CHANGING THE GAME FOR GIRLS: THE IMPACT OF COUNTER SPACES ON THE DISPROPORTIONATE REPRESENTATION OF GIRLS IN EDUCATIONAL TECHNOLOGY ENGAGEMENT

A disquisition presented to the faculty of the Graduate School of
Western Carolina University in partial fulfillment of the
requirements for the degree of Doctor of Education in Educational Leadership.

By
Brittany L. Branch

Chair: Dr. Catherine Andrews
Assistant Professor
Department of Human Services

Committee Members:
Dr. Patricia Bricker, Distinguished Professor, School of Teaching and Learning
Dr. Phillip Brown, Superintendent, Mount Airy City Schools, NC
Dr. Robert Crow, Associate Professor, Department of Human Services

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DEDICATION

This disquisition is dedicated to my family. To my children, Madeline, McKinley, Mary Priscilla, and Merritt, know you are the greatest gift in my life and that I believe you will achieve anything you set out to do. Continue to make space for yourself and most importantly, for others. Madeline and McKinley, I could not have done this without you. You have been mature beyond your years during my time in this program and have been the helpers I needed most. I hope you know that you make each day of my life brighter because you are in it. I am immensely proud of all of you.

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Abstract

This disquisition addresses the critical issue of disproportionate representation of girls in K-12 technology engagement, a problem that persists both in the local context and nationally. Grounded in post structural feminist and Black feminist theory, this improvement initiative emphasizes the importance of addressing the logistical barriers that prevent access to opportunities for girls, specifically opportunities in educational technology engagement, while acknowledging the underlying critical issues of deficit thinking, stereotype threat, and biases. The improvement initiative implemented a program, "Girls Tech," which was designed as an after school program for girls in grades 3-5 to engage in technology learning. This program included eight, 90 minute sessions facilitated by three female educators experienced in STEM. Implemented in a rural North Carolina School district, the program implementation utilized improvement science. The research design included data collection both formative and summative in nature. Data collection took place through the use of facilitator surveys, checklists, and interviews, as well as student interviews and student drawings. This study employed various coding techniques to analyze the qualitative data collected as well as descriptive statistics to analyze the quantitative data. Results indicated positive outcomes in improving girls' confidence, interest, and skills in technology. The data reported increased student engagement and improved problem-solving skills, as well as fostered a newfound excitement for coding and robotics as well as a shift in perceptions that indicated a stronger sense of belonging in the technology space. Process measures demonstrated high fidelity of implementation and balance measures showed minimal disruption to other activities. The disquisitions findings align with extant research on the importance of early exposure, countering stereotypes, and addressing systemic barriers. The initiative addressed social justice issues by confronting the lack of proportionate representation of girls in technology fields and empowering marginalized voices through the creation of counter spaces and the valuable asset of female role models. Implications and recommendations for practice include scaling the program, addressing logistical barriers, extending the program duration, and incorporating more opportunities for technology exposure and technology career opportunities. Policy recommendations include expanding access to girls-only STEM initiatives, integrating technology learning into core curriculum, and revising assessment methods for STEM education. This disquisition contributes to the broader goal of creating a more equitable education system by providing evidence that targeted strategies, combined with continuous improvement to tackle systemic barriers can effectively make change for representation of girls in technology education. Future research should focus on longitudinal studies to assess long-term impacts and explore the intersecting identities of girls that may affect participation in STEM and technology fields.

Understanding the Disquisition

The disquisition is formal, problem-based discourse. The disquisition is closely aligned with the scholar-practitioner role of Doctorate in Education (Ed.D.) students and thus takes on a practical focus rather than the theoretical focus of traditional Ph.D. dissertations. The purpose of the disquisition is “to document the scholarly development of leadership expertise in organizational improvement” (Lomotey, 2020, p. 5). The Ed.D. program at WCU nurtures and matures students as both scholars and practitioners who are trained to understand systems and institutional challenges and opportunities through a lens of research and scholarship. Students apply their knowledge, using their institutional access and positionality, directly to the educational institutions where they lead. The Ed.D. is an applied degree, and the disquisition is similarly an applied capstone experience for doctoral work. The disquisition at WCU specifically utilizes an Improvement Science methodology, is shaped by critical theory and scholarly research, and engages the candidate in the application of the concepts in an applied manner through the development and implementation of an intervention within their local institution, focused on improvement of equity within that system. Ultimately, the disquisition serves as documentation and assessment of an improvement initiative that “contributes to a concrete good to the larger community and the dissemination of new relevant knowledge” (Lomotey, 2020, p. 5).[1]

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[1] Statement prepared by Alison Joseph, Ed.D. and Educational Leadership faculty

Gender Gaps in Technology Education

Imagine Amelia, a Latina 4th grade girl from a low-income family who enjoys building Legos and toying with the robots in the maker space at school during free time. Then imagine Weston, a White male student whose dad is a small town lawyer and has already begun to develop his own video games on his PC at home. Every student at Amelia and Weston's school is entitled to go check out the coding club resources and decide if they want to join the club. When it comes time to go, Weston and several of his friends, who are also boys, jump up and run to try out the equipment. Amelia, who was excited at the opportunity, notices none of the girls get up to see what it is about. Do none of the girls like coding? Amelia chooses not to go try it out. Later on, she approaches the teacher and says she wants to join the club. At the first meeting the boys exude confidence as they start coding the robot and Amelia's teacher, noting her hesitation, suggests Amelia work on the poster presentation. In this scenario several actions tell Amelia that maybe coding is not for girls. She feels confident about doing the poster because her teacher seems to think she is the perfect person for that job, not for the coding job.

A National Issue in K-12 Schools

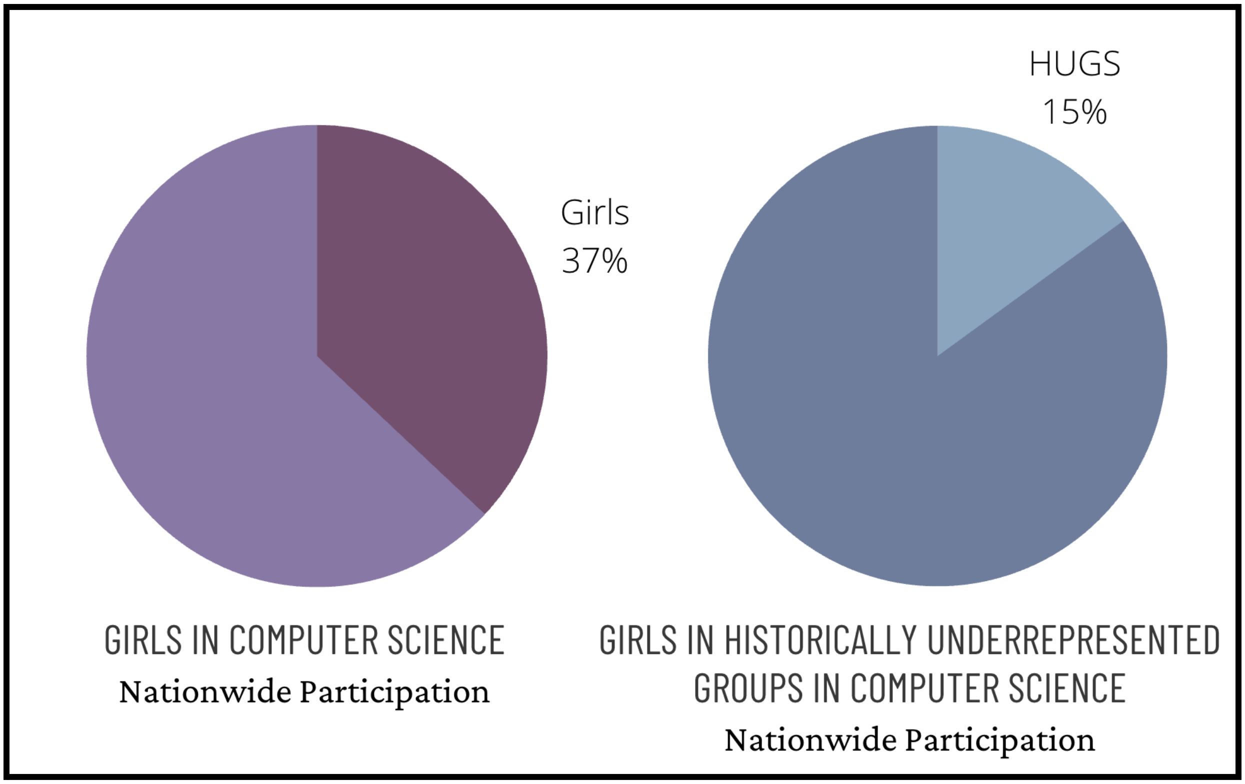
A disproportionate representation of girls exists in technology offerings in the K-12 educational setting. Public education in the United States has prioritized a commitment to building access to the areas of science, technology, engineering, and math (STEM). It is disheartening to realize that, despite this priority, the United States has seen a consistent decline in the representation of girls in technology education opportunities[1] (Dasgupta & Stout, 2014). The underrepresentation of girls in technology learning, an important subset of the larger umbrella that is STEM, is evident across the United States. As shown in Figure 1, there is a

[1] Education opportunity refers to any optional extension of learning that takes place in addition to the core curriculum in the K-12 setting, either during or after the traditional school day. For example elective classes, clubs, and competition teams.

nationwide participation rate of approximately 37% for all girls and 15% among girls from historically underrepresented groups (Girls Who Code, 2019). These numbers highlight the urgent need to further examine efforts to address the gender gap in technology education.

Figure 1

National representation of girls in computer science/technology learning.



It is no surprise that there has been a decline in women in technology and computational thinking related careers in the last 30 years (Hughes, Schellinger, & Roberts, 2021). Men outnumber women in STEM careers and particularly in the more focused area of technology (Sullivan & Bers, 2019). Corbett and Hill (2015) share that, in 1990, women represented 35% of computing fields and 25 years later that representation dropped to 26%.

Sheryl Sandberg (2013), former chief operating officer of Meta Platforms, points out the ways that women continue to be marginalized despite decades of efforts to improve representation of women in spaces where their voices have not been equally heard. Sandberg notes the progress that has been made in the United States over the last century while also pointing out that, "knowing that things could be worse should not stop us from trying to make them better" (p.5). While female higher education participation and academic achievements have grown steadily towards realizing more equal representation, women are still not represented in many career fields or in high level leadership at anywhere near the rate of men (Sandberg, 2013).

When women are underrepresented in STEM careers, which includes technology, the innovation in STEM organizations and even in the larger field suffers. While social norms continue to encourage women to be nurturing and altruistic, men traditionally hear the message that they should be providers and leaders (Corbett & Hill, 2015). Corbett and Hill also suggest that diversity develops better business outcomes. According to Lambert (2016) there is a relationship between diversity in an organization and positive outcomes. Lambert goes on to share that innovation is the result of creativity and that cultural diversity impacts organizational creativity. Women sometimes experience a unique culture as a result of their gender identity and their intersecting identities. The diverse experiences of women can contribute to the innovation in a workplace when they are included.

This under-representation of women in STEM fields is finding its way into the arts and popular culture. Inspirational stories based on real life events give a glimpse into the experiences of those that have been stereotyped or discriminated against in STEM fields because of their gender. Shetterly (2016) wrote *Hidden Figures* which, based on real events, depicts the women who processed data and calculated by hand formulas and equations necessary in order to make important contributions to the space program. The challenges these women faced were then represented on the movie screen in an award-winning film based on the book. Garmus (2022) depicts this same challenge in the book, *Lessons in Chemistry,* a work of historical fiction, where a woman scientist is not only discriminated against and belittled for her role in scientific research but also assaulted and pushed out of the space she worked so hard to get into. Garmus shares inspirational words for women in this text saying,

> Whenever you feel afraid, just remember. Courage is the root of change - and change is what we're chemically designed to do. So when you wake up tomorrow, make this pledge. No more holding yourself back. No more subscribing to others' opinions of what you can and cannot achieve. And no more allowing anyone to pigeonhole you into useless categories of sex, race, economic status, and religion. Do not allow your talents to lie dormant, ladies. Design your own future. When you go home today, ask yourself what YOU will change. And then get started.

Dasgupta and Stout (2014) suggest that the global economy is shifting towards exponential job growth in the STEM areas. Funk and Parker (2018) with Pew Research Center share that STEM jobs have grown by 79% since 1990. The STEM Education Guide (2023) shows that jobs in technology areas have grown by 23.1% in the decade between 2010 and 2020 and is predicted to grow another 15% by 2031 (US Bureau of Labor Statistics, 2021). Dell Technologies and the Institute for the Future predict that 85% of STEM jobs needed by 2030 do not even exist yet. The loss of human capital due to lack of access in girls' formative years could be significant (Dasgupta & Stout, 2014, p.22). The gender gap identified in K-12 educational technology opportunities correlates with the gender gap in related career fields, suggesting that a lack of interest development in the formative years may perpetuate the problem into higher education and career selection with little effort to remediate this essential barrier.

Historically, this problem has been recognized to an extent by lawmakers (Obama, 2011), who have enacted policy action to attempt to remediate the participation discrepancies among students, but without specific efforts focused at underrepresented groups. Typically, the policy changes have involved adopting standards and/or programs to increase participation or understanding of computer science and technology. An example of this is the *Every Student Succeeds Act* (ESSA, 2015). ESSA was signed into law in 2015 and includes provisions to allow for the use of federal funds for technology and computer science education programs. Then, in 2016, former President Barack Obama put in place the Computer Science for All (CSforAll) initiative to encourage states to develop computer science standards and develop teacher training on those standards (The White House, 2016). Next Generation Science Standards (NGSS, 2013) were developed to create cross curricular integration between science and areas such as technology and education. The international society for technology in education (ISTE) developed standards for students and teachers focused on technology in education beginning in 1998 and modified regularly to keep up with the changing technology environment (Sykora, 2015).

In each case the reform has involved developing standards. School districts can then use those standards to lead instruction in whatever ways they prioritize. While these standards may result in more technology-centered experiences in schools, the root of the problem is not being addressed. The problem results from a lack of true access to opportunities for students, particularly girls, during their interest forming years and often beyond, as a result of systemic, foundational barriers in societal culture.

Literature Review of the Problem

Adrito, et al. (2020) evaluated the impact of identity on participation in computational thinking-type learning activities in middle school. This study reviewed journal entries written by

47 middle school students, 25 girls and 22 boys, participating in a Lego robotics program. Review of these students' reflections in their journals suggests that girls were more interested in the teamwork and communication strategies and boys were more focused on the building and coding of the robot. This shows that girls are participating at a lower rate, or only in ways that they feel safest; the question then is, why is it that girls appear less interested in the STEM-related tasks than the boys?

How have stereotypes been developed and then relayed to girls telling them that they are better suited to other areas besides coding and technology? Gender stereotypes suggesting that technology is "for boys" are already evident in perceptions among girls in elementary school. Master, et al. (2017) evaluated the impact of stereotypes surrounding STEM on first grade girls through a mixed methods study. This study focused on 96 six-year-old children, 48 boys and 48 girls. The outcome of this study showed that six-year-olds did hold stereotypes that boys are better than girls at robotics and programming.

These barriers are reflected long-term through lower enrollment of girls in higher education opportunities that involve technology and lower rates of women in technology-centered jobs (Gorman, 2019). While women are graduating from college at higher rates, only 19% are pursuing degrees in computer science type fields (DuBow & Kaminsky, 2019). The question then is whether the lower representation in careers and higher education stems from the lower participation in primary and secondary school. In one qualitative study, DuBow & Kaminsky (2019), reviewed social media posts from a closed group for women in computing. In this study women reviewed the challenges they experience being in a male-dominated field and the efforts necessary to support each other. Kugler, et al. (2017)

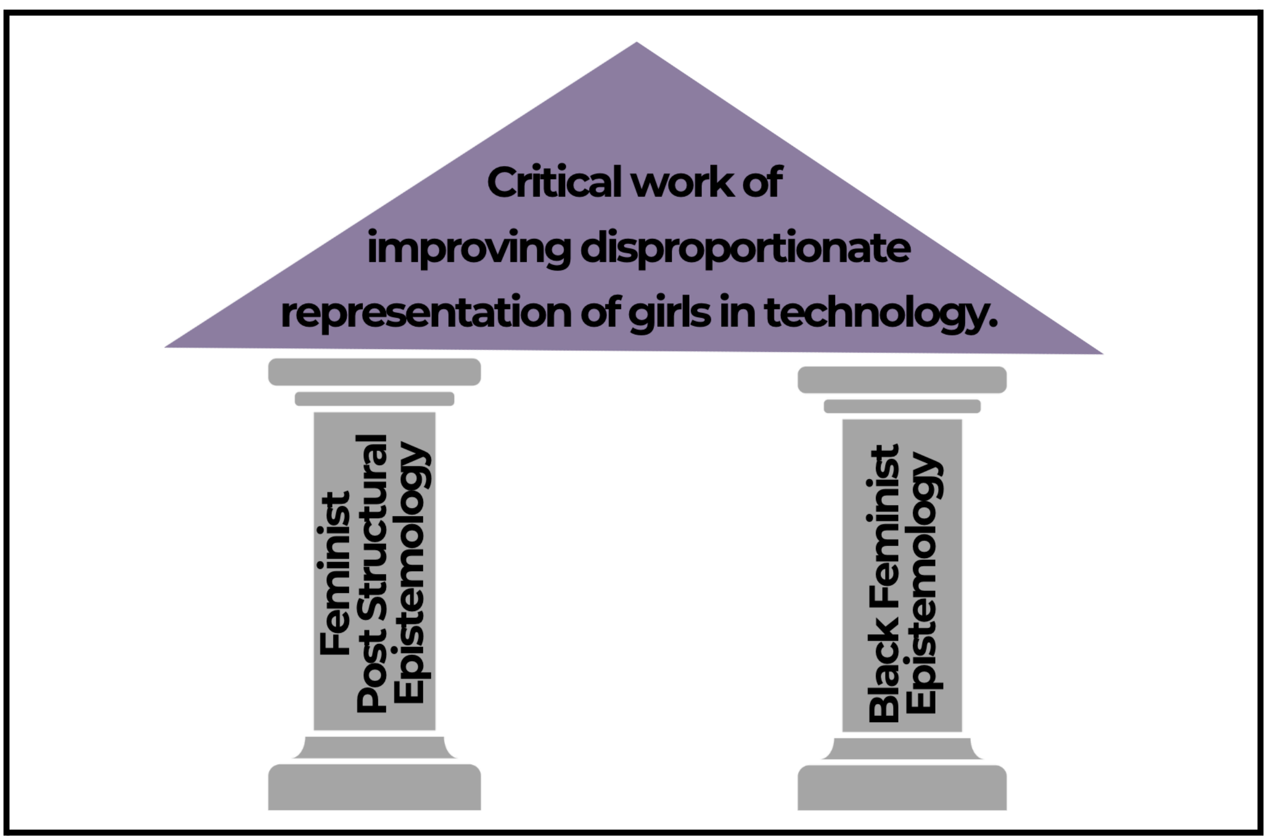
evaluated the choice of majors among women in college and found a higher attrition rate for women in technology-based majors.

Theoretical Framework

Theoretical frameworks allow for the analysis of problems through a critical lens (Capper, 2019). This problem of practice, identified as the critical work of improving disproportionate representation of girls in technology, was addressed through theory, as it relates to education. As shown in Figure 2, and according to Capper's work (2019), this problem or practice can be grounded in post structural feminist theory (Weedon, 1987) and Black feminist theory (Collins, 1999) as a product of patriarchal structures and cultural gender norms as well as apparent male privilege in both experiences and perspectives.

Figure 2

Foundational theories and the work they can support.



There are multiple feminist lenses to consider including feminism, post structural feminist, and Black feminist theories all of which have tenants relevant to this problem of practice. Feminist post structural epistemology and Black feminism are the most relevant lens through which to evaluate the causes of the problem of gender gaps in participation across STEM learning opportunities.

Feminist Post Structural Epistemology

Feminist post structural epistemology examines how power, language, and discourse impact experiences for those marginalized based on their gender (Capper, 2019). While there are no specific tenets that are unique to feminist post structural epistemology, there are certain thought processes and themes that are consistent in this framework. Differing from feminist theory, Weedon (1987) describes this epistemology as a way to theorize gender using structural concepts and as a tool for social change. Feminist post structural epistemology addresses a more social perspective and allows for recognition of the spectrum of gender as well as considering, in a more critical way, the intersections of other identities that can impact lived experiences (Capper, 2019). Tisdell (1998) explains that post structural feminism is an intersection of feminist theory and critical theory.

The theme of discourse and language in this theory is essential to understanding perspective. Weedon (1987) emphasizes that humanity naturally wants to accept what is deemed normal, which gives power to that discourse. Capper (2019) explains that the way we speak, and share information and thoughts, impacts where power is held. Tisdell (1998) shares that educators play a role in power relations when their discourse bears evidence to their own bias with regards to marginalized identities such as gender or race. Capper (2019) explains that, "a feminist post structural epistemology suggests that an educator take a stand on an issue, overtly identify their own epistemological position, recognize the partiality and contradictions within the position, and then engage in self-interrogation of that position," (p.89). This theory leans into the postmodernism desire for change and values the emotional aspect of feminism.

Black Feminist Epistemology

Black feminism is an equally relevant lens. While being postmodern in perspective, Black feminist epistemology informs a social justice desire for radical change (Capper, 2019). The core tenets of Black feminism include: concrete experience as a criterion of meaning, dialogue to assess knowledge claims, ethics of caring, and ethics of personal accountability (Hill Collins, 2000).

The first tenet focuses on how wisdom or knowledge is necessary and true knowledge is acquired through lived experiences (Capper, 2019). Just as with post structural feminism, Black feminism recognizes the value of dialogue in impacting knowledge and understanding of the world. The theme of "ethics of caring" is rooted in the African tradition of humanism (Capper, 2019) and emphasizes the empathy that should be held for those who struggle due to marginalization. Finally, the ethics of personal accountability requires that a person stand up for what they believe or know. This final tenet is also similar to the ethical requirement to take a stand that Capper shares about post structural feminism. Within the core tenets, three themes emerge: "moral obligation from within, community of mothers, education as political liberation," (p. 161). With regards to change theory, Capper identifies four themes that emerge when evaluating change through a Black feminist lens, these include: multiple approaches to equity, leadership as activism, everyday acts of resistance, and bridge leaders.

Relevance to Problem of Practice

The overarching theme of language and discourse in the post structural feminist perspective as well as the Black feminist perspective is explicitly valuable to consider when evaluating the reasons for gender gaps in education. When language, spoken, written, or even unsaid, holds power, it drives students to perceive what is true or accepted in their context. In the case of gender gaps in technology programming, this is evident in the way language and discourse perpetuates stereotypes that create invisible barriers to access. The way we speak holds power in our schools. Black feminism takes an activism approach to recognizing inequities and then taking personal responsibility to take action based on one's beliefs. In the case of this problem of practice, realizing the problem and the underlying causes of the exclusion of girls and even more so, girls with other marginalized identities is the first step to change. The themes Capper (2019) shares that connect Black feminism with change theory then allow for discourse that will begin to change the biases and stereotypes that create barriers for girls. Educators can use the lens of leadership as activism to create space for girls in technology and realize the value of everyday acts of resistance to slowly changing the landscape.

A Local Context

The underrepresentation of girls is consistently evident nationwide (Girls Who Code, 2019). Extant research suggests there are many intersecting factors that have been evaluated and determined to play a role, including: lack of early interest forming (Hughes et al, 2021), marketing geared towards boys, stereotypes that communicate boys are better at STEM topics than girls (Master et al, 2017), and lack of access to coding and engineering/design opportunities during elementary school (Mammes, 2004). This underrepresentation and its intersecting factors also exist in the State of North Carolina and in the context where the scholar-practitioner will implement the improvement initiative.

State and District Policy

In the state of North Carolina policies and programs exist to encourage access to technology learning for students. The North Carolina Digital Learning Plan (Appendix A) is outlined through a partnership with the Friday Institute of Educational Innovation. The most recent iteration of this was released in the spring of 2023. This plan sets the groundwork for the integration of technology into teaching strategies. North Carolina Department of Public Instruction (NCDPI) has stated a commitment to providing digital-age learning to all students. NCDPI has adopted the International Society for Technology in Education (ISTE) standards for students (Appendix B) and educators (Appendix C) as a part of the NC Digital Learning Plan which encourages learning centered around technology in a way that builds both technology skills and durable skills. These durable skills are reinforced by the North Carolina Portrait of a Graduate (Appendix D). In the state of North Carolina, prior to 2023 teachers were required to complete two continuing education credits (CEUs) in digital teaching and learning each license renewal cycle (typically 5 years), however that requirement was eliminated, although access to technology based CEUs is still available in NC through DPI. These requirements should have encouraged more access to technology learning, by creating structures through programming and classroom integration that make digital learning embedded in the core curriculum in a way that does provide access to all students. The disconnect lies in very little accountability at the district level and very little data collected to realize the true outcomes of these requirements.

Mount Airy City Schools, the district in which this improvement initiative took place, has board policy to support learning around technology. MACS Board Policy 3220 (Appendix E), adopted from the North Carolina School Board Association, is presented in a way that encourages access to digital learning standards for students. The policy requires that teachers teach according to the NC Digital Learning Plan in order to "foster globally competitive students prepared for modern life" (MACS, 2022). The reality is that this statement alone is extremely market-driven with a focus on career readiness and the development of a workforce in the community. This market system treats leadership like CEOs and thus students like machines. Horsford, Scott, and Anderson (2019) reflect on how public school leadership generally serves to create opportunity for *all* children, but the reality is this is rarely the case in practice. That practice then becomes one size fits all which immediately gives the advantage to the groups identified historically as the "norm," thus perpetuating the exclusion of the historically marginalized. Statements such as the one quoted above represent the way in which education is attempting to create human capital. The goal of these policies seems to be to churn out workers for our capitalistic society. Initiatives like the NC Digital Learning Plan focus on creating opportunities for students to become career ready. While being career ready is helpful as students leave their K-12 education and go out into the workforce, the plans and policies are not written in a way that ensures all students truly have access to these programs. Due to lack of access and exposure as well as stereotypes or stereotype threat, many groups of students are often marginalized and left out.

