you agree with this statement: My middle school/high school teachers used instructional technology tools and/or internet resources to help me brainstorm new ideas.	89	1	5	3.80	.97
Please rate how much you agree with this statement: My middle school/high school teachers used instructional technology tools and/or internet resources to encourage discussion about real life scenarios, issues, and problems.	89	1	5	3.64	.99
Please rate how much you agree with this statement: Instructional technology was a central part of my education in middle school and/or high school.	89	1	5	3.74	1.01

The standard deviation of 12 of the questions is below 1.0, which indicates a low variance. This low variance allows for better predictions to be made from the data set. The mean of means is 3.75, which indicates a high overall level of confidence from respondents in their technology skills.

The results of our analysis of correlation are depicted in Table 2; results suggest that 10 out of 15 correlations were statistically significant on these questions with a $p<.05$ at the two-tailed level. Of those 10, five were statistically significant at the $p<.01$ level and five were significant at the $p<.05$ level. A total of five technology skill questions were not correlated at the significant level. These are questions 4, 6, 10, 13, and 15. Results broadly indicate that students' comfort level and ability to implement technological components in their classrooms are positively correlated with feeling instructional technology was a central part of their own education at the middle and high school level.

Table 2. Table 2 details the correlation between the technology skills questions and the background.

Correlation Data

Background Question: Instructional technology was a central part of my education in middle school and/or high school.	
Variable – Technology Skill	Correlation
Collaborate with classmates on an academic project using technology tools	.682**
Collaborate with classmates using technology tools to communicate instead of being in the same location	.384**
Create a presentation to present to classmates	.325**
Presenting in front of a class or group or your peers	.148
Express your ideas fully, clearly, and professionally in an online setting	.425**
Find creative solutions to real life problems	.155
Express yourself using media created using online or digital tools	.261*
Agree with the statement: My middle school/high school teachers used instructional technology tools and/or internet resources to: (next eight variables)	
Encourage collaboration between classmates	.321**
Encourage communication between students and teachers	.213*
Enhance communication skills in their students	.125
Encourage creativity in their students	.241*
Enhance critical thinking skills in their students	.209*
Help me view problems from different points of view/perspectives	.122
Help me brainstorm new ideas	.241*
Encourage discussion about real life scenarios, issues, and problems.	.195
**** p<0.01 (2-tailed); * p<0.05 (2-tailed)**	

To establish reliability on the novice measure, or a never before distributed survey instrument, an analysis was conducted to establish a Cronbach Alpha score. It is

generally recognized that a score above .7 is acceptable and anything above .8 is optimal. This would indicate a strong internal consistency of the items being measured. Internal consistency of the items on this instrument was found to be excellent with a Cronbach Alpha coefficient of .911.

Summary

This project was designed as exploratory research to gauge the confidence level of pre-service teachers with their technology and 4C skills. The research focused on pre-service teachers who attended middle school or high school in a 1:1 technology environment. The researchers found that respondents had a higher level of confidence in their ability with the 4Cs than in their technology skills. Results from the 2022 study based on respondents' confidence in their own ability to implement different technological components in their classrooms found that of the 15 included questions, 13 were significantly correlated to the background question. Findings from this study found that 10 of the 15 questions based on student's ability with the 4Cs were significantly correlated to the same background question. An even distribution was observed across all 15 questions with five statistically significant highly correlated ($p<.01$), five statistically significant moderately correlated ($p<.05$) and five with no statistically significant correlation ($p>.05$). All 15 were positively correlated to the background question though.

Table 3. Table 3 details the correlational significance of the technology skills to the background question.

Correlation Data

Background Question: Instructional technology was a central part of my education in middle school and/or high school: Correlational Significance to Technology Skill		
Not Significant Low Correlation p > .05	Presenting in front of a class or group or your peers	.148
	Find creative solutions to real life problems	.155
	Enhance communication skills in their students	.125
	Help me view problems from different points of view/perspectives	.122
	Encourage discussion about real life scenarios, issues, and problems.	.195

	Presenting in front of a class or group or your peers	.148
Statistically Significant Moderate Correlation p < .05	Express yourself using media created using online or digital tools	.261
	Encourage communication between students and teachers	.213
	Encourage creativity in their students	.241
	Enhance critical thinking skills in their students	.209
	Help me brainstorm new ideas	.241
Statistically Significant High Correlation p < .01	Collaborate with classmates on an academic project using technology tools	.682
	Collaborate with classmates using technology tools to communicate instead of being in the same location	.384
	Create a presentation to present to classmates	.325
	Express your ideas fully, clearly, and professionally in an online setting	.425
	Encourage collaboration between classmates	.321