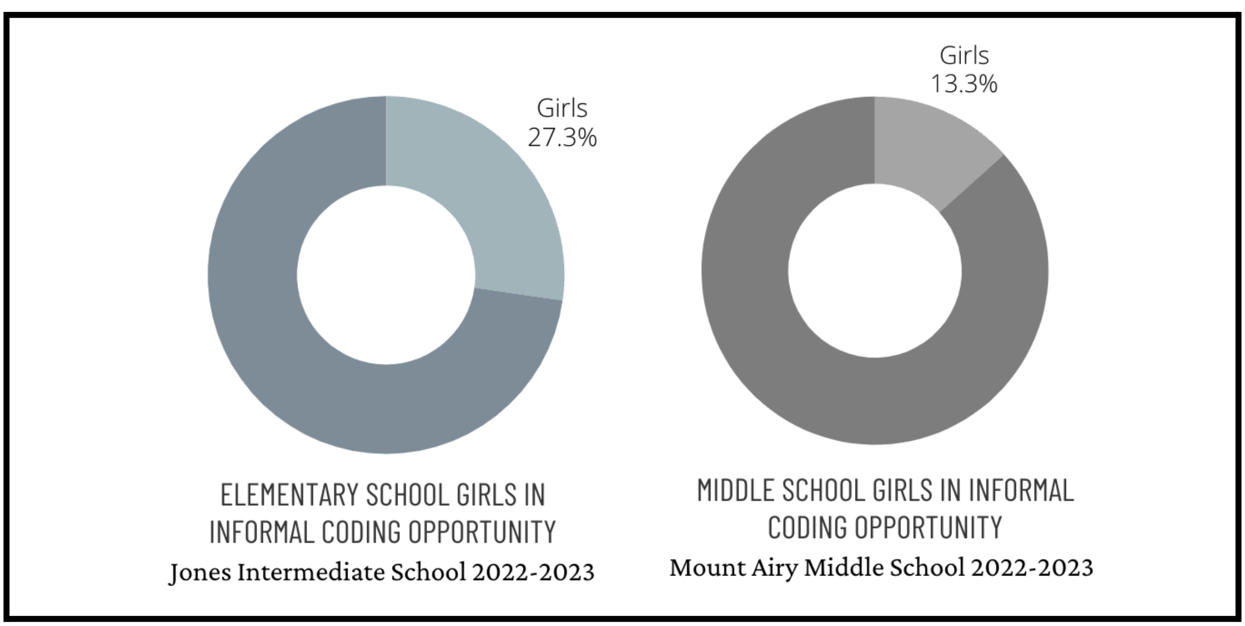
Ameliorating the problem of lack of proportionate representation of girls in technology offerings in the K-12 setting requires more than just new standards. It requires a recognition of the barriers that exist due to the systemic gendering of careers in the United States, and then it requires that these barriers are removed and access is given to students in order to close the gender gap. When educators can realize that invisible barriers such as stereotypes, marketing, and lack of access to opportunities, resources, and support systems, exist from an early age, then the work can be done to realize the untapped potential in girls (Master, et al. 2016, Girls Who Code, 2019).

The District Context

Mount Airy City Schools (MACS) is a small, rural, North Carolina city school district comprising of four schools. MACS has an organizational system to determine protocols and practices for teaching and learning in the district. The teaching and learning team works on many robust initiatives to promote student success and positive learning outcomes. Girls make up 48% of the school population, Black and LatinX students make up approximately 45% of the student population, and 50% of students live in poverty. The staff demographics are majority female with approximately 20% of certified teachers being LatinX and 0% of teachers being Black. The district vision is to graduate all students to lead, innovate, and serve. MACS core beliefs (Morrison, 2016) include the statement: "MACS believes that a positive, safe, and healthy environment fosters respect and culturally responsive practices for staff and students."

Figure 3

Representation of girls in the local context in technology coding clubs.



Historically, Mount Airy City Schools has lacked proportional representation of girls in technology offerings (Figure 3). In MACS, girls comprised 48% of the student population but during the 2022-2023, in technology learning offerings, and specifically those focused on computational thinking, girls represented 27% of participants at the elementary school level and 13% at the middle school level. Conversations with and observations of girls who participated at the elementary level uncovered that though they participated in the club, they did not participate in the actual technology, coding, and programming components and instead worked on the poster and presentation. This makes the 27% of elementary girls somewhat inflated since those students were exposed to some technology learning in that space but did not engage with that learning in any meaningful way based on those informal conversations and observations. Nationwide there are consistently lower rates of girls participating in these types of offerings which include things like coding or engineering clubs and robotics teams (Girls Who Code, 2019).

While the district culture was positive and aimed for equity, there were persistent stereotypes, implicit biases, and microaggressions directed towards girls that deterred them from participating in certain opportunities, including technology opportunities. The example of Amelia, fictional in identity, is a real scenario of this sort of unintended message in MACS. While the intention of staff was not to create barriers, there seemed to be a lack of understanding for how girls can be up against invisible barriers that prevented them from participating in opportunities that appeared to be available to all. The underrepresentation of girls in elementary programs continued in MACS in both middle school and high school. During the 2022-2023 school year there were zero girls that participated in the coding competition at the middle school. At the high school level there were disproportionately fewer girls in technology-based classes like aerospace engineering (12% girls), drone technology (13% girls), game art and design (6%

girls), and principles of engineering (17% girls). While some employees of MACS espoused that they were supportive of equity in education, their actions were piece-meal and did little to make significant change. In evaluating this information, post-implementation, the need for micro-level changes, slow and small in scale initially, through creating counter-spaces for students, was identified as having potential to be impactful in the local context.

The Scholar-Practitioner

A scholar-practitioner, according to Hinnant-Crawford (2020) has a unique perspective on using research and data to inform their practice as they navigate professional work. A scholar-practitioner combines peer-reviewed research with practical experience in order to make improvements. This viewpoint on navigating improvement is particularly relevant to fast paced environments (Suss, 2015) such as education which is the context in which this problem of practice is set.

The scholar-practitioner for this improvement initiative was a White female who worked as Digital Learning Coordinator in Mount Airy City Schools, a small, rural district in the state of North Carolina. Drake (2011) states that insider research requires the researcher to have experience either from a personal or professional perspective. There are many factors that impact an educator's approach to their professional practice. Upon reflecting on the epistemological and ontological perspectives associated with education, the scholar-practitioner found that personality, upbringing, education, and experience as an educator impacted the lens through which she viewed issues. There are components of certain theories that seemed to reflect the way the scholar-practitioner for this improvement initiative viewed the world, and how they analyzed problems in professional practice. These epistemological theories allowed for reflective analysis of experiences both personal and of others in the local context.

In understanding and addressing the gender gaps that persisted, despite years of effort to ameliorate them, the scholar-practitioner in this improvement initiative, reflected on her own experiences as a woman in technology and as a former student who was a girl in an environment that did not foster or encourage engagement with STEM or technology. In the case of this change initiative connecting with and understanding the experiences of the students was essential. While she did experience what it felt like to be a girl who was deterred from an interest in technology, she did not have some of the additional barriers resulting from the intersecting identities of the students who will engage in this intervention such as race, language, and socioeconomic status. It was important that the scholar-practitioner remained aware of any implicit biases or stereotypes that may have persisted in her thinking as she navigated this intervention.

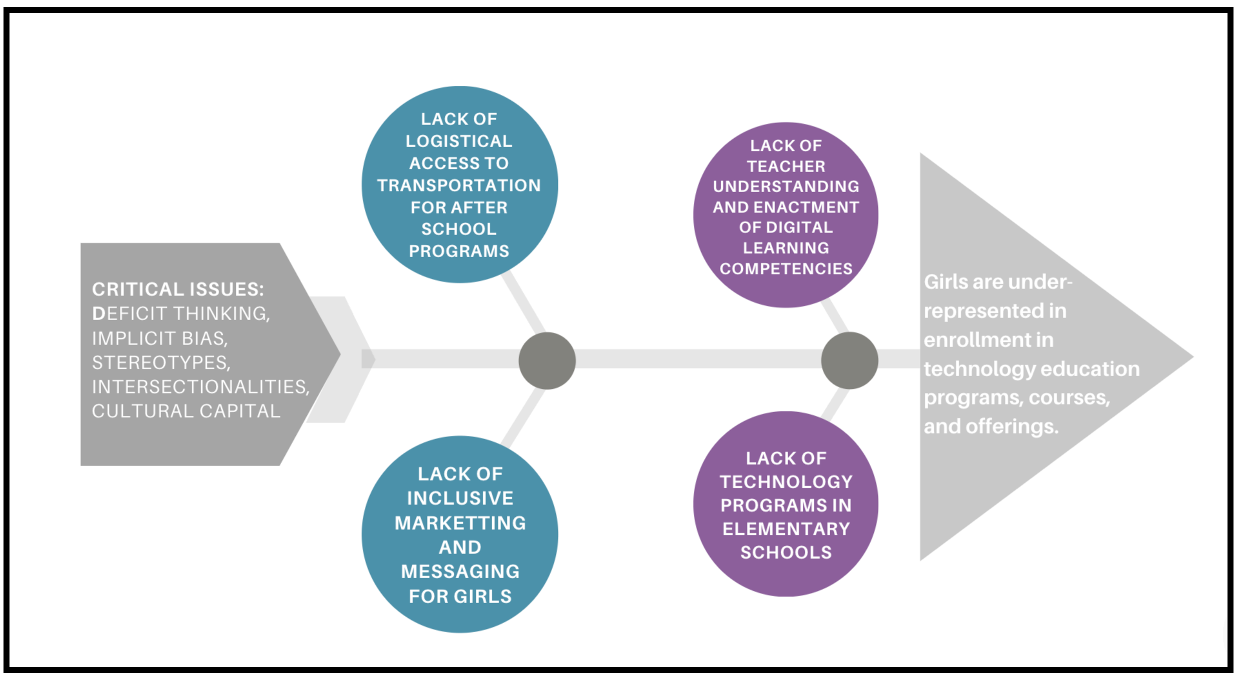
Connecting with the Black feminist epistemology and specifically the themes of this theory (Capper, 2019), allowed for reflective practice that encouraged equity in the intervention. Black feminism has a few core tenets but the theme of “community of mothers,” is one that the scholar-practitioner connected with throughout this study. The feeling of a moral responsibility to “mother” is a strong feeling she has had in many situations. Helping and lifting up each student, while realizing all of the intersecting lived experiences that impacted the individuals was one strategy she used. In addition, the scholar-practitioner in this improvement initiative utilized her impact as coordinator of digital learning and lead for STEM programs to make change with regards to the efforts directed towards improvement in this area. The theme Capper describes as, “everyday acts of resistance,” was a part of her personal philosophy surrounding making change in the context and was used in this research.

A Causal Analysis

In this section a causal analysis of the identified problem is presented, starting with a description of causal analysis as an improvement tool followed by Figure 4 that depicts four root causes associated with the under-representation of girls in technology education opportunities in a fishbone diagram. In order to realize the inherent causes of the problem of a practice, an Ishikawa or fishbone diagram was used. This tool is a type of cause-and-effect diagram that visually represents the problem as the head of the fish and the causes as the bones (Hinnant-Crawford, 2020). Additionally, a tail has been added to this fishbone diagram that represents the critical issues that drive the entire problem.

Figure 4

Fishbone diagram.



Causes

First, logistical Access is an often-overlooked barrier to effective participation in student programming at the elementary. Many opportunities exist as after-school programming that require students to have transportation home after the program ends. With only one in five children having a stay-at-home parent nationally (Pew, 2023) and some lacking access to reliable transportation in general, this is not a realistic expectation and excludes many students from the opportunities.

Secondly, teacher capacity is necessary and sometimes lacking at the elementary level. North Carolina has adopted the aforementioned Digital Learning Plan (Appendix A0 that includes certain digital learning competencies or standards students should learn and all educators should be held accountable to incorporate into their daily instruction. Based on discussions in School Improvement Team meetings across all MACS schools when facilitating the annual Digital Learning School Rubric many teachers stated that they do not know these competencies existed and while some teach in alignment with them, as a practice of good instruction, many did not have an awareness, understanding or ability to enact these competencies in the classroom.

Also, a lack of technology programming in the area of STEM, is a deficit, specifically at the elementary level. While MACS was a STEM school district, meaning each student received special area/elective time in STEM class once a week, much of the time students spent in STEM class at the elementary level was focused on science curriculum to make up for the lack of time in the instructional day that core area educators had to teach those standards. At the secondary level there were pathways that focused on technology through Career and Technical Student Organizations (CTSO) and Career and Technical Education (CTE) courses, but the few opportunities at the elementary level prevented interest-forming and that, paired with previously mentioned stereotypes, often resulted in low numbers of girls selecting these options.

Finally, marketing is a cause that could have impacted messaging to girls. While the other causes impacted access to many students, not just girls, this cause specifically focuses on the messaging, and stereotypes in that messaging that impact girls' participation at a critical level.

While school districts have implemented more technology education programs in order to scale learning around this career avenue, social capital and intersecting identities, such as race and socioeconomic status impact access to the technology learning opportunities for some students (Calabrese Barton et al., 2013). Identity development plays an important role in whether girls chose to choose to engage in STEM areas (Archer et al, 2012). Stereotypes that say technology is a male-centered interest and career date back to the 1980s, when home computers and video games were sold with marketing that targeted boys and men (Henn, 2014). Master et al. (2017) suggests that gender stereotypes result in girls having fewer opportunities and experiences surrounding technology which perpetuates the problem. Stereotypes that communicate that boys are better at STEM topics than girls have continued in more modern times beyond when computers and video games were originally marketed to boys and men. In most stores, there is a clear distinction between what toys are intended to be "for girls" versus "for boys." Cheryan et al. (2015) hone in on these stereotypes and share the example of the Barbie who has been an iconic "girl" toy for decades. In 2010 Mattel allowed girls to vote on the next career Barbie would represent. Their choices included news anchor, architect, surgeon, environmentalist, and computer engineer. The vote came in decisively for computer engineer but only after a group of women in technology created a movement to get votes so the career would be better represented. Mattel delivered on the computer engineer Barbie, but also released a news anchor Barbie as the company determined this was the most appealing to girls (Master, et al. 2016). The toys girls see on the shelves as well as the messages they hear on the television and in the media are all examples of how girls are consistently being told what avenues are for or not for them.

Critical Issues in the Causal Analysis

During identity forming years more than just marketing, programming, and transportation can impact girls' perceptions of technology as an option. Lack of access to role models, games, peer influence, bias voiced by parents, family members, or respected adults, are all examples of ways that girls begin to develop a sense that this area of focus is not a viable option for them (Hughes, Schellinger, & Roberts, 2021, Dasgupta & Stout, 2014). Stereotypes develop barriers to interest forming and play a role in identity development (Cheryan et al, 2015). Studies show that some girls as young as age eight already have a sense that technology areas are not for them (Sullivan & Bers, 2019).

Deficit Thinking and Stereotypes

Extant research gives evidence that stereotypes and deficit thinking have an impact on students and despite efforts to create more opportunities, gender inequities persist due to invisible barriers (Archer et al. 2012). Research by Bian, et al. (2017) found that gender stereotypes begin to form as early as age six and that those stereotypes then impact girls' selection of activities. Mammes (2004) concluded that technology education can increase interest in all students and can intensify interest for girls in a way that could prevent gender stereotypes. The dilemma is that these opportunities are often hindered for girls by the deficit thinking of staff, parents, and other influential adults. Archer, et al. share that, based on their research of more than 9,000 students ages 10 to 11, the impact of teachers and the gendered messages they share, often inadvertently, leave girls feeling that STEM areas are for boys. These micro level messages are examples of deficit thinking that lead girls to choose different paths rather than challenge the social norms. Archer, et al. goes on to suggest that, despite interventions to increase female participation in STEM, very little change has been realized.

Evidence suggests that a sense of belonging plays a role in breaking down stereotypes. Master, et al. (2016) completed a quantitative study on the impact of stereotypes on 104 high school students from various backgrounds. The results of this study conclude that an increase in computer science programs will not result in an increase in participation by girls unless girls feel they belong in these spaces. It is necessary to understand what barriers are impacting a lack of belongingness among girls as stereotypes were formed well prior to high school course registration (Master, et al, 2016). Steele (1997) explains that stereotype threat causes those in the marginalized or non-dominant group to feel a lack of confidence or anxiety in circumstances where there are stereotypes about the ability or belongingness of their group. This sense of an impending stereotype can result in girls underperforming or lacking confidence in an area, such as computer science and technology, that they have no reason to be unable to perform well in (Cheryan, et al, 2009). Sandberg (2013) noticed in her observational research that females face these barriers, which they internalize and then often unknowingly hold themselves back instead of taking their seat at the hypothetical table. Once an organizational understanding of the stereotypes and stereotype threats is developed, then educators can begin to support the development of a sense of belonging for girls in tech spaces.

Intersectionality and Cultural Capital

Identity plays a role in human experience and individuals have multiple cultural identities that do not exist in isolation. Consideration of the intersectionality of identities such as race, socioeconomic status, gender, and more is necessary when evaluating ways to eliminate barriers causing gaps in access to opportunities. Systemic change is necessary to equalize representation of marginalized identities in STEM. Ramiah, et al (2022) explain how intersecting identities can form systems of oppression and that embracing and prioritizing diversity, equity, and inclusion (DEI) practices that recognize intersectionalities is essential. While the data presented in earlier sections demonstrates there is a disproportionate representation of girls involved in STEM and more specifically in technology, the intersecting identities of girls are an important factor to consider to move toward inclusiveness.

One example of intersecting identities that are significantly impacted are race and gender. Black and Brown girls are significantly underrepresented, as are those who are multilingual (Harper & Kayumova, 2023). Harper and Kayumova's qualitative study brings together these identities plus a language component. They used an intervention involving community partnerships to encourage participation in STEM by girls who are Black or Brown multilingual learners. The results showed that unless those in education challenge deficit thinking that multilingual Black and Brown girls, or girls with intersecting marginalized identities, do not belong in STEM, girls with these identities and an interest in STEM will slowly lose that interest.

Ireland et al. (2018) discuss how often the lack of Black students or the lack of girls in STEM are discussed in isolation when the intersection of the two is notable. Black women make up about 7% of the population but earn degrees in computer science at a rate of less than 3% (National Science Foundation, National Center for Science and Engineering Statistics, 2017).

Lane and Id-Deen (2023) analyzed how summer STEM programs impacted Black girls' interest in the field. This qualitative research involved interviews of 14 students who participated in the programming and were all Black and low or middle income. The study focused on the social and aspirational capital with regards to STEM that students had prior to and after the program. The results of the study determined that in the students interviewed, participation did build positive experiences and more social and aspirational capital with regards to STEM (Lane & Id-Deen, 2023). Realizing that the gaps in representation in technology are not only due to gender but can far significantly impact students with other intersecting marginalized identities is essential. Students from marginalized races, low socioeconomic status, or other intersecting identities can feel an even stronger lack of belonging in spaces designed for technology education. With privilege, it appears there is a cultural capital to belong in the space, or in the case of girls, and particularly girls with other intersecting identities, a lack of cultural capital.

Archer et al. (2012) suggest that student interests and aspirations are primarily formed by ages 10-14. In Archer et al.'s qualitative study on the impact of family and socioeconomic status on engagement in science they found that the cultural capital students have, as a result of their lived experiences and family life, does have an influence on their interests. STEM areas are not an area of focus for families that lack this cultural capital while families with a strong understanding of the opportunities STEM holds can and do sway their children in the direction of these opportunities, showing that agency plays a role in interest forming.

A Proposed Improvement Initiative

Theory of Improvement

The aim of this initiative was to improve the sense of belonging and representation of girls in educational technology in order to pave the way for improved representation of women in technology-based careers. A review of the literature shows that there are many ways to address the overarching problem of practice, which is the lack of proportionate representation of girls in technology. For the purpose of this disquisition, creating access for girls through the development of counter spaces was the foundation of this improvement initiative. The counter space in this initiative was an after school program led by female educators called "Girls Tech." This program was for girls in grades three through five from a single elementary school. Girls Tech took place over the course of eight, one and a half hour, twice weekly sessions in a high-tech learning environment.

Counter Spaces

Counter spaces are defined as safe spaces that allow people who are marginalized or underrepresented to access learning and validation (Solorzano et al., 2000). Counter spaces can be literal spaces or just groups or times when the access to a space or program is limited to the marginalized or underrepresented groups. One common barrier for girls in technology is their feeling that boys are better. Hilliard and Albrecht (2020) set the stage for how interest in STEM can plateau as students approach middle school and messages begin to make girls feel that this is an area for boys. Counter spaces can ameliorate this problem. Ong et al. (2018) qualitative study examined the experiences of 39 women who were interviewed so they could tell their stories of journeying through STEM as a woman. Many of the participants also had another marginalized identity, such as race. The results of this study realized the value of counter spaces for these women and the safe feeling those counter spaces provided that combated the stereotypes and microaggressions these women felt working in STEM. As a historically underrepresented group in technology, girls need counter spaces in order to embrace learning in a psychologically safe environment. There are a few programs that intentionally create counter spaces for girls in STEM and specifically technology.

One organization that develops counter spaces for girls in technology is Girls Who Code. Girls Who Code is a non-profit, nationwide organization, that specifically works through engagement with policy actors and development of programming for use both in and out of school to create access and spaces for girls in technology. This programming has improved access for girls through during school and after school coding and computational thinking clubs just for girls. This program has served 580,000 girls and non binary students, over 50% of which come from another historically underrepresented demographic (Girls Who Code, 2019). A quantitative analysis of former participants in the Girls Who Code program showed that of the over 1000 women surveyed, approximately half have had a negative experience pursuing a job or internship in the tech field (Girls Who Code, 2019). These findings suggest that while these counter spaces create interest-forming opportunities for girls where stereotypes and microaggressions cannot impact their experience as severely, there is still work to be done to break down barriers.

STEM Like a Girl is another organization that creates counter spaces and experiences that promote a sense of belonging for girls in STEM, including technology. This organization focuses on the power of mentors and caretakers to develop inclusivity and space for girls in STEM. This non-profit leans into the impact these role models have as well as the necessity of early exposure to STEM fields.

A final organization that uses the power of counter spaces to create access for girls, specifically Black girls, is Black Girls Code. Black Girls Code recognizes that the demographic of Black girls and women are often missing in spaces where technology innovation happens and works to ameliorate that problem through empowering young Black girls.

Edwards & King (2023) realized that there is a social and emotional value to creating counter spaces for girls, and in this study specifically Black girls, to explore technology. This qualitative study used semi-structured interviews to elicit feedback from both teachers and students on experiences with counter spaces for these Black girls to learn about technology. The results of this study showed that a formation of a sort of sisterhood, made students feel like they were not being judged for taking risks. The results of the study reported that counter spaces are essential for creating belongingness for underrepresented groups deterred by microaggressions, stereotypes, and implicit biases.

Female Role Models

The relationships a student has with teachers plays a significant role in their interests (Anderman & Kaplan, 2008). When teachers share gendered stereotypes, whether intentional or not, they can impact a sense of belonging. When teachers break down those stereotypes, the opposite can happen. Girls and women are consistently exposed to messages about what they can and cannot do. In an overview of three studies on stereotype inoculation, Stout, et al. (2010) suggest that access to same-sex peers, professionals, and educators can impact confidence and self-efficacy in the area they represent. It is essential to realize that messages and stereotypes are telling girls that technology is not for them and that these messages can come from trusted adults. When educators are willing to consider how their implicit bias might impact a students willingness to try something new, then change will begin to happen.

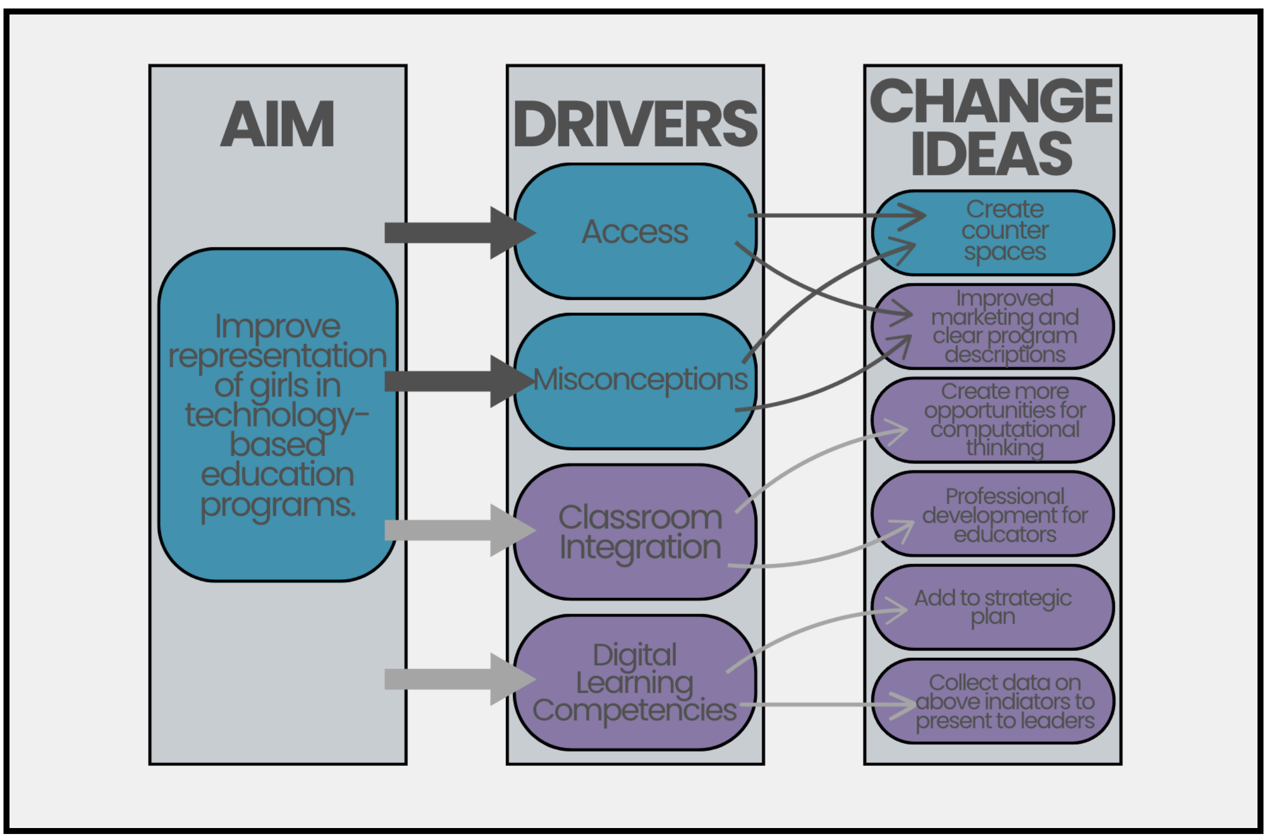
Interventions that intentionally create space for girls and develop access for this underrepresented group, are necessary. In previous sections, interventions were mentioned that have shown to improve access for girls in technology. Primarily those interventions that break down stereotypes and uncover implicit biases that prevent access to technology as well as those interventions that create interest forming opportunities early on, before stereotypes begin to impact student willingness to try something different.

Driver Diagram

Hinnant-Crawford (2020) shares that developing a good understanding of the system can help inform the development of a theory of improvement. A theory of improvement can then address the drivers through the development of change ideas. Figure 5 identifies the drivers and potential change ideas through a driver diagram.

Figure 5

Driver diagram.



The drivers of interest in this improvement initiative are access and misconceptions. A counter space for girls was implemented as a form of stereotype inoculation in order to ameliorate this problem of practice. My theory of improvement holds that *if we create spaces where girls can experience learning in the realm of STEM, and specifically technology and computational thinking, without the weight of stereotypes and biases that boys are better than girls, we will see that girls feel greater self-efficacy and feel a stronger sense of psychological safety and belongingness which can combat stereotypes that girls do not belong*. In this improvement initiative participants engaged in an adaptation of a program created by the national organization, Girls Who Code, which was customized and led by local female educators to meet the unique needs of the girls in the district. The literature holds that counter spaces improve this sense of belonging (Ong, et al, 2018, Solorzano et al., 2020) and that developing interest forming in the elementary years will combat stereotypes that tend to form later in a student's education (Edwards & King, 2023).

Improvement Initiative Design

This improvement initiative was designed with a team of experienced educators to implement and impact change in the Mount Airy City Schools organization using extant research and grounding the work in post structural feminist and Black feminist epistemology.

Design Team

In improvement science, a design team is utilized in order to include multiple perspectives, experiences, and backgrounds (Hinnant-Crawford, 2020). A design team is used to systematically identify the problem, determine the causes, and develop a plan for improvement and data collection (Hinnant-Crawford, 2020). The design team for this improvement initiative was intentionally exclusively female in order to ensure the female perspective is at the forefront of the work. In addition to the scholar-practitioner, the team included the Executive Director of

Academics of the local contest, who has a background as a secondary educator, secondary and elementary school-based administrator, and district level administrator. The Executive Director of Academics also holds an Ed.D. from Appalachian State University where her research focused on the intersectionality of motherhood and leadership. She brings a unique perspective on the role of women in various spaces as a result of her research and experience. Also on the team was the Executive Officer of Communications and Technology for MACS who has many years of experience in program development and evaluation and holds a background in instructional technology. In addition, she is the mother of two female students, one who has found a pathway in technology at school and one who has not found interest in this area.

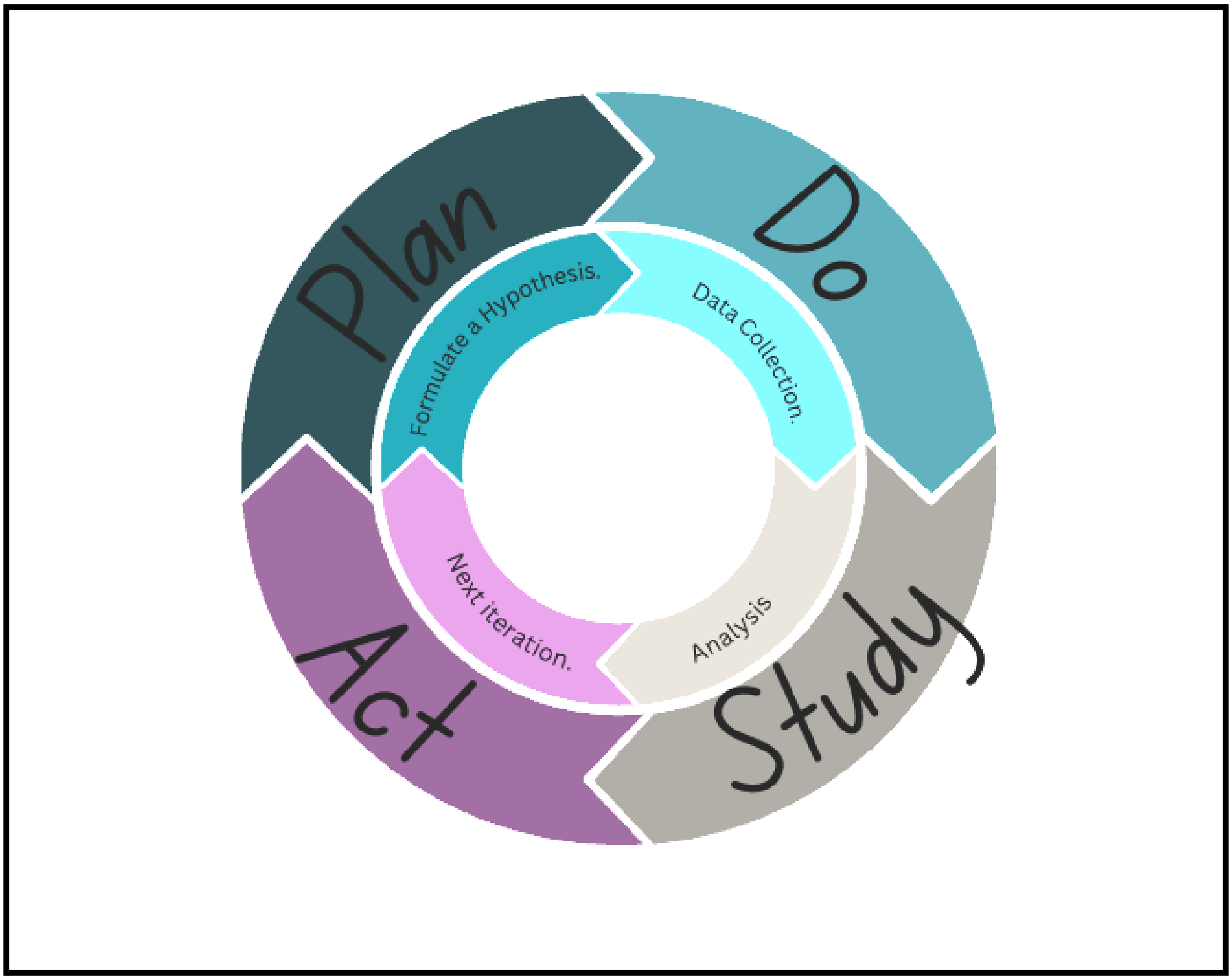
The scholar-practitioner had worked closely with these two team members on other projects, and they have developed a solid team relationship. The scholar-practitioner's experience was amplified by the Executive Director of Academic's scholar and practitioner background and the Executive Officer of Communication and Technology's lifelong immersion in the area of instructional technology. Engagement with the community was at the center of this improvement initiative and the design team's experience supported the development of methods to market the program to a diverse group of girls.

Implementation Plan

The scholar-practitioner used Improvement Science through a Plan, Do, Study, Act (PDSA) protocol (Langley et al., 2009) represented in Figure 6, to evaluate the effectiveness of the improvement initiative while working with a design team made up of stakeholders with unique perspectives on this area of study.

Figure 6

The PDSA cycle (Langley et al., 2009).



Timeline

A general timeline is depicted in table 1. This timeline represents the months in which each element of the improvement cycle took place. A more detailed timeline (Appendix F) shares specifics for each component of the improvement initiative.

Table 1

Implementation timeline.

GOAL: Improve sense of belonging for girls in technology learning opportunities in order to break down stereotypes and improve psychological safety around participation in technology and STEM learning.	Feb 2024	Mar 2024	April 2024	May 2024	June 2024	July 2024	Aug 2024
1) PLAN: Design team schedule was determined.							
2) PLAN: Design team identified problem, reviewed causal analysis, evaluated research based-interventions, designed implementation plan, and created measures.							
3) PLAN: Design team reviewed baseline data to finalize improvement plan and worked to identify any barrier-producing factors to participation.							
4) DO: Recruited students for program							
5) DO: Program implementation, 8 sessions, twice a week for 4 weeks.							
6) STUDY: Analyzed measure outcomes							
7) ACT: Reflect and prepare for future iteration							

Step one: (PLAN): The design team, identified in the previous section, determined a meeting schedule for the purpose of carrying out the PDSA cycle. This schedule involved monthly meetings. These meetings were identified as a time to reflect on and collectively brainstorm around best practices based on extant research and knowledge of the local context.

Step two (PLAN): During meeting times the design team evaluated the information available with regards to the problem of practice and reviewed the causal analysis to determine any additional causes or adjustments to currently identified causes that impact the problem of practice. During these meetings in the first two months the team also developed research-based interventions using aforementioned programs as a model, finalized an implementation plan, and developed four types of measures to evaluate the effectiveness of the intervention. These measures include: process measures to evaluate how the program is going, driver measures to determine, at intermediary times, whether the initiative is working, outcome measures to evaluate the resulting changes of the initiative and balance measures which will look for unintended outcomes of the program.

Step three (DO): This step was the beginning of the program implementation and involved recruiting students for the program focusing on girls in technology. Marketing and access were a priority during the recruitment process with information shared clearly with students and parents including the access to transportation home in the afternoons.

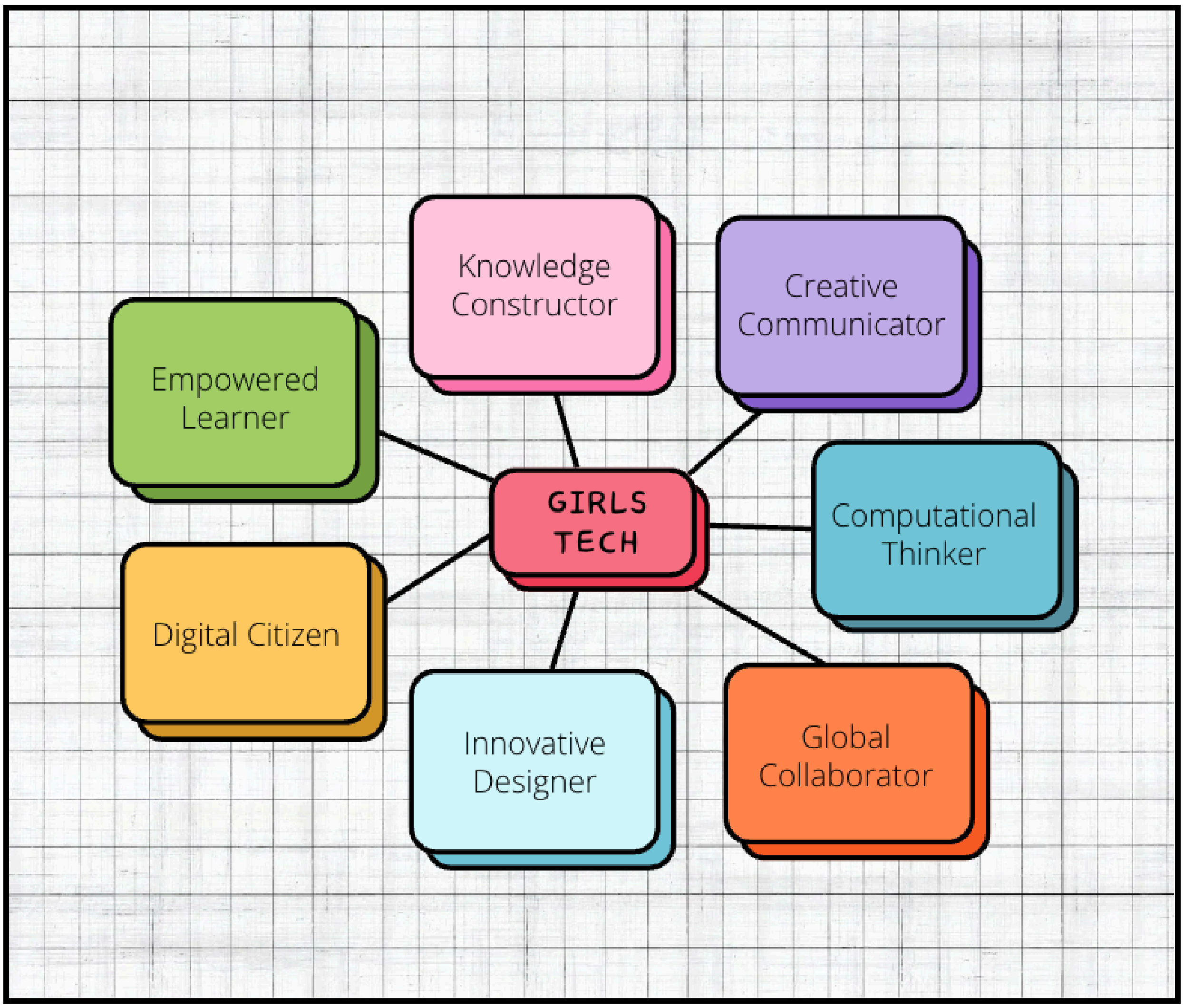
Step four (DO): This step was the major implementation portion of the disquisition. During this time eight students engaged in the counter space programming for girls focused on STEM and specifically technology learning. The curriculum (Appendix G) was adapted from Girls Who Code, ISTE standards for students, and with insight from the two program facilitators with STEM experience. Additionally, external partners experienced in the field and offering diverse perspectives gave feedback and ideas about the curriculum. The program was then implemented by the facilitators on a twice weekly basis for four weeks.

Curriculum

The curriculum for Girls Tech (Appendix G) was adapted from Girls Who Code (2019) with input from the facilitators who have experience teaching and differentiating for students in this community. In addition, the curriculum was adapted based on input from educators of color with experience in technology learning and based on consultation with resources from Black Girls Code. As shown in Figure 7, session focus areas are aligned with ISTE standards for students (ISTE, 2016) which are the accepted technology standards in the NC Digital Learning Plan (Appendix A).

Figure 7

Girls Tech focus areas.



The Girls Tech sessions took place twice a week for eight sessions. These sessions took place immediately after school for 1.5 hours in High-Tech learning spaces (Figure 8) with access to robots, computers, and other technology of high caliber.

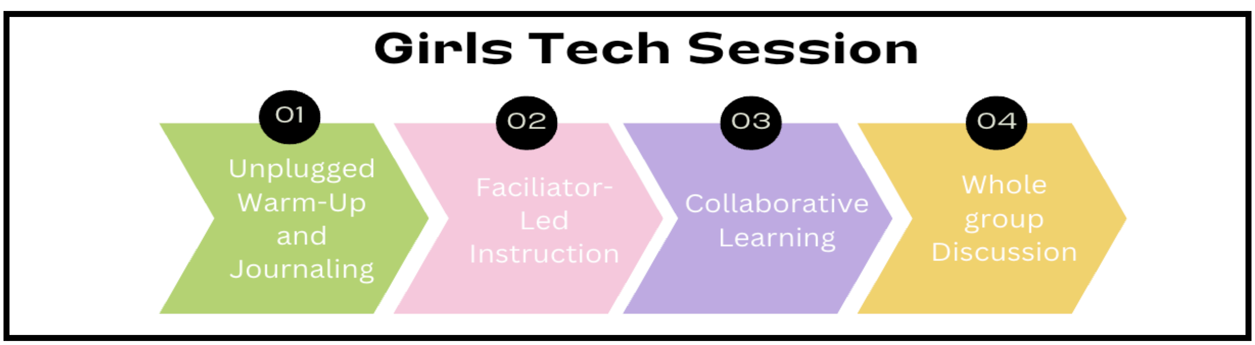
Figure 8

High tech learning spaces.

Participating students were offered transportation home at the conclusion of each session in order to eliminate the barrier of access to transportation which was utilized by multiple participating students. In order to provide consistency and contribute to the student's psychological safety, each session followed the same protocol represented in Figure 9.

Figure 9

Girls Tech session protocol.

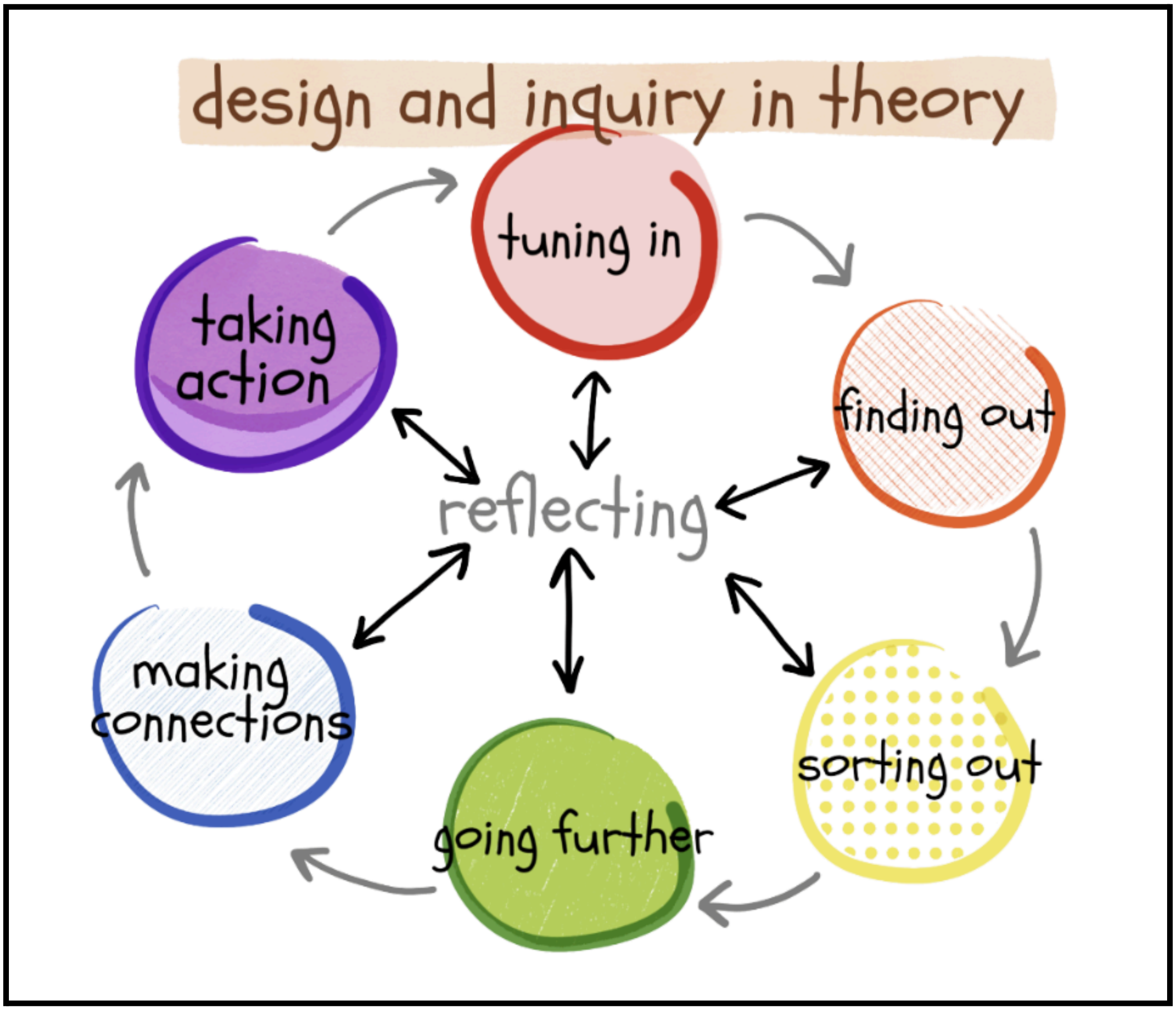


The Girls Tech sessions began with an unplugged warm up that encouraged thoughtful reflection through journaling, followed by brief facilitator-led instruction to guide learning.

Students then engaged in collaborative, student-centered learning that encouraged risk taking, problem solving and design thinking using the framework represented in Figure 10.

Figure 10

Framework for design thinking,



Participants

Facilitators. For the purpose of this intervention three facilitators led the after-school Girls Tech sessions. Each of these facilitators was female. Each held a NC teaching license and had practical work experience teaching STEM and teaching in the local context at the elementary level. These facilitators supported the work of differentiating the Girls Tech curriculum for the unique learners in the space as well as delivering the Girls Tech sessions. The facilitators provided driver, process, and outcome data through surveys, interviews, and checklists.

Students. The participants in the Girls Tech after school program were nine girls in grades three-five. These girls were given the opportunity to sign up for Girls Tech after receiving information during their STEM class at school. The recruitment process included a 10 minute meeting where girls from each class in grade three through five remained in STEM class at the conclusion of their usual class period. They viewed information about the program (Appendix H) and had the opportunity to ask questions. Girls brought home a sign-up form (Appendix I) that was to be returned within one week. A lottery took place to select the participants, and the remainder of the students' forms were held for a second cycle of the Girls Tech program.

Anticipated Challenges/Barriers

Throughout this improvement initiative certain challenges were anticipated. Factors identified on the fishbone diagram, but not addressed in this improvement initiative, may act as barriers. Students often lack access to transportation that would otherwise allow them to participate in informal, after school learning programs, so this barrier was addressed by providing transportation, though there could still be persisting stereotype threat around using that transportation..

A resistance to equity-based interventions was expected. The current political climate in NC has resulted in a certain level of discomfort among those who carry biases toward equity work and this has become even more apparent as opportunity gaps expand (Foraria, 2023). The lack of inclusion of boys in this programming could have resulted in some push back from staff or community members. This participation barrier could be addressed through the realization that boys do have access in the local contest to similar programming that is open to students of all genders. These existing programs included First Lego league after school program, in school STEAM class for all students, and other STEM oriented extracurriculars.

Evaluating the Improvement Initiative

Improvement science (Crow, et al., 2019) is used to evaluate the effectiveness of a proposed intervention. Improvement science uses frameworks for change and informs the work of scholar practitioners making advancements in a context. Organizational improvement is a prime focus for educational leaders (Hinnant-Crawford, 2020). In the context for this improvement initiative, MACS, a design process was used. This was achieved through a continuous cycle of improvement via a PDSA (plan, do, study, act) cycle. The use of a PDSA cycle allowed for the improvement and adaptation of the implementation work in order to create access to technology learning for girls through the use of counter spaces designed specifically for their engagement, separate from the pressure of stereotypes that tell them technology learning is not for them. The improvement initiative implemented for the purpose of this disquisition was the first cycle that will be continued in the local context in order to improve representation of girls in programming to a more proportionate level.

In improvement work, analyzing measures both intermediary and summative allows for timely adjustments to the change work. In this improvement initiative, practical measures helped answer the question "What works?" (Crow, et al., 2019). In this initiative four types of measures were used to evaluate the effectiveness of the implementation. These measures are explained in detail based on the work of Crow, Hinnant-Crawford, and Spaulding (2019) and included: driver measures, process measures, balance measures, and outcome measures (table 2).

Table 2

Practical measures.

Measure	Underlying question answered (Crow, et al., 2019)
Driver Measure	Is it working?
Process Measure	How is it working?
Balance Measure	Is it working as intended?
Outcome Measure	Did it work?

Driver measures can be equated with formative measures that evaluate if the drivers referenced in the driver diagram are being addressed during the improvement initiative. These measures tell the scholar practitioner if the initiative is working throughout the implementation. Outcome measures then act as summative assessment to evaluate the effectiveness of the initiative at its conclusion. Process and balance measures offer necessary information to the scholar practitioner. The process measure evaluates if the work is being carried out with fidelity. Balance measures look at unintended outcomes of the implementation.

Data Collection and Analysis

Data were collected throughout and at the conclusion of this improvement initiative to inform the work, realize the outcomes, and plan for future opportunities that create access. Curriculum was prepared using ISTE standards for students (ISTE, 2016), Girls Who Code resources, and with input from the facilitators as experienced STEM educators and other stakeholders. The developed aim, along with the drivers of this aim provide a foundation for the change ideas and instruments used to evaluate the outcome.

Timeline

A specific timeline was used for data collection both formative and summative to evaluate the impact over the course of the implementation. This timeline is represented in table 3. These data were then analyzed using descriptive statistics, in vivo, versus, pattern, and focus coding methods, and visual and thematic analysis. In vivo coding uses exact words or phrases as codes to capture perspectives. Versus coding focuses on comparisons and in this case will contrast experiences. Pattern coding as a second cycle coding method organizes the previously coded data into any patterns or constructs that might be present. Focus coding is used to refine themes and codes in order to narrow the focus to the most relevant themes.

Table 3

Evaluation timeline.