** p<0.01 (2-tailed); * p<0.05 (2-tailed)

When comparing the results of the current study to the earlier study (Artman et al., 2022), we observed some interesting trends. Results do show that while more questions from the first study were significantly correlated to the background question (13) than the fifteen 4C questions (10) in this study, the strength of those significant correlations was, on average, greater in the current study. When looking at the questions that were significantly correlated to the background question, the average correlation in the original study was .304 compared to .33 in this study.

Among the findings of note, the correlational data showed that respondents had the highest level of confidence in their ability to collaborate with others using technology tools (.682), using technology tools to communicate over distance (.384), and

expressing ideas fully and clearly in an online setting (.425). Respondents also expressed more confidence in their own abilities when the technology skills were active with hands-on, personal use while in middle and high school compared to when it was passive interaction with a teacher modeling the use of technology. Of the seven questions related to respondents' personal use of 1-1 technology in middle and high school, the average correlation was .34 and 4 were highly statistically significant ($p<.01$). There was a total of 8 questions that related to the respondents' teachers use of technology in the classroom during their middle and high school education. The average strength of their correlation to the background question was .21, with just 1 being highly statistically significant ($p<.01$).

Discussion

This research study set out to answer a central question: Are pre-service teachers who graduate from a 1:1 technology environment more prepared in their career-ready technology skills or in their 4C skills? General findings from an earlier study (Artman et al., 2022) show that respondents did not rate themselves as confident in their technology skills simply by virtue of having attended of a 1:1 technology environment as secondary students. Respondents in this study do rate themselves as more confident in their ability to use their 4C skills. This indicates a higher level of preparation with the 4Cs compared to their technology skills. This higher level of comfort may be attributed to preferred teaching styles and learning activities that are more student-centered (group work, research projects, presentations, etc.). The increased comfort level may also be attributed to the technology tools used in classrooms or materials potentially embedded in the curriculum that aid in the development of the 4Cs, but not in the development of technology skills.

Overall findings suggest that respondents who identified technology as a central component of their middle and high school experiences felt more confident in their overall general ability to implement different technological components in their future classrooms. The strength of that confidence was greater in their ability on the 4C questions. Respondents showed that they are more comfortable with certain 4C skills than others. Questions aligned to the collaboration area showed the overall strongest correlation to the background question, with an average correlation of .462. This would indicate that respondents feel the most comfortable using technology when it is being used to collaborate with classmates and peers both in person and from a distance. The category with the second strongest average correlation to the background question was the area of creativity with an average correlation of .269. The final two categories with the weakest correlation to the background question were communication (.228) and critical thinking/problem solving (.162). Questions involving in-person communication and presentation to peers reported the lowest correlation. This would indicate that while technology can help facilitate collaboration and the expression of thoughts and ideas

through media, it does not help improve confidence in one's ability to orally present when done in person.

Of note is the fact that respondents felt more confident as middle/high school students in their use of technology tools than they did in their teachers' ability to teach with technology. This may be attributed to respondents' bias or their status as digital natives while their teachers were digital immigrants (Prensky, 2001). The results of the study also support the findings of the longitudinal Canadian study (Leger & Freiman, 2016) indicating students from 1:1 technology schools were more tech-savvy and better able to problem-solve with technologies.

The results have generalizable implications for the respondents and other students. The lack of preparation in career-ready technology skills has the potential to negatively impact student success in career and higher education endeavors. The respondents' increased confidence in their 4C skills, specifically critical thinking and creativity may help them compensate for their lack of technology skills. The confidence also had the potential to aid the respondents in their higher education or unknown career goals.

Further Research

Because the respondents attended middle/high school prior to the COVID-19 pandemic, it may be of interest to survey another group of pre-service teachers to see if 1:1 technology use in the middle/high school classroom has changed post-pandemic. Since respondents felt more confident in their technology use than that of their teachers, passive vs. active technology use in teacher education programs should be the focus of future research. This study was conducted at a regional mid-western university, it may be worthwhile to replicate the survey at a different university to account for regional differences in the use of instructional technology.

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