Improvement Science Measure	What Inquiry question did this measure answer?	Who did I collect this data from?	What type of data collection tool did I use to collect this data?	What type of data did I collect from this measure?	When did I collect this data?	How did I analyze this data	When did I analyze this data
Outcome – Facilitator Interview	What changes in comfort and participation did the facilitators of "Girls Tech" notice?	Girls Tech Program facilitators (3 female STEM educators)	Semi-structured interview	Qualitative	End of Girls Tech 8 session program	Versus coding followed by pattern coding	After the completion of the 8 week Girls tech program
Outcome- Student Interview	What feelings do the students have about tech programs after completing the "Girls Tech" program? Will the girls continue to participate in similar	Girls Tech student participants (9 girls grades 3-5)	Semi-structured interview	Quantitative and Qualitative	End of Girls tech 8 session program	Versus coding followed by pattern coding and focus coding Descriptive Statistics	After the completion of the 8 week Girls tech program

	programs beyond "Girls Tech"?						
Outcome-Student Drawings	Did the students' ideas for what a person working in STEM and tech change?	Girls Tech student participants (9 girls grades 3-5)	Student drawings: observations	Qualitative	Beginning and end of Girls Tech 8 session program	Visual Analysis Thematic Analysis Descriptive statistics	After the completion of the 8 week Girls Tech program
Driver-Facilitator survey	How well did the students collaborate? How well did the students communicate? How well did the students innovate? How comfortable did the students appear?	Girls Tech Program facilitators (3 female STEM educators)	Qualtrics survey	Qualitative and Quantitative	End of session 2, 4, and 6 of the Girls Tech program	In vivo coding Versus coding Descriptive Statistics	Immediately after collection and after the completion of the 8 week Girls Tech program
Process - Facilitator Checklist	Did each element of the Girls Tech	Girls Tech Program facilitators (3	Checklist	Quantitative	End of each Girls Tech	Descriptive Statistics	Immediately after collection

	program for that particular day take place as planned?	female STEM educators)			program session		
Balance-Student Interview	What would the student be doing if they were not in Girls Tech during the time period?	Girls Tech student participants (9 girls grades 3-5)	Semi-structured interview	Quantitative and Qualitative	End of girls tech 8 session program	Versus coding followed by pattern coding Descriptive Statistics	After the completion of the 8 week Girls tech program
Balance-Facilitator interview	What unintended outcomes did the facilitators of Girls Tech notice?	Girls Tech Program facilitators (3 female STEM educators)	Semi-structured interview	Qualitative	End of the 8 weeks girls tech program	Concept coding	After the completion of the 8 week Girls tech program

Driver Measures

The purpose of the driver measures was to provide formative evaluation throughout the Girls Tech program and inform any necessary adjustments throughout the PDSA cycle. Driver measures assess for changes that can be made prior to the outcome being measured at the conclusion of the research cycle. Driver measures give a predicted validity for the outcome measures (Crow et al., 2019).

Driver measures were collected at three intermediary times throughout this improvement initiative. As Girls Tech participants engaged in eight after school sessions in the district High-Tech learning spaces, a facilitator survey taken in Qualtrics (Appendix B) was collected at the end of session two, four, and six. This survey (Appendix B) used primarily Likert-type scale questions as well as two open-ended questions. The survey was completed by the facilitators of the program who were licensed and experienced elementary educators that taught STEM classes in the district to students PK-5. The survey utilized was adapted, in part, from a survey used to assess student comfort in a content area (Bray, et al., 2020). The facilitators used student feedback and perception via their professional observations to determine the comfort level of students with the content and experience throughout the process. The additional questions were developed and informed based on similar research by Prieto-Rodriguez et al. (2020) to evaluate the perceptions of girls in STEM programming. In this case the questions were adapted to be completed by the facilitator as a short narrative. No student information was collected in these surveys, only general information about the progression of the program and its overall impact on the group.

The open-ended questions were coded using in vivo and versus first cycle coding methods to infer the progressing impact of the program on participating girls. In vivo coding is the process of capturing the exact words used to capture the perspectives of the person speaking (Saldana, 2016). In vivo coding was used to highlight the voices of the facilitators of Girls Tech in order to get a firm grasp on the experiences they observed and facilitated. Versus coding was also used to make comparisons to previous experiences the facilitators have had as the cycle progressed. Versus coding is the process of using comparisons to recognize what is happening versus the alternate or opposite, sometimes through the use of binary language (Saldana, 2016). The Likert-scale questions were analyzed using descriptive statistics.

Process Measures

The process measure is an element of evaluation in improvement science that recognizes the progress and effectiveness of the work. The process measure tells us that the initiative is being carried out according to its design (Hinnant-Crawford, 2020). The process measures verify that the outcome is the result of an appropriately implemented change idea and that the initiative was completed with fidelity.

The process measure used in this improvement initiative was a facilitator checklist (Appendix K). This checklist identified each component of the program that should have been completed during the eight student learning sessions. This checklist included the warmup independent activity, the facilitator-led instruction, the student-engaged activity, and the end of session whole group reflective discussion. The curriculum plan (Appendix G) also informed the process measure to ensure that standards were being addressed appropriately during the engagement sessions. Components of this checklist were also used as a balance measure. The facilitators completed this checklist eight times, at the conclusion of each engagement session of the Girls Tech program. Descriptive statistics was used to analyze the results of these checklists.

Balance Measures

Balance measures in improvement science are developed to aid the scholar-practitioner in identifying and understanding unintended outcomes of the intervention (Crow et al., 2019). Change in an organization can unintentionally impact or upset other parts or programs of an organization (Crow, et al., 2019). Evaluating using balance measures ensures that any unintended consequences of the program are addressed and accounted for.

Balance measures were collected based on two questions in the student interviews (Appendix L). This interview served as an outcome measure as well. The specific questions related to balance measures have to do with attendance, what other opportunities the student might be missing or giving up to participate in this program, and any unintended barriers that might have impacted participation. These questions were developed specifically for this intervention. The questions were evaluated using versus coding to look for alternative responses followed by pattern coding which in order to reveal themes and unanticipated outcomes.

Outcome Measures

The summative measurement tool or outcome measures was evaluated through a facilitator interview, student participant interview, and review of student journal entries from sessions one and eight. Outcome measures are intended to assess the aim of improvement work and whether that aim was met or moved closer to (Crow et al., 2019). In this improvement initiative, the aim or goal was to improve proportional representation of girls in technology engagement by creating counter spaces where girls can explore the interest without the burden of stereotypes. These spaces are intended to create a sense of belonging and comfort to learn and engage with technology. The outcome measures evaluated the impact the program had on the girls as well as their willingness to continue to engage in the technology component of STEM.

This measure was collected through feedback from facilitators and students via interviews as well as student drawings on journal entries.

The first outcome measure was semi-structured interviews with facilitators. The prompts developed (Appendix M) were based loosely on Prieto-Rodriguez et al. (2020) methods used to evaluate the effectiveness of STEM programming for girls. The information collected from these interviews was compared to the driver measure data to evaluate for progress in the programming.

In coding the facilitator interviews for the outcome measures, in vivo coding was used as a first cycle coding method, followed by versus coding. This is a form of affective coding and allowed for recognition of the voices of the facilitators and evaluation of the comparisons the facilitators made to their experiences with girls prior to the program and as the program progressed. Pattern coding was then used as an additional cycle coding method in order to draw on the themes present in the observations of the facilitators.

The second outcome measure was the student interviews (Appendix L) which were semi-structured interviews including some survey type questions that were given in interview form to address the age of students and the ease of answering questions orally as opposed to completing a survey. Some of these questions were loosely Likert-scale type questions used to assess the opinions and feelings of the students at the conclusion of the program. A Likert-scale collects ordinal data on a scale. According to Olsen (2012) Likert-Scales are a method of collecting opinion data but can often lead to more ambiguity, for that reason the neutral option was, in some cases, expanded on through clarifying questions in the semi-structured interviews used in this data collection. Descriptive statistics was used to analyze the Likert-scale type questions. Additionally open-ended questions allowed for feedback on the program in a more authentic manner. Olsen (2012) explains the need for carefully crafted questionnaires that are organized in a specific manner. Based on this mentality the questions were limited to the most essential. The open-ended student interview questions were coded using in vivo coding for the first cycle coding in order to recognize the voice of the participants followed by focused coding for the second cycle coding to identify themes.

The final outcome measure was student drawings where students drew a picture of a person working in STEM and Technology. Students drew these at the beginning and end of the Girl Tech program. Visual and thematic analysis along with descriptive statistics was used to evaluate these images.

Results & Findings

Improvement science is a structured approach to solving problems of practice by understanding the system in which the problem exists, designing evidence-based interventions, using practical measures to evaluate the outcomes of those interventions and then refine the change initiative based on the analysis (Langley et al., 2009 & Hinnant-Crawford, 2020). To evaluate the findings and outcomes of this improvement project it was important to begin by understanding each of the measures. According to Crow, et al. (2019), it is essential to use formative and summative data while also attending to process and balance data that show whether the improvement is working and any unintended outcomes. For this disquisition both qualitative and quantitative data were collected to evaluate driver, process, balance, and outcome measures. PDSA cycles (plan, do study, act) are a cornerstone of improvement science where the scholar-practitioner determines an aim or desired outcome, plans a change initiative to move closer to or achieve the aim, implements, then studies the results, and redesigns or refines before repeating the cycle (Langley et al., 2009). A PDSA cycle was used to implement this initiative. The aim of this initiative was to improve the sense of belonging and representation of girls in educational technology which could pave the way for improved representation of women in technology-based careers. In this improvement cycle access was created for girls by use of a counter space called Girls Tech, an after school program facilitated by three female, experienced, and innovative educators. This program took place in eight, one and a half hour, twice-weekly sessions. The PDSA cycle was laid out over several months where the program was designed, students were recruited, the program was implemented, and then the data were collected and analyzed, followed by planning for future iterations.

Driver Measure

In Improvement Science, driver measures provide formative evaluation throughout the implementation and inform any necessary adjustments during the PDSA cycle. Driver measures were used to understand the formative progression of how providing a counter space for elementary age girls to engage instructional technology engagement might improve their confidence and sense of belonging in the tech space. A facilitator survey (Appendix J) was implemented to collect driver data. These driver measures were then used to assess for changes that could be made to the implementation during the program and prior to the outcome being measured at the conclusion of the cycle (Crow et al, 2019). These driver measures were used to give a predicted validity for the outcome measures (Hinnant-Crawford, 2020).

The facilitator survey was completed by the Girls Tech program facilitators after sessions two, four, and six. This survey provided formative information throughout the PDSA cycle. This survey provided intermediary perceptions from the facilitators on the impact of the program, evaluating progress with regards to student comfort level, sense of belonging, and skill development as well as overall success and failures of the sessions. Likert-scale type questions were analyzed using descriptive statistics and open-ended questions were analyzed using in vivo first cycle coding and versus seconds cycle coding to capture the perspectives of the facilitators as well as capture any comparisons they made in their feedback survey.

Descriptive statistics were calculated in order to understand central tendency and variability of the responses to this survey which is appropriate for small sample sizes, where more advanced statistics cannot be applied. Descriptive statistics also provides an easy-to-understand summary for the average audience of educational research. This helps avoid over interpretation by focusing on summarizing rather than inference and can often capture nuances in opinion as well as provide easy to identify patterns to support decision making and further analysis.

In vivo coding was used as the first cycle coding method to capture authentic participant voices while also identifying key concepts, descriptions, and themes without applying interpretation bias (Saldana, 2016). Versus coding was used as the second cycle coding method because it highlights conflicting or contrasting perspectives within the data (Saldana, 2016). Coding this way was particularly relevant for this data set because it can reveal changes over time, highlight tension between different aspects of the program, and identify contrasts between facilitator expectations and actual outcomes.

Participants

The participants of the study were eight students and three facilitators. The facilitators provided the driver measure data based on their own observations and experiences in the Girls Tech sessions. The facilitators were each NC licensed, female educators, with experience in teaching STEM. While having three facilitators is a smaller sample size, it does give multiple perspectives on the program implementation, impact, successes, and growth areas. In every survey all facilitators who completed the survey answered all four Likert-type questions. After session two, two out of three responding facilitators answered the three open ended questions. After session four, two out of three responding facilitators answered the three open ended questions. After session six, one of the three responding facilitators answered the three open ended questions. While a small sample size, there was a very effective staff to student ratio of 3:8 and educators within this demographic are limited in the local context.

Results & Findings

The Likert-scale questions were intended to identify the facilitators perception of student comfort with the program by evaluating the student participants as a whole group for the indicators highlighted in table 4 below.

Table 4

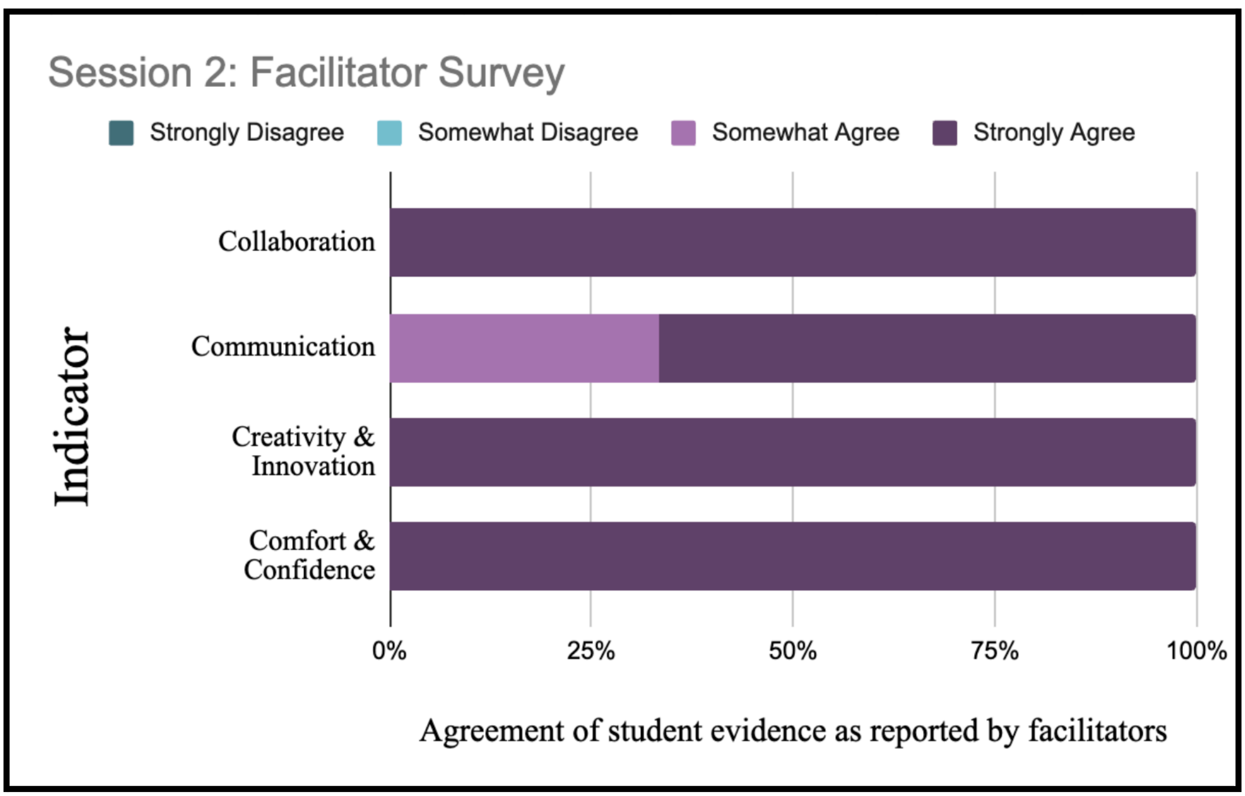
Student comfort as reported by facilitators.

Indicator	Number of facilitators reporting this response after session 2				Number of facilitators reporting this response after session 4				Number of facilitators reporting this response after session 6			
	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Agree	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Agree	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Agree
Collaboration: Students were able to work in pairs or small groups to effectively complete a task in the last two sessions	3	0	0	0	3	0	0	0	3	0	0	0
Communication: Students were able to communicate their ideas and answer questions using technology and oral skills in the last two sessions.	2	1	0	0	3	0	0	0	3	0	0	0
Creativity & Innovation: Students were able to come up with problems and test their ideas, then work to improve them in the last two sessions.	3	0	0	0	2	1	0	0	3	0	0	0
Comfort & Confidence: Students showed confidence and comfort in the program and expressed this during the end of session group discussions in the last two sessions.	3	0	0	0	3	0	0	0	3	0	0	0

When reviewing the responses to the Likert-scale questions on the facilitator survey completed after session two, it was evident that facilitators generally observed very high levels of engagement, creativity, innovation, communication, and collaboration among student participants after the first two sessions. Critical thinking and problem-solving skills were also rated highly, although with slightly more variation in responses than the other factors. Overwhelming, the feedback after session one and two, which is visualized in Figure 11, showed promise that the initiative would be effective. The median and mode were both "strongly agree" with a range of one for the communication indicator and no range for other indicators due to the unanimity of the responses.

Figure 11

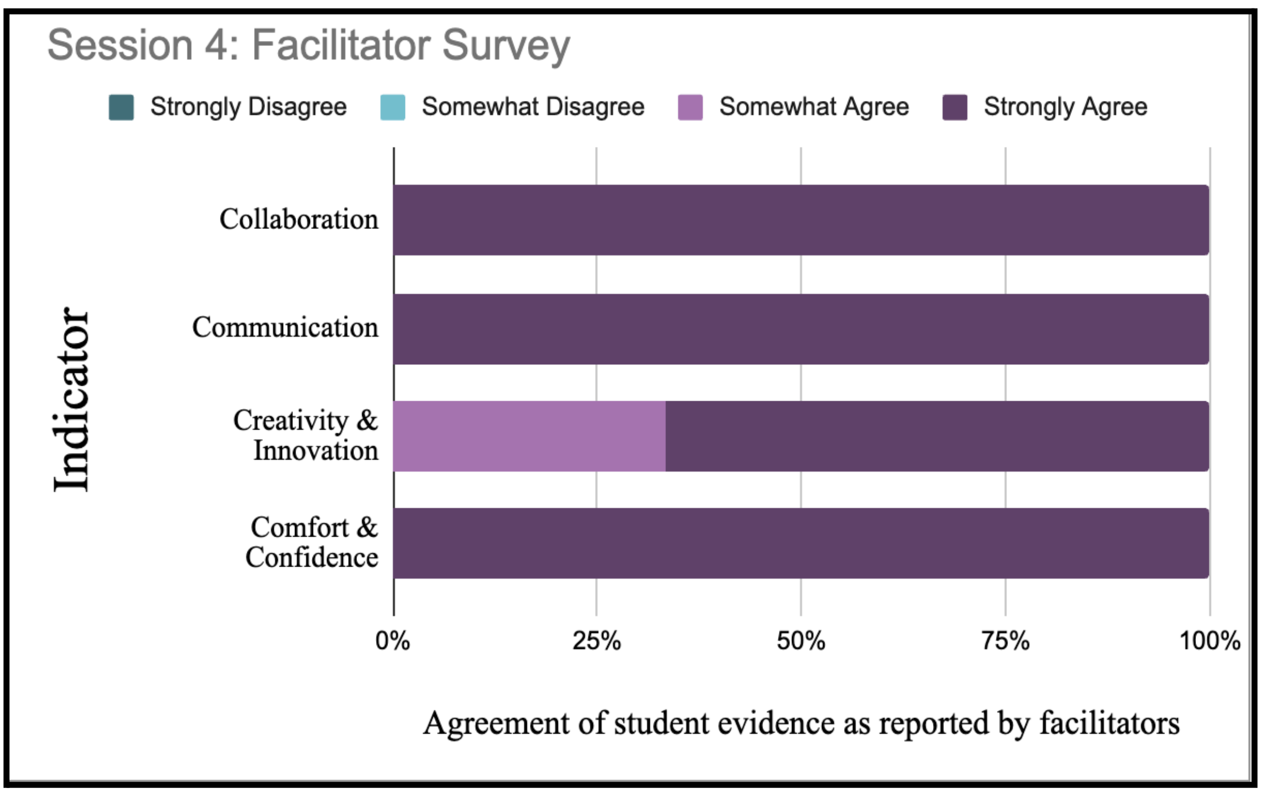
Student comfort as reported after session two.



Post session four, the responses to the Likert-scale questions in the facilitator survey indicated the facilitator observations of student participants with regards to collaboration, communication, creativity/innovation, and comfort/confidence show very high levels of engagement for all indicators with some slight variation in the responses for “creativity & innovation,” as represented in Figure 12. The mode and median of this data set is “strongly agree” with a range of one for “creativity & innovation” and no range for the other three indicators due to the unanimous response of “strongly agree.”

Figure 12

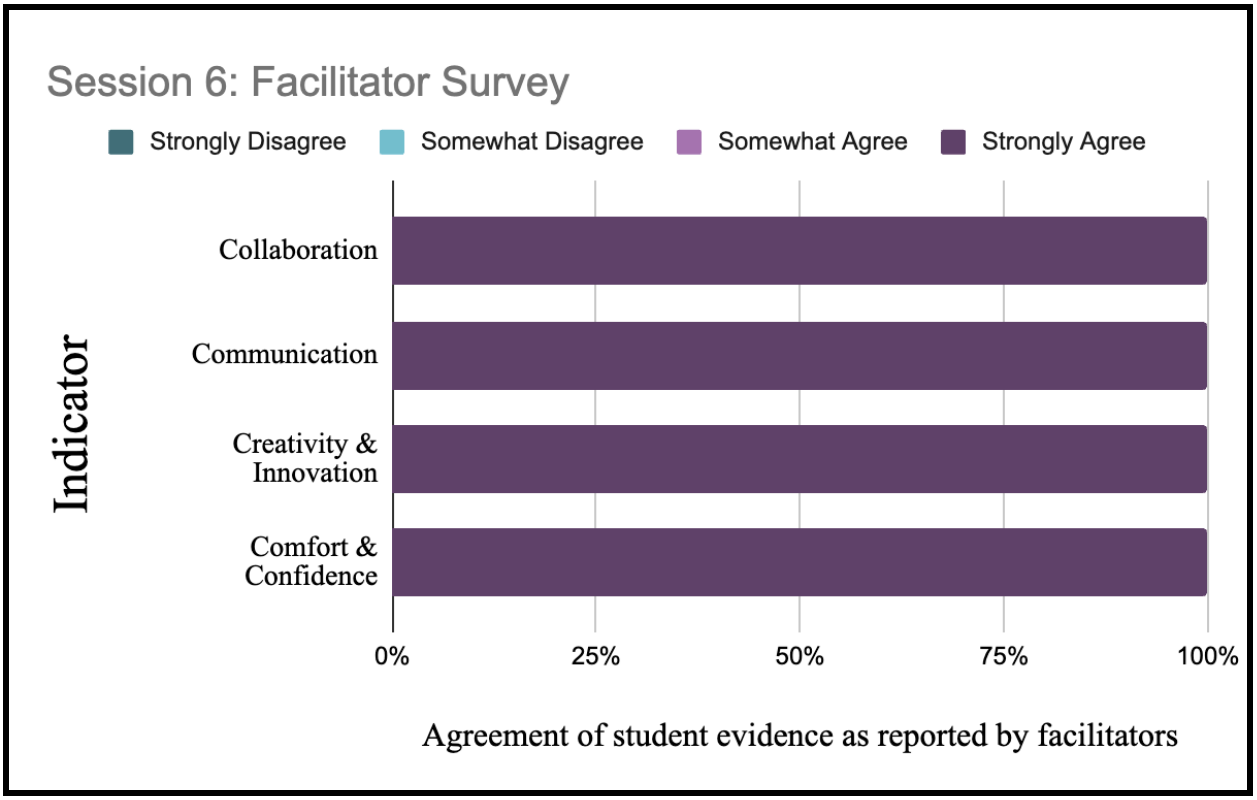
Student comfort as reported after session four.



This survey was completed for the last time after session six of the Girls Tech eight session program. The descriptive statistics of these responses show unanimous observations of all indicators as “strongly agree,” as shown in Figure 13. The mode and median of this data are again "strongly agree" with no range in this data due to the consistent response to all four questions.

Figure 13

Student comfort as reported after session six.



In the facilitator survey that acted as the driver measure for the purpose of this research investigation, three open-ended questions were coded using first cycle in vivo coding. This was followed by second cycle versus coding. Based on the in vivo and versus coding of session two responses to the facilitator survey, several key themes emerged.

According to the facilitator survey collected after session two, the facilitators noted high levels of student engagement and participation. Students were described as "focused on the task" and having "conversations about the task," indicating active involvement in the activities. There was a contrast between structured activities and student autonomy. While students were engaged in the prescribed tasks of the protocol for the Girls Tech program, there was some evidence noted in these responses that student participants were beginning to make independent choices and share more confidently as the program progressed through the sessions.

Time management emerged as a challenge after session two, with facilitators noting time constraints to completing each planned element. This was also evident in the process measures explained further in the next section. One facilitator noted that, “time constraints might have been the only factors of failure,” suggesting a level of tension or conflict between the desire to follow the protocol for the session and cover all material and activities, and allowing sufficient time for student exploration and reflection.

The feedback indicated growing student confidence, with one facilitator noting that, “students needed extra support for confidence, but once they were encouraged they seemed to feel more comfortable with their decisions.” This highlights the importance of the facilitator as a support and mentor in building student self-efficacy. The qualitative analysis of this data, collected post session two, suggests a theme of engagement and the development of student participant confidence that was observed by the facilitators in the early stages of the Girls Tech program.

As a result of the data analysis from the facilitator survey completed after session two, slight modifications were made to the way the program was implemented. These adjustments included making sure students were given ample space and time for their own reflection and group discussion while also relaxing the expectations that the facilitators may have been putting on themselves. In addition more care was given to preparations so that the session time could be maximized.

The same facilitator survey was given after session four and qualitative data analysis of the open ended questions, completed using in vivo and versus coding suggests the facilitators observed a high level of student engagement and enthusiasm. Discussions were described as "lively" which indicates both a significant increase in active participation compared to earlier sessions as well as evidence that the minor adjustments to make time for reflection and discussion were effective.

This qualitative review after session four indicates there was a noticeable balance between structured activities and student-centered exploration. The feedback mentioned specific activities and described them with positive enthusiasm, suggesting successful integration of engaging, structured activities with opportunities for student creativity, in order to effectively support technology interest development.

Time management remained a consideration in the feedback after session four, but the tone and details of the response suggests this was viewed more as a learning opportunity and less as a failure, the open-ended responses remained positive and included suggestions for ways to improve time management while also mentioning that the student engagement may have created the time management issues. The feedback noted that some activities took longer than expected, indicating a need for further adjustment to the session planning and pacing.

Student confidence and participation depth reportedly increased by the conclusion of session four, with facilitators noting that students were asking questions and sharing ideas. One facilitator stated that, "students actively engaged in activities like engineering challenges and coding exercises. This hands-on approach helped them critically think and foster creativity in problem-solving." The overarching themes of session four responses encapsulate high engagement, enjoyment of activities, and the development of critical thinking and problem-solving skills observed at the mid stage of the Girls Tech program. This skill development paired with engagement indicates that students were developing interest in technology-based activities. This also indicates a positive progression of the Girls Tech program from session two to session four, with increased engagement, more interactive and enjoyable activities, improved discussions, and growing student confidence, despite some persistent time management challenges.

Another observation uncovered during the coding of the first two sets of facilitator surveys was a change in tone in the response to these open-ended questions. Post session two the tone was more neutral, with simple descriptions of what the students were doing. In contrast, post session four the tone is more enthusiastic and descriptive of the student engagement and excitement. This possibly indicates a growth in engagement and excitement for the facilitators as well.

As a result of the qualitative analysis from session four survey responses, slight adjustments were made to the protocols and pedagogy of the program to continue to improve issues with time management. These adjustments were primarily to save time during the delivery of the facilitator led portion in order to provide more time for exploration and reflection. In addition, the feedback from session four open ended survey questions indicated that providing more time for reflection and discussion was beneficial and should be continued throughout the remainder of the sessions.

At the completion of session six a final driver measure survey was completed and the open-ended questions were coded in order to make any final adjustments necessary to continue to improve the Girls Tech program through the last two sessions. Based on the in vivo and versus coding analysis of session six feedback, several key themes emerged.

The facilitators observed continued growth in student comfort, confidence, and engagement. One facilitator noted that students were, “getting more comfortable with making choices,” and, “more confident to share.” This suggests a significant progression in student self-efficacy and autonomy compared to feedback after session two and session four.

The feedback highlights a continued shift towards less structured activities and more student-centered, open-ended exploration of the resources provided in order to develop interest, as well as skills in technology. Feedback suggests that interactions and discussions between students continued to increase, indicating a sense of community and strong peer support being developed among the group.

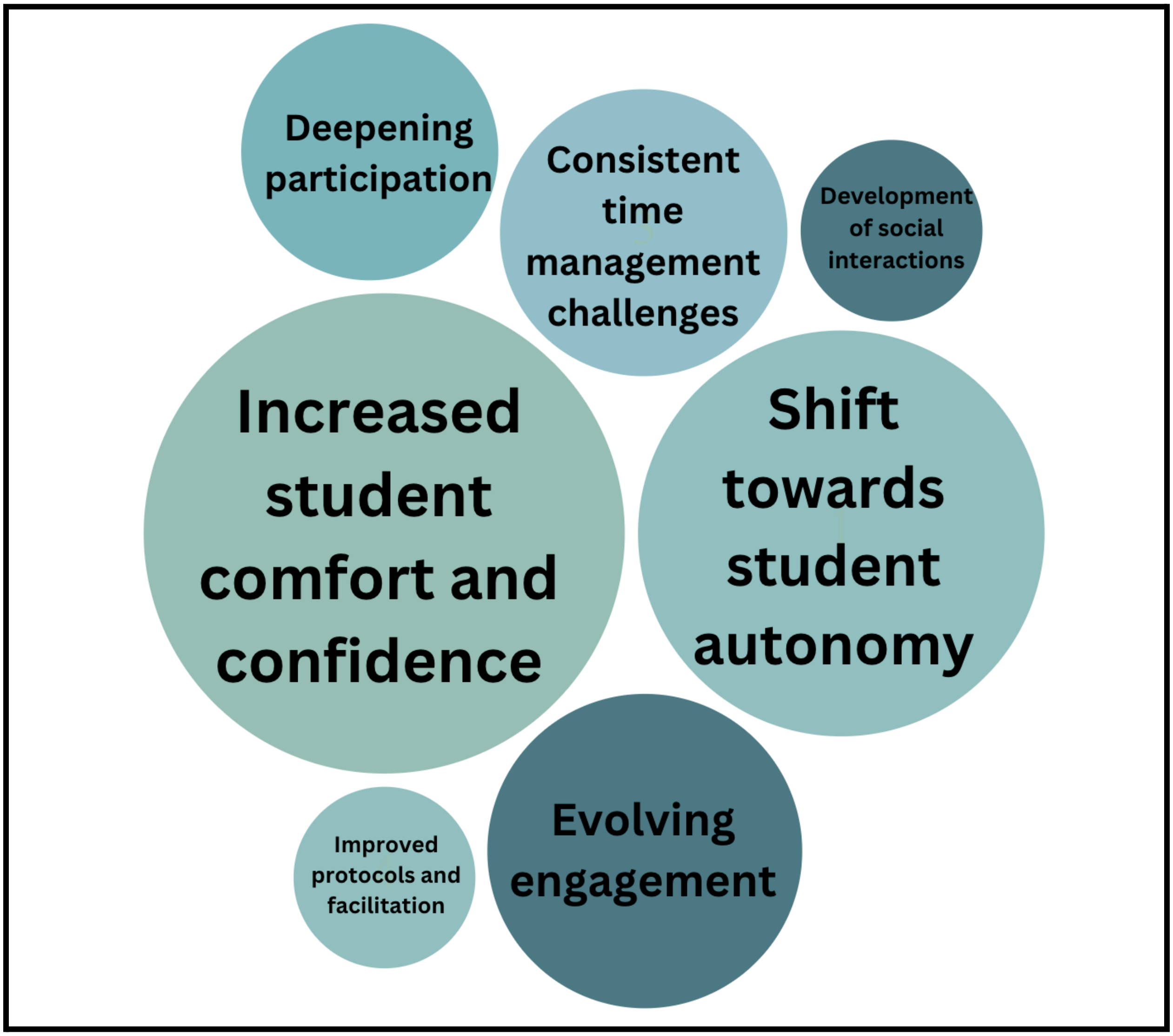
The analysis also suggests improvement in the flow of the sessions, with regards to organization, planning, and facilitator collaboration with one facilitator stating that, “lessons were organized and facilitators shared all responsibilities.” This is evidence that the adjustments made throughout the Girls Tech program refined the protocol effectively.

The tone of the facilitator responses after session six were more matter of fact than the enthusiastic and lengthy, detailed descriptions represented in session four survey responses. This could suggest that facilitators were more settled, comfortable, and functioning well as a group with a focus on growth and progress of the program. This subdued tone could also suggest facilitators were tired, or overwhelmed by the additional work of facilitating the Girls Tech program which should be addressed in future iterations.

Overall, the driver data suggests, formatively, that the implementation was having positive intermediary outcomes and several themes emerged throughout the series of surveys which are represented in Figure 14. These themes showed alignment with durable skills among students as well as the continuous improvement in confidence and engagement.

Figure 14

Emergent themes indicated by driver measures.



Process Measure

Process measures were used to evaluate the effectiveness of the protocol implemented to make change in this context. To identify if the improvement initiative was carried out with fidelity, a facilitator checklist (Appendix K) was used as the process measure at the conclusion of each of the eight sessions. Crow, Hinnant-Crawford, and Spaulding (2019) explain that ensuring the change was carried out as designed is essential to show reliability of the results and that the outcomes were because of the change idea, not a poor implementation. This change idea included lessons delivered to students using a consistent format. A checklist gives quick insight into whether each piece of the lesson was delivered to students during the sessions. The checklist was delivered in the form of a Qualtrics survey to the Girls Tech facilitators to learn how well each element of the protocol was attended to. Descriptive statistics was used to analyze the data collected in this checklist at the conclusion of each session.

Participants

The three Girls Tech facilitator participants completed this checklist together at the conclusion of each session. In some circumstances there was a facilitator absent and the two remaining facilitators would complete the checklist. The facilitators of this program were all female, licensed educators with experience teaching STEM and other innovative programs.

The sample size of this measure has more to do with the number of sessions analyzed than the number of participants as the checklist was completed collectively for each session. The purpose was primarily to evaluate the fidelity of the program as it relates to the intended program design. Eight sessions gave us a typical view of how a program like this might play out in normal circumstances. More sessions would likely not change results of this measure, fewer sessions could have resulted in unseen barriers that impacted the program.

Results & Findings

The facilitator checklist (Appendix K) was conducted for the purpose of a process measure and consisted of four yes or no questions administered on eight occasions to the facilitator participants. This checklist was completed in Qualtrics at the completion of each Girls Tech session. The raw data of the facilitator checklist shown in table 5 represent the findings of the process measure.

Table 5

Facilitator checklist data.

	Warm up completed	Facilitator directed learning completed	Learning challenge completed	Whole group discussion completed
Session 1	YES	YES	YES	YES
Session 2	YES	YES	YES	YES
Session 3	YES	YES	YES	NO
Session 4	YES	YES	YES	YES
Session 5	YES	YES	YES	YES
Session 6	YES	YES	NO	YES
Session 7	YES	YES	YES	YES
Session 8	YES	YES	YES	YES

The results of the facilitator checklist revealed a strong trend towards affirmative responses across all questions, with complete unanimity on two of the four items. The first two questions asked if the warm-up was completed and if the teacher-directed instruction was completed. In all eight sessions, the answer was yes, revealing a 100% rate of fidelity around that component of the protocol. The mode and median for both of these questions is yes, again underscoring a trend of following the protocol.

The third and fourth question asked if the learning challenge and the whole group discussion were completed. The results show slightly more variation, though still with a strong affirmative. For each of these questions, 7 out of 8 times (87.5%) this element of the protocol was completed. The high level of completion, albeit not 100%, indicates that the protocol was carried out with fidelity.

As a result of these findings it was clear that the protocol was an effective one and for the most part the planning and activities for these sessions were appropriate for the time given. In each of the two instances where an element was not completed, changes were made to the curriculum in order to be sure there was both time to finish that element during the next session and complete all elements necessary for that next session. While this was only one PDSA cycle, each session became its own cycle of sorts and slight adjustments were made based on the process data specifically to session four and seven. Adjustments can be made in future cycles to attend to the timing issues by lengthening the session times.

Balance Measure

When implementing an improvement initiative, balance measures are used to ensure that any unintentional impact is realized (Hinnant-Crawford, 2020) and evaluated. Within the student interviews at the conclusion of the program, balance measures were collected based on the first questions of the semi-structured interview (Appendix L). These particular questions specifically asked students about their attendance and what other opportunities or experiences the students might be missing out on as a result of the participation in Girls Tech. Descriptive statistics and versus and pattern coding was used to analyze the student responses to these questions in order to reveal themes.

Participants

The student participants provided the data for this outcome. Eight students were interviewed at the conclusion of each of the eight sessions in the program. Each student was in grades three, four or five and attended the same elementary school. The sample size is small which allows for a more intimate experience for the students however does limit the quality of the data with the lack of size.

Results & Findings

In order to evaluate for unintended impact, two balance measures were accessed. These were, attendance and alternative activities to Girls Tech. For the sake of attendance, students reported the number of sessions they attended, which they kept track of in their program journals. Five of the student participants attended all sessions, while one student participant missed one session and two student participants missed two sessions.

Descriptive statistics is the most appropriate method for analyzing this student attendance. The discrete nature and the small sample size of the data makes it well suited for descriptive analysis in order to summarize the central tendency of this data. Descriptive statistics provides a straightforward view of the data, accessible to a wide audience and avoids overinterpretation in small sample sizes by summarizing the data rather than making broad inferences.

The attendance data collected for the eight students over the eight sessions of the Girls Tech program reveals a generally high level of attendance with some variation among students. On average, students were present for 7.375 days out of the eight days observed, indicating a strong overall attendance rate of 91.19%. This high average attendance is further supported by the median and mode, both of which are 8 days, showing full attendance was the most common outcome.

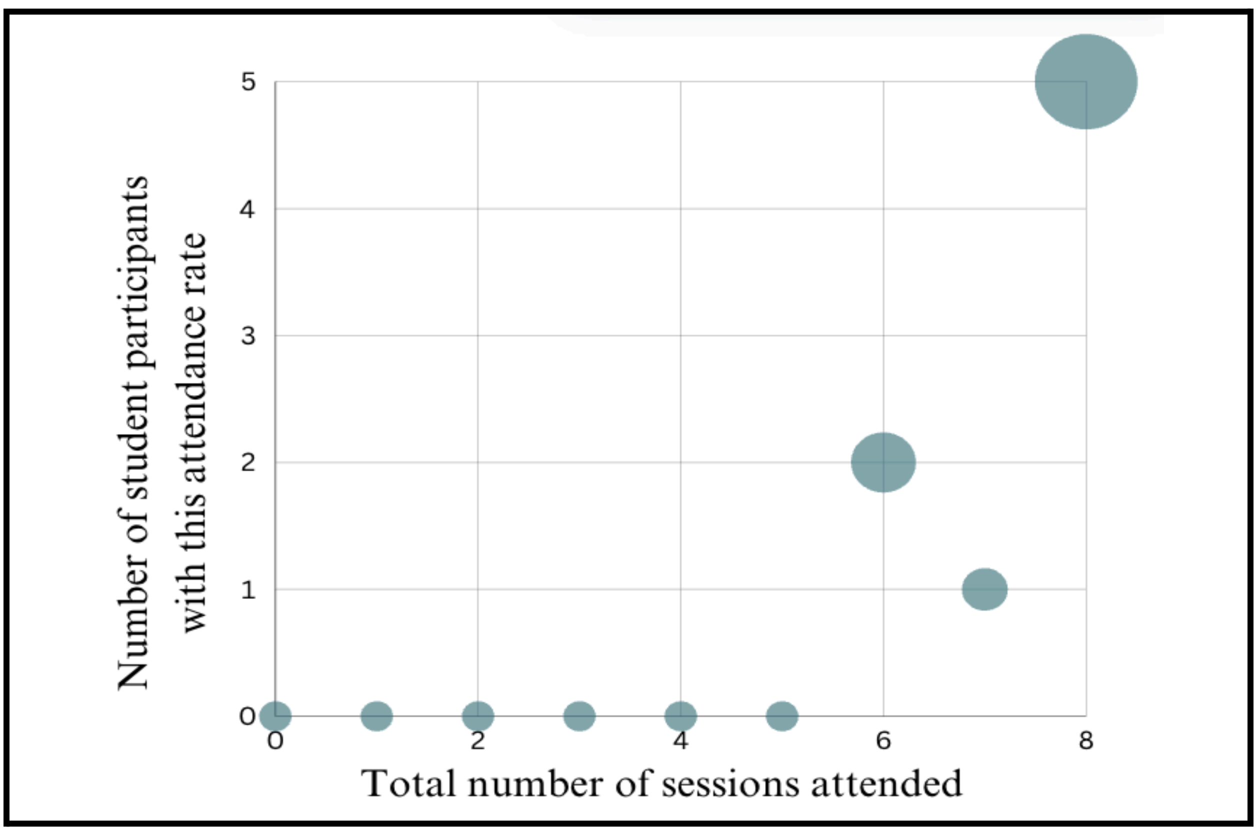
When analyzing the attendance information, the majority of students, five out of eight, were present for all eight days. This distribution is reflected in the range of two days, with attendance varying from a minimum of six days and a maximum of eight days. The standard deviation being 0.9161 days indicates a fairly low level of variability.

The frequency distribution can be visualized in Figure 15 below which shows a clear skew towards high attendance, with 62.5% of students having perfect attendance, 12.5% missing only one day, and 25% missing two days. This pattern is also evident in quartile analysis where both the median quartile (Q2) and the upper quartile (Q3) are eight days, while the lower quartile (Q1) is seven days. This small interquartile range of one day further emphasizes consistency in attendance, painting an overall picture of strong attendance in the eight session program.

For student participants with an imperfect attendance record, when asked why they were absent they reported that they were out of town (2 occasions), were on a field trip (1 occasion) and were out sick (2 occasions). This indicates that the students with lower than perfect attendance missed for reasons unrelated to their interest in the Girls Tech program.

Figure 15

Frequency distribution of the student participant attendance.



Student participants were also asked what two activities they might have been doing during the window of time they were at Girls Tech sessions had they not chosen to participate in the program. Students answered this question as an open ended question during the student interviews so their answers would be authentic to their voice and not directed by the option of choices. Students reported several activities, listed in Table 6.

Table 6

Alternate activities for student participants.

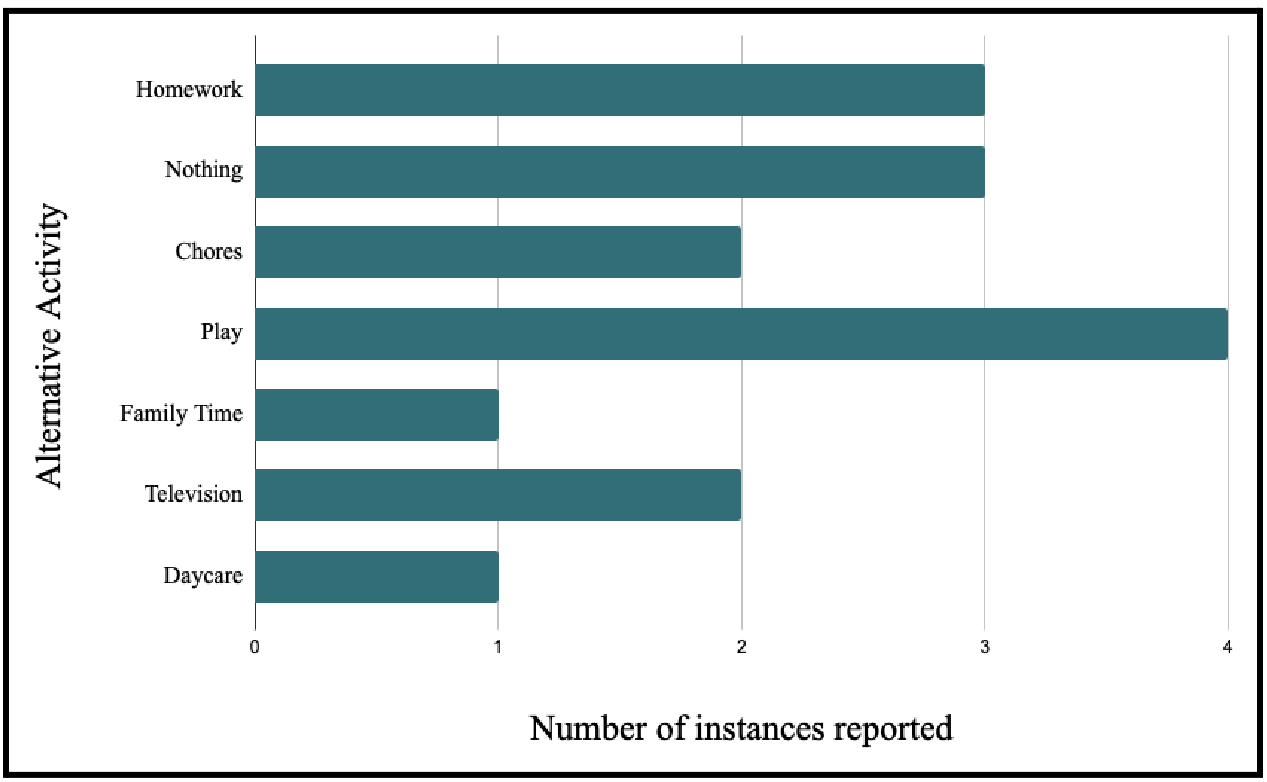
Alternate Activity	Number of instance reported
Homework	3
Nothing	3
Chores	2
Play	4
Family time	1
Television	2
Daycare	1

This data was analyzed using descriptive statistics as well as versus and pattern coding to identify alternatives as well as themes amongst the alternatives. Initially the versus coding revealed the alternative activities listed above, which were then quantified in order to analyze using descriptive statistics. Descriptive statistics is the most appropriate method of analysis for the quantitative results listed in table 10 due to the sample size and the type of data collected. Descriptive statistics helps the researcher understand the distribution of alternative activities and is ideal for developing easy to understand ways of communicating these results . Due to the categorical nature of the responses there are some limitations to the types of descriptive statistics that would give relevant information. As each student provided two responses, a frequency-based analysis is the most well-suited structure of analysis. Pattern coding was then used to evaluate this open ended question for trends.

The data collected from students regarding their alternative activities to the Girls Tech program reveals insights into how these student participants spend their time immediately after school on an average day with no other commitments. Each student provided two potential activities, resulting in a total of 16 responses which resulted in seven different categories of activities. The frequency of each activity is shown in Figure 16.

Figure 16

Alternative activities to Girls Tech..



Along with descriptive statistics, pattern coding shows that there is a preference for unstructured or leisure activities. The range for this data is three with the highest frequency being and the lowest being one. “Play” stands out as the most frequently mentioned alternative, cited four times and accounting for over a quarter (26.67%) of all responses, thus identified as the mode for this data. “Nothing,” closely follows, mentioned three times (20%), which could indicate either a desire for downtime or a lack of access to other activities. Together these two options along with television (13.33%) show that leisure activities represent more than half of all responses, suggesting a strong inclination towards free-time and recreational activities.

Another notable pattern or theme is the presence of responsibilities. “Homework,” and “chores” were each mentioned twice (13.33% each), indicating that some students view or are required to use the after school period as a time to fulfill obligations. The less frequently mentioned options of “family time” and “daycare” each mentioned once (6.67%) suggest that for some students the after-school period is structured by adults in their lives.

The diverse responses, ranging from active activities like playing to passive activities like watching television or doing nothing, reflects varied circumstances and interest of student groups and may suggest differing access to resources that allow for certain activities after school. These results help the researcher better understand the exposure the student participants have outside of the school day as well as any potential barriers to access to after school experiences. None of the students mentioned alternative clubs or programming which might require a cost or transportation, suggesting a possible lack of resources, transportation, or other barriers. Many of these barriers were eliminated in order to allow student participation in the Girls Tech program.

Outcome Measures

To summatively evaluate this improvement initiative, which aims to improve representation of girls in technology through counter spaces that provide safe, interest -building opportunities, three measures were used to evaluate the outcomes of the Girls Tech program implementation. Outcome measures assess the aim of the improvement work and whether that aim has been met or moved closer to (Crow, et al., 2019). The summative measurement tools were facilitator interviews, student participant interviews, and review of student journal drawings. Results and findings were analyzed using both qualitative and quantitative means.

The first outcome measure evaluated was the semi-structured interviews with the facilitators of Girls Tech (Appendix M). These interviews were intended to evaluate the effectiveness of the program on improving interest and comfort for girls in technology. These interviews were evaluated qualitatively using in vivo coding as a first cycle coding method, followed by versus coding. These forms of affective coding allowed for recognition of the voices of the facilitators and evaluation of the comparisons the facilitators made to their experiences with girls prior to and as the program progressed. Pattern coding was then used as an additional cycle coding method in order to draw on the themes present in the observations of the facilitators.

The second outcome measure was semi-structured interviews with the student participants (Appendix L) which asked students both open-ended questions and some loosely Likert-scale type questions (limiting to three options). As a result, ordinal data was collected and analyzed. In some cases the neutral option was expanded on through clarifying questions. The data collected in these Likert-scale type questions was then analyzed using descriptive statistics which was an ideal form of evaluating this data due to the relatively small sample size as well as the ordinal nature of the data. In addition, the open ended questions and clarifying questions were analyzed using in vivo coding as a first cycle coding method because it captured authentic participant voices while also identifying key concepts and themes without applying interpretation bias. Focus coding was used for second cycle coding to help synthesize and categorize the most frequent and significant codes. This allowed for a more analytical approach to viewing the data while still grounding the analysis in the participants' true voices. Focus coding found categories in the data set which revealed patterns and themes across multiple interviews. Together these two coding methods allowed for both individual voices to be preserved and the broader trends to be identified across all student participants.

The final outcome measure evaluated was pre and post implementation student drawings. These images were coded collectively pre improvement initiative and collectively post improvement initiative. The images were evaluated using visual and thematic analysis in order to identify patterns among the depicted characteristics with the following categories emerging: gender, race, apparel, accessories/environment, and activities represented. This allowed for the development of some categorical nominal data. Descriptive statistics was then applied which revealed themes to allow for comparison between pre and post images collectively.

Participants

The facilitators provided the data from the facilitator interviews used as a summative measure of the outcome. Three facilitators were interviewed. Each facilitator was a NC licensed, female, educator, with experience in STEM education. Three facilitators was a smaller sample size, although it was still a 3:8 teacher:student ratio. Having multiple facilitators gave access to various perspectives on the program implementation, impact, success, and growth areas.

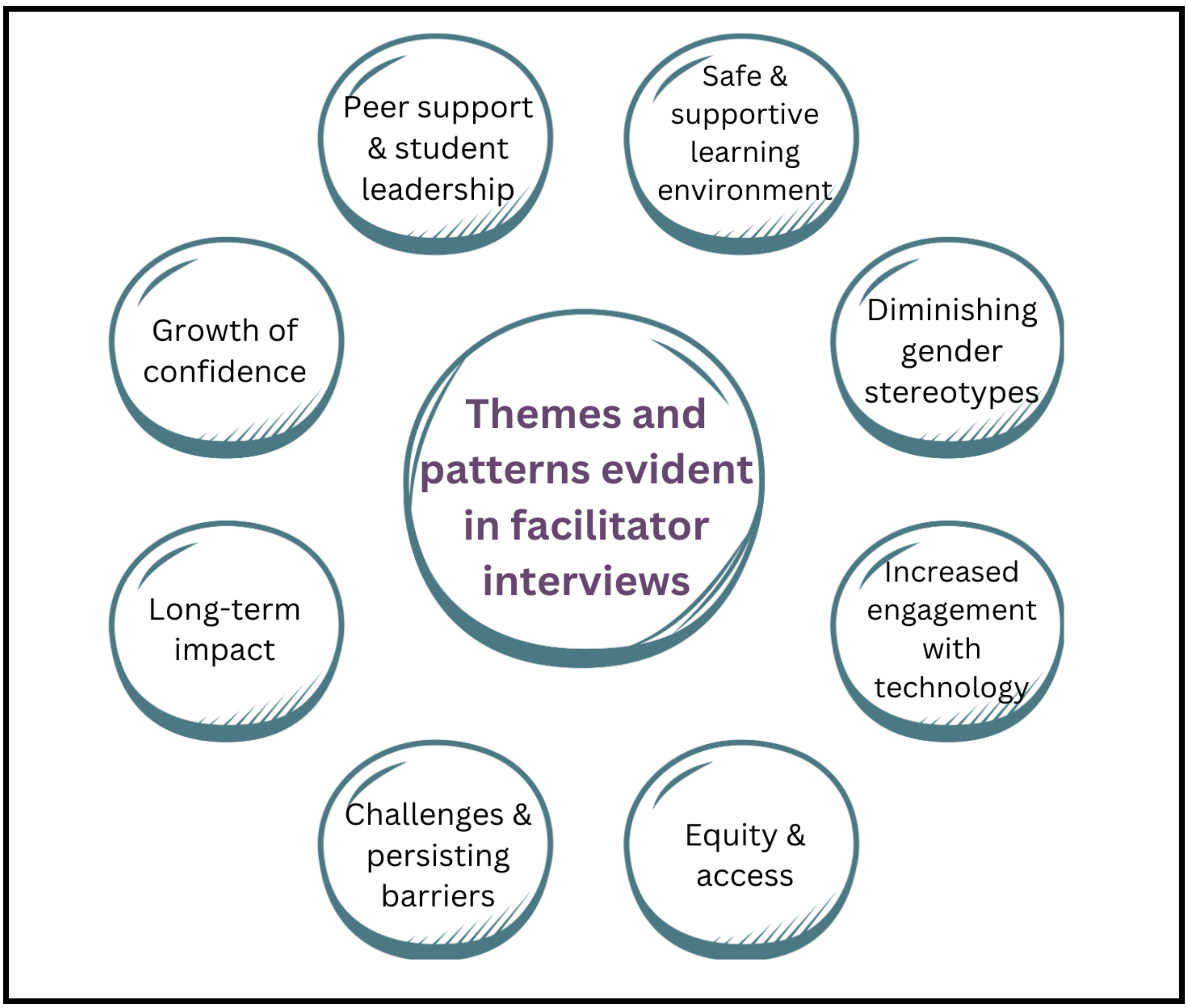
The student participants provided the data for the student interviews and the student drawings used as summative measures of the outcome. Eight students were interviewed as the conclusion of each session program. Each student was in grades three, four, and five and attended the same elementary school. This smaller sample size allowed for a more intimate experience for the students though it was recognized that it may limit the reliability of the data.

Results & Findings

Facilitator interviews as an outcome measure. Facilitator interviews were coded using in vivo coding as first cycle coding followed by both versus and pattern coding. Based on the facilitator interviews and survey questions, the Girls Tech program had a significantly positive impact on the student participants. The facilitators observed and reflected on notable growth in the student participants' confidence, skills, and interest in technology over the course of the program. Analysis of this data revealed patterns and themes represented in Figure 17.

Figure 17

Themes and patterns evident in facilitator interviews.



All three facilitators reported seeing an increase in confidence as the program progressed. One facilitator stated, “I could see the student participants' confidence grow in their willingness to be open in the things they were trying.” This growth was attributed to several factors, based on the themes evident in the interviews, including the girls only-environment, which facilitators believed “really helped” by allowing student participants to be “more comfortable taking risks and trying new things.”

The program also seemed to improve the student participants’ technology skills, particularly in coding. One facilitator noted that, “their skills with technology definitely grew, especially in that coding aspect.” The facilitators consistently alluded to the conclusion that the students became more open to being creative and less afraid of failure as the program progressed.

Another theme that highlights a positive outcome was the creation of a supportive, non-judgemental learning environment. The student participants “realized they were not going to be judged” which likely contributed to their exponential willingness to try new things, ask questions, and collaborate with their peers.

The summative interviews with facilitators suggest that the program did in fact challenge gender stereotypes in technology with one facilitator pointing out that they observed student participants engaging in technology activities in other settings and “they were not so willing to automatically assume that the boys might be right.” This shift in perspective that extended beyond the Girls Tech program counter space also included facilitators noting that student participants were taking on leadership roles in their regular, heterogeneous-gender classroom.

Peer-to-peer support and student leadership among the student participants, along with collaboration were important elements of the program according to the facilitator interviews. It was observed that the older student participants were quickly willing to help and support the younger student participants which boosted confidence and skills for both groups.

Observations by the facilitators, reported in the interviews, suggest that the program seemed to have sparked longer-term interest in technology among participants with one facilitator mentioning student participants discussing that they would participate in technology options when they go to high school, which indicates that the program was “planting those seeds” for future engagement and defining itself as an interest building opportunity.

Facilitators mentioned some challenges and barriers that perpetuated throughout the program. Specifically they mentioned resources to continue programs like this, logistics to allow students to participate while not eliminating their opportunity to engage in other opportunities, and the very significant barrier of transportation, which while provided during these sessions still proved to be a distraction as students often vocalized concern about who was picking them up or if they were supposed to be taking the school provided transportation home.

In summary, the facilitator interviews reflected an outcome of success in improving student participants' confidence, skills, and interest in technology while also addressing the broader issues of equity, access, and gender representation in STEM fields. The program's impact extended beyond the program sessions, influencing participants behavior and confidence with technology in their general classrooms. This suggests that the improvement work resulted in movement towards the aim or goal of the initiative which was to improve proportional representation of girls in technology engagement by creating counter spaces where girls can explore the interest without the burden of stereotypes.

Student interviews as an outcome measure. Student interviews were coded using in vivo and focus coding in order to provide insight into the student participants experiences and preferences, as well as identify the impact of the Girls Tech program on their confidence around and interest in technology. Additionally, some quantitative data were extrapolated from the interviews and were analyzed using various descriptive statistics. These analyses provided evidence to show if the aim is closer to being achieved.

Analysis of the student interviews revealed an empowering experience for the students. Themes identified through focus coding as being significant and frequent throughout the interviews (Figure 18) show significant student growth with confidence in taking risks and trying new things, interest in technology learning, and enjoyment of the counter space environment.

Figure 18

Themes and patterns evident in student interviews.

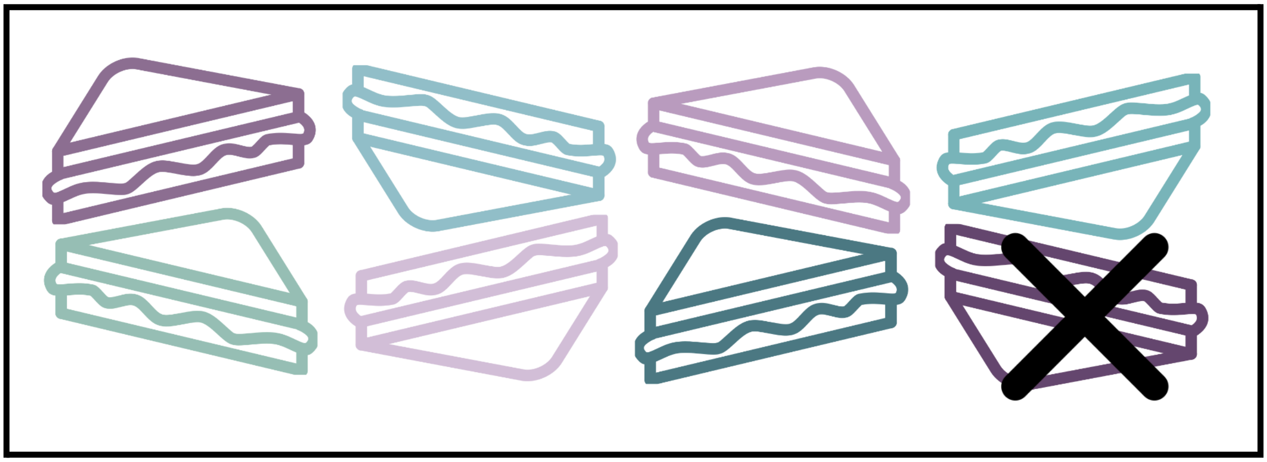
Students reported an increase in their confidence working with technology. One participant stated, “before it was like I didn’t know what to do, but after I entered the club, I could do everything.” This sentiment was mirrored by other student participants who felt more excited about and capable of technology learning after being in the Girls Tech program. 62.5% of student participants explicitly stated that they felt more confident or knowledgeable about technology after the program, indicating that the program helped them overcome their initial hesitations.

The girls-only environment was also a recurring theme, with some students (37.5%) expressing preferences for this setting, while 25% preferred mixed-gender, and 37.5% were neutral about which was their preference. One student stated, “I prefer girls only,” indicating that this counter space context fostered a sense of safety that encouraged participation. This builds on the remarks of the facilitators, described in the section above focused on how separating the girls seemed to make them appear more comfortable taking risks and trying new things.

Hands-on activities, particularly coding and robotics, were mentioned as favorites among the student participants. One student mentioned with excitement, “I liked when we got to code the robots!” Another recalled, “I liked when we used the apple pencils and coded stuff.” Many students expressed that the “Code a Peanut Butter and Jelly Sandwich” activity was one of their favorites, with 87.5% of participants mentioning enjoying this activity (Figure 19).

Figure 19

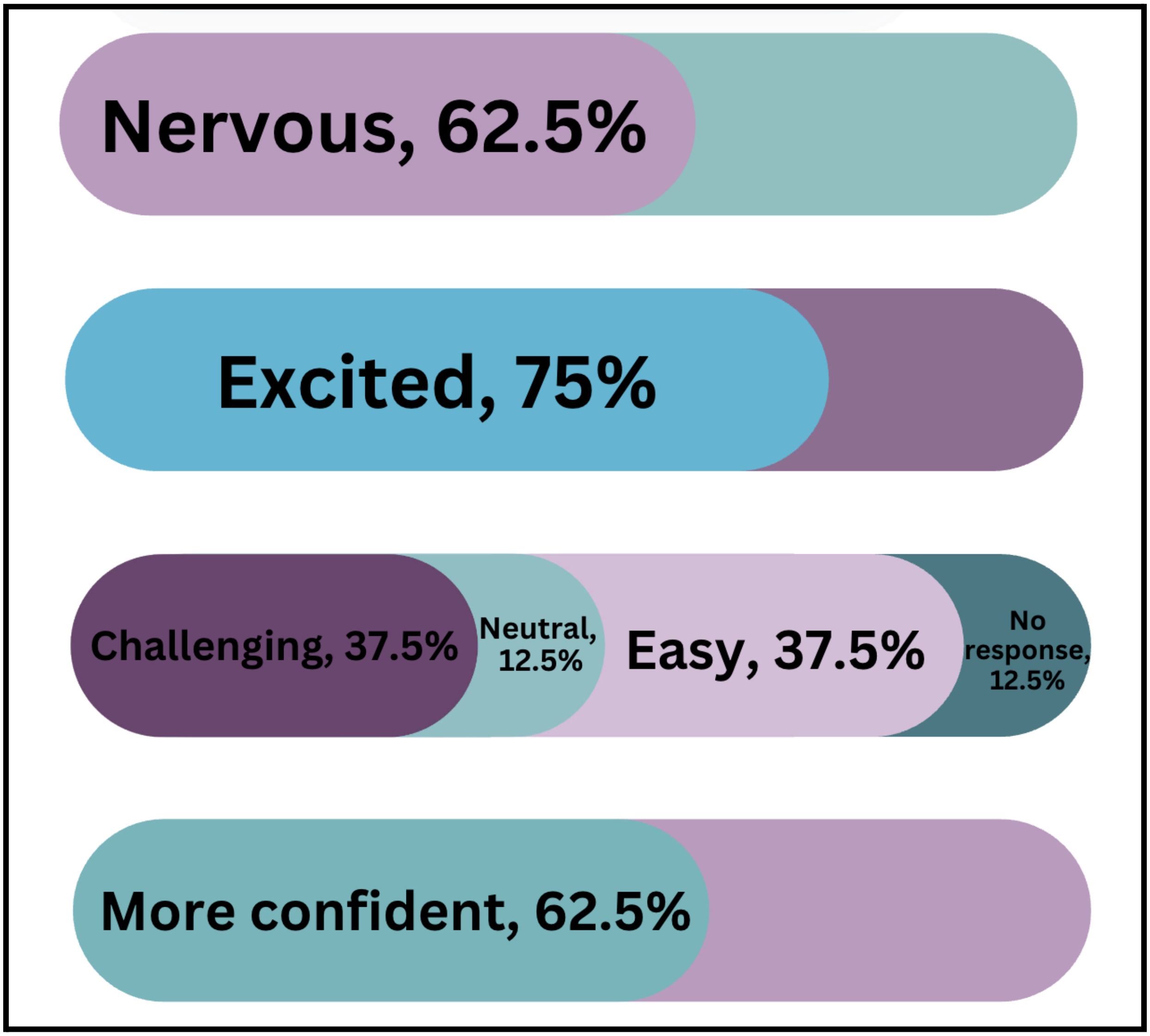
Student reflection on coding activity.



Students reported many of their feelings about the Girls Tech program sessions and the outcomes (Figure 20). Nervousness was mentioned by many students (62.5%), with one mentioning, “the first time I was nervous and then I got really excited and then I just got really happy once I got used to it (the sessions)...it just was really fun and once I got used to it, I just was like, I’m so excited for it each time.” Despite some challenges such as initial nervousness and struggles with some of the coding tasks, students demonstrated resilience and determination when working in this counter space. As one participant remarked, “It was hard trying to code at first, since I didn’t really know how to code, but then I got the hang of it and then I was more like a pro.” Another student stated, “Before it was like I didn’t know what to do, but after… I could do everything.” “Coding when we were doing the robots (was hard) because I kept like putting them in the wrong order and had to keep trying,” was mentioned by another student. This reflected student participants’ willingness to take on challenges during their learning.

Figure 20

Student feelings.

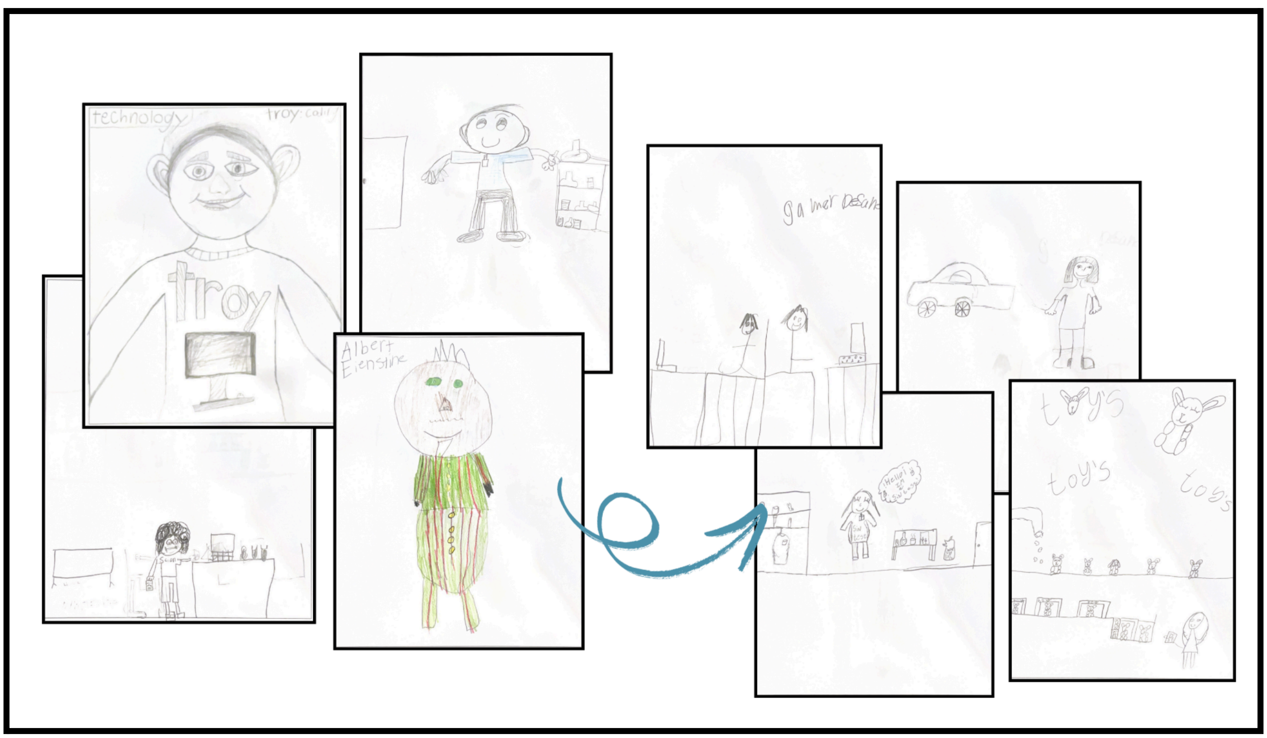


Overall, the interviews of student participants reveal that the Girls Tech program successfully fostered a learning environment and counter space where girls could gain confidence in their technological abilities while enjoying collaboration with peers and engaging, hand-on activities. The positive feedback from participants indicated a strong desire to continue to have access to and participate in Girls Tech or similar programs, which underscores the initiative's impact on the student participants interest in STEM fields which may perpetuate into high representation of girls in technology related educational programs and fields, the aim of this initiative.

Student drawings as an outcome measure. Student participants in the Girls Tech program were asked to complete a drawing both at the beginning of session one and at the end of session eight. The prompt said: “Draw a person who works in science/engineering/technology that shows what you know about their work.” These drawings were then analyzed for certain characteristics, including: gender, race/ethnicity, apparel theme, accessories/environment theme, and activity. Descriptive statistics were used to analyze these findings. In addition, qualitative thematic analysis unveiled some other nuances in the drawings (Figure 21).

Figure 21

Student drawing samples pre and post.

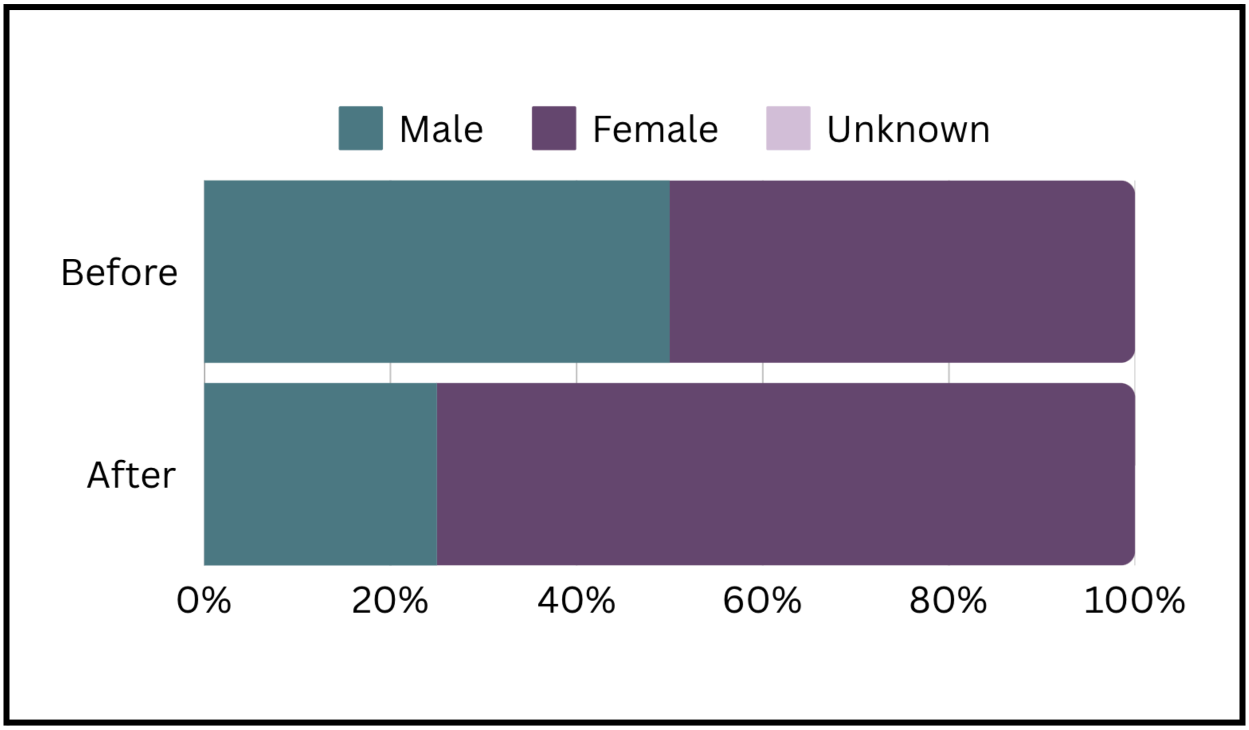


Genders observed in the drawings showed a significant shift in gender representation in the student participants' drawings after participating in the Girls Tech program, shown in Figure

22. Initially, 50% of drawings were female, and 50% were male, however after the program implementation 75% of drawings were female, and 25% were male. This shows a change in 25 percentage points. The initial data had a range of zero, while the mode of the post data was female with a range of four.

Figure 22

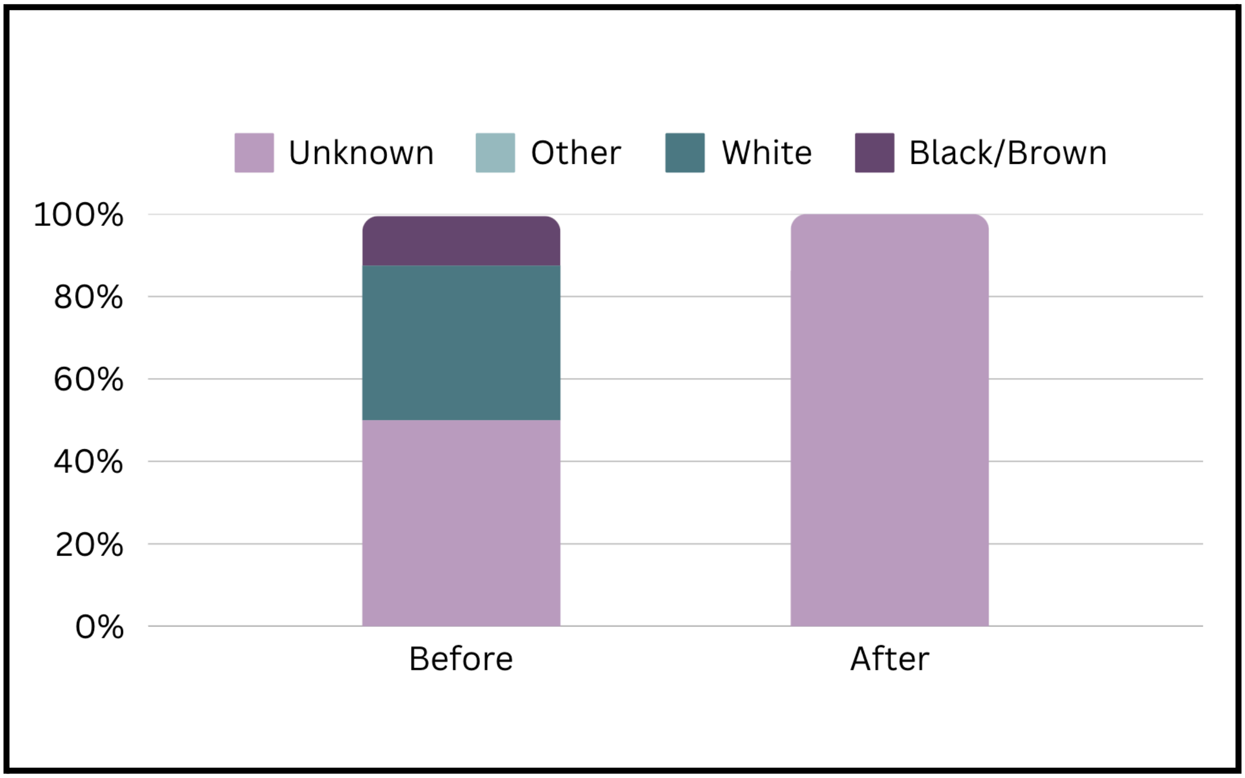
Gender depiction in drawings.



Analyzing the student drawings both pre and post for race/ethnicity shows a shift from some racial diversity depicted in the drawings to all drawings representing race that is unable to be determined (Figure 23). The mode for race for both the before and after implementation drawings is "unknown" while the range pre is four and post is zero. While it is impossible to determine why there was a shift in racial representation in the drawings, some potential reasons could be an increased focus on the gender, skills, accessories, and environment or due to random variation as opposed to an actual trend, given the small sample size.

Figure 23

Race depiction in drawings.

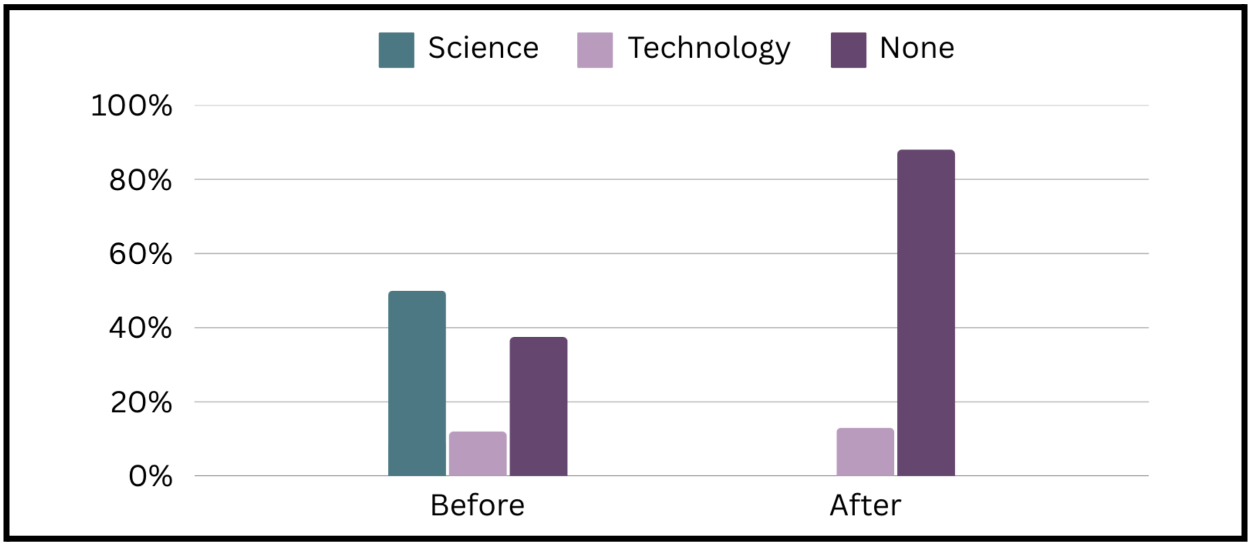


Student drawings were also evaluated for the themes of the apparel that person depicted is wearing (Figure 24) as well as the themes of their accessories/environment and activities (Figure 25).

Comparison of the pre and post drawings shows a complete disappearance of science representation in apparel. The mode in the drawings completed before the program was "science," and the mode after was "none," with a range for the pre data being three and the range for the post data being eight. Again there is no direct evidence that there is a reason for this shift and given the small sample size it may just be a random variation, but some possible reasons for this shift could be more focus being attended to the actual work and actions of the person, as opposed to their apparel.

Figure 24

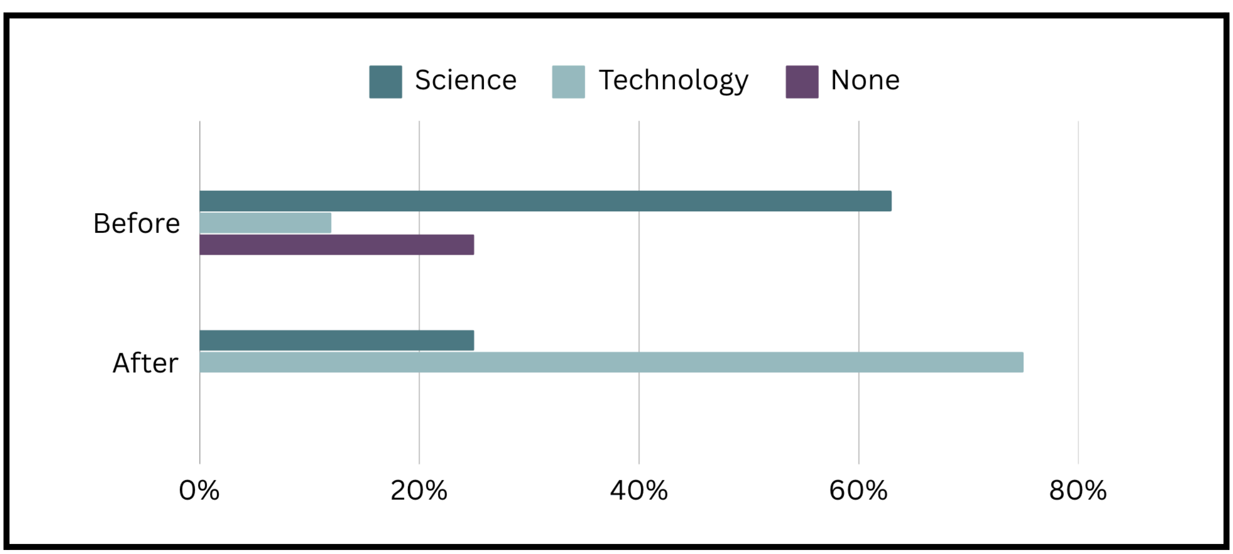
Apparel theme depiction in drawings.



Comparisons of the pre and post drawings with regards to the environment and accessories showed a significant shift from science themes to technology themes with a notable disappearance of a lack of accessories or environment. The results of this analysis suggested that student participants' focus had shifted to more technology-oriented careers.

Figure 25

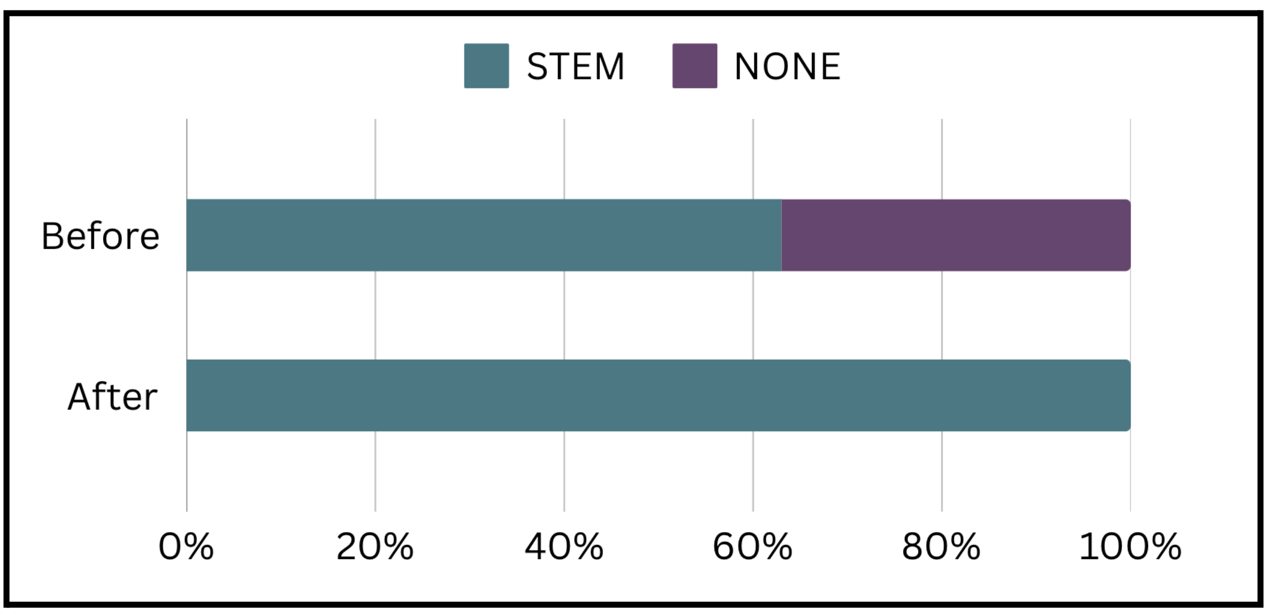
Accessories/environment theme depiction in drawings.



In some of the drawings it was evident what the person depicted was doing or what sort of activities they were participating in (Figure 26). Pre-implementation, 62.5% of the people depicted in the drawings were participating in some sort of STEM related activity. Of those, all were stereotypical science related activities (all were depicted with beakers, or similar glassware-type science equipment) except one that was technology related, showing a computer. In the post-implementation drawings 100% of the people depicted were participating in some sort of STEM activity and there was vastly more variety among those activities, with engineering, technology, gaming, manufacturing, and science all represented in different ways. In these drawings each depiction showed a different representation of a person working in science/technology/engineering, with the exception of two that were both demonstrating gaming, or game design.

Figure 26

Activities depicted in drawings.



The overarching changes in these drawings as an outcome measure of this improvement initiative showed a trend shifting towards more female representation, suggesting that student participants were beginning to self identify with these areas and recognize them as spaces for women and girls. This supported progress towards the aim of the initiative. The other shift that supported progress towards the aim of this improvement initiative was the shift to more diversity among the activities the people depicted in the drawings were participating in. This suggests that student participants developed a better understanding of the opportunities available to them in technology, both in their education and post graduation careers.

Limitations of the Findings

While the protocol established for the PDSA cycle was followed carefully, there were some limitations to the findings. These limitations include the smaller sample size, the short duration, the possibly of self-selection bias of the student participants, the potential for social desirability bias in the interviews, the limited demographic information, the possibility of bias and subjectivity in coding and analysis of qualitative data, the lack of standardized measures of technology skills and interest, the possibility of a novelty effect of participation in the program, lack of longitudinal data, potential facilitator bias, limited exploration of balance measures, and lack of parent/guardian perspectives.

The sample size of student participants was intended to be larger but there was limited access to students due to conflicts with other clubs and activities. The Girls Tech meetings were scheduled as much as possible, on days there were not other club meetings to allow the most access to participation. In addition, resources and space limited the sample size as well. There were a few findings that were hard to interpret. One example is the drastic change in race depicted in the student drawings which could not definitely be identified as a result of the program due to the small sample size and though women of color were represented in the lessons there was a lack of intentional discussion about racial diversity in technology. Additionally the sharp change in the theme of the people depicted in the drawings from pre to post, going from diverse themes to no themes evident cannot be effectively interpreted with reliability. The sample size of the facilitators, while small, was more than sufficient as a ratio to the student participant sample size but did lack racial diversity, though this was due to the lack of women educators of color in the district and that the focus of the study was solely on the female identity.

The results of this work can be interpreted in the affirmative of the goal of the program. This implementation of the PDSA cycle had an aim of improving the representation of girls in technology by moving the needle through counter spaces where female students can learn and engage in technology education without looming gender stereotypes. The findings of this improvement research indicates that the protocol could be transferable to other similar contexts to improve comfort and confidence for girls in technology and set them on a track to consider pursuing further engagement in technology learning.

Implications and Recommendations

Based on the results and findings and thorough analysis of the outcomes of this improvement initiative as well as evaluation of current literature and policy, several key implications and recommendations have been revealed. The Girls Tech program demonstrated significant positive impacts on girls' confidence, skills, and interest with technology, addressing the critical need for improved female representation in technology based secondary education, post-secondary education, and career pathways. However, the findings and subsequent analysis also revealed areas for improvement and further research. This section outlines implications and recommendations for practice, future research, and policy. These recommendations aim to build on the success of this counter space initiative as well as those represented in the current literature of a similar nature. The recommendations leverage the positive outcomes in this type of program as well as the policies, procedures, and funding already in place to support further improvement. These recommendations would allow educators, researchers, and policy makers to work towards improvement of representation of girls in technology and can be transferable to support other historically marginalized demographics as well.

Implications and Recommendations for Practice and Future Research

Based on the analysis of outcome data, the implementation of a counter space for girls to support interest building around technology and STEM is strongly recommended to elementary schools, and other STEM education advocates. In both driver and outcome measures, the program demonstrated a significant positive impact on the girls' confidence, skills, and interest in technology. This addresses the critical need to increase female representation in STEM fields.

The initiative created a safe counter space that allowed student participants to feel more comfortable taking risks and trying new things without the pressure of gender stereotypes. One facilitator mentioned, "separating the girls from the gentleman really helped." Students also reported feeling more confident and knowledgeable post implementation.

The protocol, pedagogy and curriculum of the program was carefully crafted, organized, and followed. This curriculum and pedagogy, when delivered during the Girls Tech sessions, resulted in high engagement and sparked greater interest in technology among participants. Students were exposed to real world opportunities to see future options for themselves in technology by visiting the high school technology lab. This exposure is crucial for maintaining interest as students progress through their education and consider career fields.

It is significantly notable that the initiative had lasting impacts beyond the Girls Tech program sessions. Facilitators observed the student participants become more proactive leaders in the regular classrooms when working specifically with STEM learning. This along with the shift in gender depiction in the student drawings from pre to post, challenges gender stereotypes and assumptions in a mixed-gender space. This suggests a shift in how student participants perceive scientists and technologists, showing more diverse and less stereotypical representations which can perpetuate that shift into their general classroom through the newfound confidence working with technology.

This type of initiative is particularly valuable for schools serving diverse populations, as it provides opportunities for girls who may have barriers preventing access to extracurricular STEM opportunities, or feel unsure about participating due to gender stereotypes. One facilitator of this cycle stated, "we had a really cool population of kids…some of our students who don't have these things at home, who don't have extra curricular options, they were able to participate." In order for that outcome to perpetuate it is recommended that protocols for removing barriers persist, including intentional marketing of the program, no cost enrollment in the program, and provided transportation.

By recommending this initiative to other similar contexts, the gender gap in STEM fields can begin to be addressed during the early, interest-forming years for students, fostering confidence, skills, and interest in technology among younger girls. Based on the driver and outcome measures, this approach has the potential to create a more diverse and equitable representation in STEM secondary, post-secondary, and career opportunities.

This work represents the first cycle of the improvement initiative and more cycles of improvement must occur in order to continue and sustain the work. Considerations for adjustments to the program in order to improve its overall effectiveness, include: scaling the program, acquiring funding sources, providing compensation for the facilitators, refining the data collection methods, addressing transportation barriers, extending the program duration, diversifying activities in the curriculum, formalizing the student leadership and collaboration, incorporate more exposure to women in the field and further educational and career opportunities, family involvement, address additional barriers such as race and socioeconomic status through data collection, and conduct more longitudinal research.

These next steps in future cycles can continue to improve the overall effectiveness of the program in making progress towards the aim of the initiative and will address sustainability barriers such as personnel, resources for activities, access to broader demographics and larger sample sizes. Efforts have been made in order to ensure that this work persists in the local context. This includes access to funding for one additional year of programming which would allow multiple cycles of the Girls Tech program to reach more students and for facilitators to be compensated in future cycles as well as pay for additional resources and materials.

Implications and Recommendations for Policy

This program addresses requirements outlined in local, state, and national educational policy. Requirements for fulfillment of these expectations as well as support for the educators delivering this type of programming, include both fiscal support and training support.

The Every Student Succeeds Act (ESSA, 2015) allows for the use of federal funds for technology and computer science education programs. The national Computer Science for All (CSforAll) initiative encourages states to develop computer science standards and develop teacher training on those standards. Standards for computer science and technology education have developed both at the national and state level including: Next Generation Science

Standards, International Society for Technology in Education Standards for students and educators (which have been adopted by NC), NC Portrait of a Graduate standards, as well as several career and technical education programs with standards of learning developed for NC.

At the state and local level expectations and support have been integrated into policy and procedure. These include The North Carolina Digital Learning Plan, access to Career and Technical Education pathways, and MACS board policy 3220.

Ameliorating the lack of proportionate representation of girls in technology requires more than just policy, it requires funding to support that policy through personnel and resources. Currently the state of North Carolina distributes approximately 650,000 annually in grant funding to approximately 10-15 districts for enhancement of digital teaching and learning through district level programs that implement the NC Digital Learning Plan (Appendix A) as well as NC Portrait of a Graduate Standards (Appendix D) and ISTE Standards for students (Appendix B) and Educators (Appendix C). These grants are provided by the NC Digital Learning Initiative. The NC Digital Learning initiative work is completed through support from the NC Legislature, specifically, HB 1030, SB 257, and SB 99. A proposed adjustment to this policy that would allow for further enhancement of work to encourage progress for girls in technology, through programs such as the Girls Tech program in this improvement initiative, is to re-evaluate how those funds for digital learning are distributed. In a state with 115 school districts the current method of distribution of Digital Learning Initiative funds vastly limits funding for many students and access to grant funding requires staff who have the time and resources to write the grants and then implement and report on them. This is a barrier for many districts, who are stretched thin with personnel due to budget shortages. While this proposed policy/procedural adjustment is actionable immediately, other recommendations for policy change and development that would build on the success of this improvement initiative include:

- Expand access to girls-only STEM initiatives through funding, development, and support.
- Address transportation barriers for students with regards to extracurricular activities at school.
- Require and support the integration of technology skills into the core curriculum with fidelity.
- Provide professional learning for educators as well as time and resources to plan new and innovative learning experiences.
- Encourage family engagement in STEM education through policy and funding.
- Revise assessment methods of the implementation of the existing policy and expectations.
- Address equity in STEM education through programs accessible to diverse populations.
- Develop policy requiring federally funded universal wifi and state funded 1:1 technology for NC public school students.

Leadership Lessons Learned

The research findings and process of implementing this improvement initiative yielded several important leadership lessons. These lessons include: the value of safe spaces, the impact of high engagement learning, the value of peer collaboration, unaddressed logistical barriers, necessity of a growth mindset, unaddressed implicit bias, the power of cross curricular integration, the need for and value of diverse representation, the necessity of analyzing demographic data for educational leaders, the need to measure and communicate results.

This implementation emphasized the importance of safe spaces that were reiterated consistently in the extant research. As a leader, it is necessary to both recognize and address implicit biases in self and contexts in which the leader has influence. One way to do that is to create a space that allows those marginalized to feel a sense of belonging without fear or risk of bias or stereotype. In educational leadership, a way this can be done is to consistently collect and evaluate demographic data and take action to address discrepancies in proportionate representation of various demographics. Facilitators of this program even noted their own biases being challenged which is evidence that as an educational leader, it is essential that there is open dialogue about historically marginalized groups, why they are marginalized, and what can be done to improve that. This will ensure more diverse representation which is beneficial in every way.

As a leader, addressing logistical barriers is often overlooked or avoided due to the fact that this can sometimes come at a fiscal cost. While the federal government requires buildings be ADA compliant and accessible to those with disabilities, there are no requirements to create access to programs and activities. As a leader it is essential to remember that just because an opportunity allows for anyone to sign up, that does not mean it is actually available to all. Barriers, such as transportation (as well as psychological barriers like bias and stereotypes) prevent students from participating in many opportunities offered after school.

Another leadership lesson learned was the value of supporting educators in order for them to support this critically conscious work. Educators need access to resources but they also need access to professional learning and planning time in order to implement more powerful and lasting learning in their classroom through the use of high-engagement, relevant, and high impact pedagogy.

The final leadership lesson learned was the value and necessity to measure and communicate the impact of change. The program's success was evident through various measures. Leaders should implement robust evaluation methods in order to identify discrepancies with access and also to demonstrate the value of their initiatives.

The evidence of the impact of social construction and power relations, explained in the literature, showed through in this improvement initiative. The potential barriers were in fact legitimate barriers and the implicit bias and stereotypes anticipated were evident throughout the implementation and were addressed using protocols grounded in existing research. As a result a clearer picture of the inequitable distribution of opportunity and access which is a result of these social constructs and power relations was established. Viewing and reflecting on this unfair access in person resulted in being more critically aware of similar inequities and barriers in other contexts as well. This awareness can and will improve critical consciousness in leadership.

This change played a role in justice-oriented reform in the local context by establishing a prepared Girls Tech program and engaging the facilitators in social justice and equity work. The Girls Tech program challenged gender stereotypes and biases, increased access for underserved students, empowered marginalized voices, addressed intersectionality, enacted transformative practices that promoted critical consciousness and addressed structural barriers, and encouraged student agency and reflective practice.

The impact of this improvement should extend beyond the eight students not only through future cycles of the program but also through the learning of the facilitators who were provided the opportunity to reflect on the power of a counter space and notice instances where there is not fair distribution of access and opportunity for all students. The implementation of the program not only showed an effective way to improve female student engagement through making a microlevel change towards dismantling oppressive practices that marginalize women in certain spaces, but also gave evidence that there are demographics of students that do not have the opportunity to participate in any type of extra curricular learning opportunity due to psychological barriers such as stereotype threat and and logistical barriers such as transportation. 75% of the student participants had never participated in an after school extra curricular and informal observations noted that more than half of the students participating required school provided transportation to get home after the club. This evidence suggests the need to consider systemic change to how educational settings provide access to extracurriculars through methods that make the opportunities attainable and recommended with careful planning and use of resources in this particular context.

As an educational leader, the scholar-practitioner of this improvement project must consistently reflect on how their actions, leadership, strategies, and interpersonal working relationships might contribute to or remove barriers that are the result of foundational social constructs and power dynamics in the current culture.

Conclusion

A disproportionate representation of girls exists in technology offerings in K-12 educational settings on a national level and despite improvements in an emphasis on STEM and computer science, the US continues to see a steady decline in the representation of girls in educational technology (Dasgupta & Stout, 2014). National data re-emphasizing this discrepancy (Girls Who Code, 2019), highlights the urgent need to continue to address this issue. The state and local context mirrors this underrepresentation. Despite efforts at the local level to promote equitable access for all students, historically marginalized groups continue to be underrepresented in many spaces. Persistent stereotypes and biases create barriers for girls' participation in technology education (Archer, et al, 2012). This critical issue is best addressed during the interest forming years of elementary school (Cheryan et al, 2015 and Sullivan & Bers, 2019) by creating true access through the removal of barriers in order to also ameliorate the disproportionate representation of women in technology-based postsecondary and career paths (Gorman, 2019 and Hughes, Schellinger, & roberts, 2021).

This problem is evident in extant literature and national demographic data and should be addressed through a critical lens. The critical work of improving the disproportionate representation of girls in technology was grounded in post structural feminist theory (Weedon, 1987) and Black feminist theory (Collins, 1999). According to Capper (2019) these theoretical frameworks highlight this problem as the result of patriarchal structures and cultural gender norms, along with male privilege. This study emphasized the importance of considering root causes, including logistical barriers, marketing stereotypes, program availability, and teacher capacity. All of these must be viewed with the underlying critical issues of deficit thinking, biases, stereotypes, intersectionalities, and cultural capital in mind.

The improvement initiative, an afterschool program named, Girls Tech, was designed as a counter space for girls to engage in technology learning. The development of this program considered the causes and barriers above as well as best practice according to extant research, including delivering this program in a counter space (Ong, et al., 2018 and Edwards & King, 2023) specifically for girls, and providing female role models (Stout, 2010) as facilitators.

The implementation followed an improvement science methodology, utilizing a Plan-Do-Study-Act cycle which supports continuous improvement and the ability to make adjustments to the initiative throughout the implementation based on formative results. This research design collects data in the form of driver measures, process measures, balance measure, and outcome measures in order to comprehensively assess the program's impact both formatively and summatively. In this improvement project, these measures provided qualitative and quantitative data through interviews with participants, surveys, checklists, and journal entries. The study used various coding methods including in vivo, versus, pattern, and focus coding to evaluate the qualitative data, while descriptive statistics was used for quantitative analysis.

The results and findings of the Girls Tech program implementation suggest a significantly positive outcome with regards to progress towards the aim of improving proportionate representation of girls in technology education offerings. The outcomes showed improvements in the student participants in areas such as confidence, interest, and skill as it relates to technology. The results also indicate improved self efficacy, student leadership, risk-taking and other social and problem solving skills that can be extended beyond technology education.

Formative data collected throughout the initiative through facilitator surveys showed a consistent improvement across all indicators. This formative data also uncovered the need to make adjustments to pacing and time in the program. Process measures, collected through a checklist suggests that the program was implemented as design with high fidelity indicating most planned tasks were carried out in all sessions with only minor adjustments to the pacing due to time constraints. Balance measures gave evidence that the program did not drastically disrupt other activities with most student participants reporting they would have been engaged in unstructured, or leisure activities if not participating. This suggests the program provided a very valuable opportunity for these student participants.

Summative data, collected in part through facilitator interviews, completed at the end of the final session of the program alongside comparison and reflection on the three facilitator surveys collected throughout consistently reported increased student participant engagement and enthusiasm as the program progressed. The facilitator data also indicated a growing comfort with technology tasks, willingness to take risks, and improved problem solving skills.

Student participant interviews as well as student drawings were completed at the conclusion of the program as an outcome measure. These revealed feelings of excitement, confidence, and the desire to continue participating in the program or similar activities. Participating students expressed a newfound enjoyment of coding and robotics and indicated the girls only environment was preferred. Student drawings compared pre and post implementation showed notable changes in how the students perceived people work in STEM. There was a significant increase in female representation as well as a drastic increase in diversity of careers and activities represented in the drawings which suggests a positive improvement in both participants' understanding of options for careers associated with STEM as well as the perception of a woman's role in these spaces.

The data uncovered some challenges as a result of the planning, pacing, and protocols which will be used for future areas of improvement. Most of these were logistical or time management needs and were evident in the driver and process data collected through the checklists and surveys.

While there is a lack of longitudinal data in the results from this single PDSA cycle, there were some suggestions of lasting impact in facilitator observations. The potential for scaling the program and evaluating long term impacts would provide further data as to the outcomes of this or similar programs. This work would be done using the suggested adjustments for time allotted and adjustments to the curriculum to more significantly emphasize marginalized voices in the area of technology.

The results of this improvement initiative cycle strongly align with the extant research as well as the work that has been or can be done in the national context where early exposure, countering stereotypes, and addressing systemic barriers are necessary in order to make an impact on this problem of practice at a national level.

The ultimate aim of this initiative was, at its foundation, intended to be culturally responsive and address critical causes to these types of problems. Girls Tech may have only made a microlevel change but it did address several social justice issues. This improvement project addressed systemic inequities by confronting and shining light on the lack of proportionate representation of girls and women in technology fields. The creation of the counter space for girls challenged stereotypes and biases that tell girls that technology is not for them and that boys are better than girls at technology related activities. This counter space also empowered marginalized voices of girls by making them the priority, Girls Tech procedures and protocols also considered the intersecting identities of the student participants by removing barriers that might prevent access to this program which aligns with social justice principles. An unintended but powerful outcome, with regards to critical consciousness is the reflective practice that took place among the facilitators who expressed a higher awareness of systemic barriers and the use of strategies that elevate marginalized people into spaces they have been previously excluded. These outcomes will inform policy and practice, having a lasting impact in the local contest and providing evidence that the strategies implemented as well as attending to continuous improvement and reflection can move the needle towards a more socially just education system.

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List of Appendices

Appendix A: North Carolina Digital Learning Plan

NORTH CAROLINA
DIGITAL
LEARNING PLAN

Detailed Plan
August 2022

Prepared by the Digital Teaching and Learning Division,
North Carolina Department of Public Instruction

North Carolina Department of
PUBLIC INSTRUCTION

NORTH CAROLINA
DIGITAL
LEARNING PLAN

Detailed Plan
August 2022

Background

In 2015, in response to North Carolina Session Law 2016-94, the original NC Digital Learning Plan (NC DLP) was developed. The plan included findings related to the current landscape of digital learning in North Carolina and outlined goals and recommendations for state-level leadership that supported growth and continuous improvement of digital-age learning in the state. The North Carolina Department of Public Instruction (NCDPI), in collaboration with the Friday Institute at North Carolina State University (FI), established focus area working groups aligned with the NC DLP goals. Over the following years, these working groups further defined strategies and action items of the NC DLP and focused efforts to implement what became known as the NC Digital-Age Learning Initiative (NC DLI).

Since 2015, the landscape of digital learning in North Carolina has evolved dramatically. Many of the goals included in the original NC Digital Learning Plan have been accomplished, have demonstrated progress, or have been refined as needed, informed by the ever-evolving nature of a digital world and the specific needs of our public school units (PSUs). Additionally, the pandemic accelerated the development of digital learning environments and amplified the need for a continued commitment to growth and improvement of digital-age learning in North Carolina.

This iteration of the North Carolina Digital Learning Plan is designed to build upon the progress of the original NC DLP as well as strategically address the current landscape and needs of PSUs across the state. Requirements from NC Session Law 2016-94 are included within the plan, and feedback and recommendations from stakeholders and strategic partners have informed the development of state, PSU, and school-level objectives and strategies. Relevant data and research, evidence-based practices, related to legislation and policy, and alignment with North Carolina State Board of Education strategic goals and NCDPI initiatives have also informed the development of the NC DLP.

Purpose

The North Carolina Digital Learning Plan is designed to provide a framework for growth and continuous improvement in the area of Digital Teaching and Learning for the Department of Public Instruction (DPI), public school units (PSUs), and schools across the state. This plan and the materials provided with it are not intended to be evaluative in nature. It is intended to share researched best practices that impact student learning experiences and offer a common language to shape conversations. Opening these types of discussions around how to improve digital teaching and learning practices can support the creation of effective action plans. The heart of the NC DLP is to create transformative student learning experiences enhanced by digital teaching and learning. Growth through the implementation of this plan will create outcomes for students who will be successful in a digital world with the skills, knowledge, and dispositions needed to be knowledge constructors, innovative designers, computational thinkers, creative communicators, and global collaborators.

Digital Learning Plan Framework

The 2022 Digital Learning Plan includes a central focus on student learning experiences and is composed of five connected categories based on researched best practices in educational technology and the most recent frameworks for successful digital teaching and learning in the K-13 environment.

Central Focus of the Plan

The student learning experience is the central focus for the 2022 Digital Learning Plan. Each category, goal, objective, and action within this plan works toward creating the best possible learning experience for North Carolina scholars. Through the implementation of action steps written in alignment with this Digital Learning Plan, students will become knowledge constructors, innovative designers, computational thinkers, creative communicators, and global collaborators through student-centered learning.

Each of the 5 categories identified within the framework of this plan relate back to this central focus in the following ways:

Leadership and Vision
Leadership and vision provide the necessary ingredients to create productive learning environments that support student engagement.

Human Capacity
By providing appropriate support through human resources and professional learning, instructional staff is better equipped to create student-centered learning environments that allow flexibility and focus on the needs of individual learners.

Curriculum, Instruction, and Assessment
Student learning outcomes are improved greatly through the alignment of curriculum, instruction, and assessment.

Data Privacy and Cybersecurity
As students begin to use more digital resources, data privacy and cybersecurity are necessary to ensure that students have a positive learning experience while remaining safe and secure.

Technology, Infrastructure, and Devices
Technology, infrastructure, and devices provide all students an opportunity to learn with modern technology that is supported by high speed internet and equitable access.

Action Plans

To ensure that resources, projects, and programs established in alignment with the digital learning plan effectively meet the goals and objectives in a way that positively impacts the student learning experiences of North Carolina's K-13 scholars, action plans will be provided yearly to the State Board of Education. Yearly action plans enable the Department of Public Instruction to evaluate resources, projects, and programs on an ongoing basis and make adjustments according to the latest data available. These plans will include:

1. **Data Analysis:** A data analysis of resources, projects, and programs that were implemented in alignment with the digital learning plan along with other annual data collected from PSUs
2. **Current Year's Action Plan:** A comprehensive plan that includes, but is not limited to:
   - plans and timelines for resource creation, curation, or review
   - descriptions of projects and anticipated timelines
   - descriptions of programs, associated activities, and anticipated timelines
3. **Upcoming Year's Anticipated Action Plan:** A summary of longer range plans that are intended to be implemented, but may be adjusted according to data from the current year's action plan data analysis.

By taking this yearly approach to action planning, the Department of Public Instruction can ensure that the resources, services, information, timeline, funding, and human capacity required are available for sound implementation. Additionally, if there are any major shifts or disruptions the action plan can be adjusted to meet the immediate needs of K-13 students, families, and staff.

Student Learning Experiences and Outcomes

By improving the learning experience, outcomes improve dramatically and equip students with the necessary skills, knowledge, and experiences to positively thrive in an ever changing world. The NC DLP will also provide direction for PSUs and schools to evaluate and modify current plans, practices, and procedures to ensure alignment by embedding digital teaching and learning experiences that improve the student learning experience.

CATEGORY 1

LEADERSHIP & VISION

Leadership and vision are paramount to the success and continuous improvement of schools and students. Leadership involves effective planning and execution as well as communication and reflection, to ensure that the student learning experience is the focus of all instructional decisions. Vision governs actions that result in achieving goals and desired student outcomes.

Goal 1 – A shared vision for digital teaching and learning is established and communicated with all stakeholders.

Department of Public Instruction Objectives:

- A state-wide vision for digital teaching and learning is communicated with all stakeholders through various methods.
- NCDPI provides resources that align all state-level plans and priorities.
- Resources that align to state-level plans are refined on a specific and defined schedule to ensure digital teaching and learning goals and action steps are meeting state and PSU needs.
- Resources for developing a strategic vision for digital teaching and learning along with professional learning opportunities and personalized support are available to PSUs as they establish and refine their own vision and plans.

Public School Unit Objectives:

- A vision for digital teaching and learning is created by a diverse group of stakeholders that represent various roles throughout the PSU.
- A vision for digital teaching and learning is communicated with all stakeholders through various methods
- A vision for digital teaching and learning is an integral part of the PSU's strategic plan.

School Objectives:

- A school-wide vision for digital teaching and learning is created by a diverse group of stakeholders that represent various roles.
- The school's digital learning plan is an integral part of the school improvement plan.
- A school media and technology advisory committee is utilized to plan, implement, and assess the success of the school's digital learning plan.

Student Impact:

- Having an effective digital teaching and learning plan in place and supported by all stakeholders ensures that all students receive a transformative education enhanced by technology.

Goal 2 – Effectively plan and implement action steps to carry out the shared vision.

Department of Public Instruction Objectives:

- A plan of action has been created and presented to the State Board of Education to include all of the following: data analyzing the success of the prior year's action plan, the current action plan, and the anticipated action plan for the following year.
- A plan of action that addresses all goals and objectives of the Digital Learning Plan has been created and is being implemented.
- The plan of action was created after carefully evaluating all relevant metrics for each DLP goal and objective to include, but not limited to: the DLMI, data from project and program implementations, data provided through statewide program analytics, and data provided through partnering organizations.

Public School Unit Objectives: • A plan of action that aligns to the vision has been created and includes all of the following: data analyzing the success of the prior year's action plan, the current year's action plan, and the anticipated action plan for the following year. • The plan of action was created with a team of diverse stakeholders. • The plan of action was created after carefully evaluating all relevant metrics to include data from multiple sources.
School Objectives: • A school-wide plan of action that aligns to the vision has been created and includes all of the following: data analyzing the success of the prior year's action plan, the current year's action plan, and the anticipated action plan for the following year. • The plan of action was created with a team of diverse stakeholders. • The plan of action was created after carefully evaluating all relevant metrics to include data from multiple sources. These sources may include but are not limited to: the PSU's DLMI data, Digital Learning Progress Rubrics, data from project and program implementations, data provided through program analytics, and data provided through partnering organizations.
Student Impact: • Processes and procedures are created with appropriate resources and support allocated to maximize every student's ability to use technology effectively to improve learning outcomes. • Through the collection and analysis of data, formation of effective partnerships with stakeholders, and outline measurable goals, each student has the opportunity to learn in a high quality digital teaching and learning environment.

CATEGORY 2

HUMAN CAPACITY

Human Capacity is the keystone to ensure that the classrooms of North Carolina's public schools are places of opportunity, innovation, and academic achievement. Through building and expanding the skills, knowledge, and available resources, challenges can be overcome to maximize student success.

Goal 1 – All staff have continuous access to quality professional learning that is utilized and accessed on a regular basis for continuous growth.

Department of Public Instruction Objectives:

- Professional learning opportunities for digital teaching and learning are available for all PSU leaders, school administrators, teachers, coaches, School Library Media Coordinators, and technicians.
- State-wide and regional data is assessed and used to design state-wide and regional job specific professional learning opportunities for digital teaching and learning.
- Resources for developing personalized professional learning and individualized support are available to PSUs as they create professional learning that aligns with their vision and meets the needs of their teachers.
- Partnerships with organizations that support professional learning are established, resources provided are aligned with the Digital Learning Plan, and impact and/or use data is assessed and shared.

Public School Unit Objectives:

- Professional learning opportunities for digital teaching and learning are available for all PSU leaders, school administrators, teachers, coaches, School Library Media Coordinators, and technicians.
- Professional learning is personalized to meet staff needs and includes all of the following: active learning, coaching, feedback and reflection, and choice.
- Data is assessed and used to design job specific professional learning opportunities for digital teaching and learning.

School Objectives:

- Professional learning for digital teaching and learning is offered to school staff and includes all of the following: alignment with the Digital Learning Competencies, Digital Learning Standards for Students, coaching, feedback, reflection, and choice.

Student Impact:

- Students benefit from having well trained classroom teachers and other educators who effectively use technology to create transformative learning experiences.
- By having educators who model growth and a willingness to continue to learn, students learn the value of productive failure and its importance to a growth mindset.

Goal 2 – There is consistent and equitable access to Instructional Technology Facilitators and School Library Media Coordinators to support the implementation of digital teaching and learning strategies.

Department of Public Instruction Objectives:

- Research, resources, and personalized support is offered to PSUs as they utilize the Instructional Technology Facilitator and School Library Media Coordinator positions.
- Professional learning and a strategic, data-driven, professional learning network is in place for Instructional Technology Facilitators.
- Professional learning and a strategic, data-driven, professional learning network is in place for School Library Media Coordinators.

- Reports are prepared for the general assembly, state board of education, and the field that captures current data regarding these roles in North Carolina schools, research around best-practice for these roles, and action step recommendations.

Public School Unit Objectives:

- There is a minimum of 1 full-time Instructional Technology Facilitator at each school location.
- There is at least 1 full-time School School Library Media Coordinator at each school location on a fully flexible schedule.

School Objectives:

- There is a full-time Instructional Technology Facilitator at the school who is on a fully flexible schedule.
- There is a full-time School Library Media Coordinator at the school who is on a fully flexible schedule.

Student Impact:

- Through having experts trained in instructional technology, students maximize their ability to have access to and use technology for an enhanced learning experience.
- The student learning experience is improved from having well trained teachers who have access to various expert personnel to support digital teaching and learning, trouble shoot, and serve as thought partners.

Goal 3 – Technical staff is available to effectively support all staff and students with minimal disruptions to teaching and learning.

Department of Public Instruction Objectives:

- Research, resources, and personalized support is offered to PSUs as they structure their technical staff positions.
- Professional learning and a strategic, data-driven, professional learning network is designed for technical staff.
- Prepare reports for the general assembly, state board of education, and the field that captures current data regarding these roles in North Carolina schools, research around best-practice for these roles, and action step recommendations.

Public School Unit Objectives:

- There is a ratio of 1 technical support staff member for every 800 devices within the PSU.
- There is enough technical support in place to ensure that an average wait time for repair tickets to be assessed and serviced is 24 hours or less.

School Objectives:

- There is enough technical support in place to ensure that an average wait time for repair tickets to be assessed and serviced is 24 hours or less.

Student Impact:

- In having well trained technicians who can quickly diagnose and respond to device issues, disruption to student learning is minimized.

CATEGORY 3

CURRICULUM, INSTRUCTION, & ASSESSMENT

Curriculum, instruction, and assessment are necessary components to engage students and create transformative learning experiences enhanced by digital teaching and learning. Curriculum is the driving force for what students learn in the classroom while instruction describes the delivery methods that engage students in learning. Assessment allows for the determination of what students have learned.

Goal 1 – All staff have access to and use digital content that is continually vetted and aligns with curriculum and assessment expectations for student learning ability levels.

Department of Public Instruction Objectives:

- Provide resources, professional learning, and personalized support to DPI divisions and PSUs on the topics of access and useability.
- Provide resources, professional learning, and personalized support to PSUs on Homebase products.
- Provide research, resources, and professional learning on healthy relationships with technology and digital content.
- Provide research, resources and personalized support for evaluating digital resources that assess content for alignment with curriculum standards.
- Research, resources, and professional learning offered are on a regular and documented refresh and review cycle.

Public School Unit Objectives:

- 100% of all digital resources meet accessibility needs of students.
  or
  There are equivalent resources that meet needs to supplant resources that do not meet accessibility needs.
- Interoperability standards are documented and 100% of the digital resources utilized in the PSU meet these standards.
- All digital learning resources are a part of a fully funded sustainability plan.
- Digital resources are a part of a documented and continuous review process that includes all of the following: data analysis of usage, analysis of impact, and documented action steps to keep, improve, or remove these resources.

School Objectives:

- School purchased digital content is on a documented and continuous review process that includes all of the following: data analysis of usage, analysis of impact, and documented action steps to keep, improve, or remove these resources.
- All staff are aware of digital resources they have access to use with students, understand how to use the resources to improve student learning, are provided professional learning around using the resources effectively, and know where to direct questions about digital resources.

Student Impact:

- Digital resources that support students learning connected to curriculum standards ensures that students are learning what they should be learning while accessing the appropriate materials needed to show mastery of those standards.
- Resources are provided to support learning at various levels allowing for each student to receive a transformative learning experience enhanced by digital teaching and learning.
- Educators are well trained in the type of digital resources available and empowered to make the best possible choices to support students who learn at different levels and in different ways.

Goal 2 – Supplemental resources are available to staff and students through physical and digital collections.
Department of Public Instruction Objectives: • Research, resources, and personalized support is provided for physical library spaces. • Resources, professional learning and personalized support is provided for digital library collections. • Data around physical and digital library access for students is collected, analyzed, shared, informs the Digital Learning Action Plan for DPI, and is disseminated in personalized reports for regions and PSUs.
Public School Unit Objectives: • The PSU has a documented library collection plan that is supported by sustainable funding, includes a data informed review process of materials, and gathers input from stakeholder groups. • Training is provided to all stakeholders on how to access and utilize digital and print resources available through the library collection.
School Objectives: • The library is utilized by staff and students for curricular aligned print books, e-books, subscriptions, research, and interactive learning activities. • Training is provided to all stakeholders on how to access and utilize digital and print resources available through the library collection. • Supplemental learning materials are on a documented and continuous review process that includes all of the following: data analysis of usage, analysis of impact, and documented action steps to keep, improve, or remove these resources.
Student Impact: • Flexible learning environments allow for learning to occur in spaces that best support each student individually. • A variety of resources are available to support the diverse learning needs of all students.
Goal 3 – All staff demonstrate mastery of the NC Digital Learning Competencies to create blended and personalized learning experiences to improve student outcomes.
Department of Public Instruction Objectives: • Resources, professional learning, and personalized support is provided to PSUs for blended learning. • Resources, professional learning, and personalized support is provided to PSUs for personalized learning. • A statewide bank of instructional resources is available to all educators in North Carolina and houses high-quality lesson plans that support blended and personalized learning for every grade-level and content area.
Public School Unit Objectives: • The PSU has created or adopted an instructional framework that supports blended and personalized learning and provides staff resources, professional learning, and coaching support as they implement this framework. • Professional learning aligned with the North Carolina Digital Learning Competencies for Administrators, the North Carolina Digital Learning Competencies for Teachers, and the North Carolina Digital Learning Standards for Students is available and used by staff within the PSU. • Resources that support personalized and blended learning are a part of a documented and continuous review process that includes all of the following: data analysis of usage, analysis of impact, and documented action steps to keep, improve, or remove these resources.
School Objectives: • The majority of lesson plans meet all of the following: alignment with North Carolina Digital Learning Standards for Students, elements of blended learning, personalized learning elements. • Student work products are readily available that reflect a minimum of 4 of the North Carolina Digital Learning Standards for Students.

Student Impact:

- Lesson plans and experiences aligned to the Digital Learning Standards and Digital Learning Competencies ensure that students have personalized learning experiences supported by digital teaching and learning.
- Students learn from educators who are well trained and supported in the use of the Digital Learning Standards and Digital Learning Competencies.

CATEGORY 4

DATA PRIVACY & CYBERSECURITY

Data privacy and cybersecurity are fundamental for a positive student learning experience and communicate the importance of digital citizenship. As digital teaching and learning experiences become more integrated into instruction, these areas are critical for the access, safety, and success of students.

Goal 1 – Align data privacy and cybersecurity policies and procedures with current best practice and federal and state laws.

Department of Public Instruction Objectives:

- Resources and professional learning opportunities are personalized for PSUs to create and align data privacy policies and procedures to current best practices and federal and state laws.
- Resources and professional learning opportunities are personalized for PSUs to create and align cybersecurity policies and procedures to current best practices and federal and state laws.

Public School Unit Objectives:

- Data privacy and cybersecurity documentation is available and accessible to necessary personnel, aligns with relevant laws and current best practice, and is on a documented yearly refresh and review cycle.
- A PSU policy governing specific requirements in usage agreements and privacy policies is in place, is in alignment with current best practices, and is on a documented yearly refresh and review cycle.

School Objectives:

- School leadership, teachers, and students understand and practice data privacy and cybersecurity best practices.
- School leadership, teachers, staff, and students understand usage agreements and privacy policies.

Student Impact:

- Data privacy and cybersecurity practices ensure that students learn in a safe digital teaching and learning environment.

Goal 2 – Implement a process for continuous improvement of data protection and risk management.

Department of Public Instruction Objectives:

- Resources and professional learning support are personalized for PSUs to implement continuous improvement of data protection and risk management.

Public School Unit Objectives:

- All data privacy and cybersecurity resources (including human, software, and hardware) are a part of a fully funded sustainability plan.
- A data privacy and cybersecurity team is identified, meets regularly to assess risks, and runs mock security disaster drills.
- There is a documented continuous improvement process in place for data privacy and cybersecurity that includes at least the following: role based permissions, data privacy incident plans, and professional learning needs of the data privacy and cybersecurity team.

School Objectives:

- The methods used to train school leadership, teachers, staff, and students to understand usage agreements, data privacy practices, and privacy policies is on a documented refresh and review cycle to ensure alignment with PSU priorities, participant need, and best practices.

Student Impact: • Staff model best digital citizenship practices for students to emulate.
Goal 3 – Provide and communicate professional learning around the importance of cybersecurity and data privacy for all stakeholders.
Department of Public Instruction Objectives: • A state-wide initiative to provide cybersecurity and data privacy education and resources to families and K-12 employees has been launched, evaluated, and refined on a continuous, documented cycle.
Public School Unit Objectives: • Training and awareness campaigns focused on data privacy and responsible use are available to all stakeholders and required for staff and students.
School Objectives: • Training and awareness campaigns focused on data privacy and responsible use are available to all stakeholders and required for staff and students.
Student Impact: • Students learn in a digital teaching and learning environment that is safe and healthy.

CATEGORY 4

TECHNOLOGY, INFRASTRUCTURE, & DEVICES

Technology, infrastructure, and devices serve as necessary components in digital teaching and learning. By ensuring that all students have equitable access to updated devices with modern technology and internet access, student learning outcomes improve. Regular updates and maintenance of technology, infrastructure, and devices are necessary for continuous improvement.

Goal 1 – Learning spaces are equipped with appropriate, functional technology to facilitate student growth and learning.

Department of Public Instruction Objectives:

- Resources, professional learning and personalized support are provided to PSUs for equipping learning spaces with appropriate, functional technology to facilitate student growth and learning.
- Data around hardware access for students is collected, analyzed, shared, informs the Digital Learning Action Plan for DPI, and is disseminated in personalized reports for regions and PSUs.

Public School Unit Objectives:

- The PSU has the ability for every student to take home a digital learning device that meets their learning needs at a ratio of 1 device per student.
- The PSU has the ability for every staff member to take home a device that meets the needs of their job at a ratio of 1 device per staff member.
- All hardware purchased for student and staff use in and out of the classroom is a part of a fully funded and sustainable refresh and review plan.
- All software needed to manage and inventory PSU assets are a part of a fully funded and sustainable refresh and review plan.

School Objectives:

- The school has the ability for every student to take home a digital learning device that meets their learning needs at a ratio of 1 device per student.
- The school has the ability for every staff member to take home a device that meets the needs of their job at a ratio of 1 device per staff member.
- All hardware purchased through school based funds is a part of a fully funded and sustainable refresh and review plan.

Student Impact:

- Students have access to devices and resources that support enhanced learning experiences.

Goal 2 – All schools have the infrastructure to support digital teaching and learning.

Department of Public Instruction Objectives:

- Resources, professional learning and personalized support are provided to PSUs for equipping learning spaces with appropriate, functional network infrastructure to facilitate student growth and learning.
- Resources, professional learning, and personalized support are provided to PSUs for E-Rate.

Public School Unit Objectives:

- All infrastructure related resources (including human, software, and hardware) are a part of a fully funded sustainability plan.
- There is a documented continuous improvement process in place for infrastructure needs that includes at least the following: policies, procedures, inventory, and professional learning needs of the technical team.

School Objectives: • School leadership, staff, and students have access to high speed internet and digital resources with less than 5% disruption of service.
Student Impact: • Students benefit from a robust infrastructure that creates transformative learning experiences enhanced by technology.
Goal 3 – Students and staff have appropriate access to the internet at school and their residence.
Department of Public Instruction Objectives: • Off campus internet access data for students is collected, analyzed, shared, informs the Digital Learning Action Plan for DPI, and is disseminated in personalized reports for regions and PSUs.
Public School Unit Objectives: • There is a documented continuous improvement process in place for network needs that includes at least the following: policies, procedures, inventory, and professional learning needs of the technical team. • Data around internet access for students at home is collected, analyzed, shared, informs the PSU action plan, and is used to develop partnerships for connecting students.
School Objectives: • Data around internet access for students at home is collected, analyzed, shared, informs the PSU action plan, and is used to develop partnerships for connecting students.
Student Impact: • Students have consistent access to high speed internet that enhances their learning and allows them to compete globally with others. • Students have access to resources to maximize their learning experience.

SECTION 1: STUDENTS

1.1. Empowered Learner

Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences. Students:

1.1.a. articulate and set personal learning goals, develop strategies leveraging technology to achieve them and reflect on the learning process itself to improve learning outcomes.
1.1.b. build networks and customize their learning environments in ways that support the learning process.
1.1.c. use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
1.1.d. understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies.

1.2. Digital Citizen

Students recognize the rights, responsibilities and opportunities of living, learning and working in an interconnected digital world, and they act and model in ways that are safe, legal and ethical. Students:

1.2.a. cultivate and manage their digital identity and reputation and are aware of the permanence of their actions in the digital world.
1.2.b. engage in positive, safe, legal and ethical behavior when using technology, including social interactions online or when using networked devices.
1.2.c. demonstrate an understanding of and respect for the rights and obligations of using and sharing intellectual property.
1.2.d. manage their personal data to maintain digital privacy and security and are aware of data-collection technology used to track their navigation online.

1.3. Knowledge Constructor

Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others. Students:

1.3.a. plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits.
1.3.b. evaluate the accuracy, perspective, credibility and relevance of information, media, data or other resources.
1.3.c. curate information from digital resources using a variety of tools and methods to create collections of artifacts that demonstrate meaningful connections or conclusions.
1.3.d. build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.

1.4. Innovative Designer

Students use a variety of technologies within a design process to identify and solve problems by creating new, useful or imaginative solutions. Students:

1.4.a. know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems.
1.4.b. select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.
1.4.c. develop, test and refine prototypes as part of a cyclical design process.
1.4.d. exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.

1.5. Computational Thinker

Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions. Students:

1.5.a. formulate problem definitions suited for technology-assisted methods such as data analysis, abstract models and algorithmic thinking in exploring and finding solutions.
1.5.b. collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.
1.5.c. break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving.
1.5.d. understand how automation works and use algorithmic thinking to develop a sequence of steps to create and test automated solutions.

1.6. Creative Communicator

Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals. Students:

1.6.a. choose the appropriate platforms and tools for meeting the desired objectives of their creation or communication.
1.6.b. create original works or responsibly repurpose or remix digital resources into new creations.
1.6.c. communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models or simulations.
1.6.d. publish or present content that customizes the message and medium for their intended audiences.

1.7. Global Collaborator

Students use digital tools to broaden their perspectives and enrich their learning by collaborating with others and working effectively in teams locally and globally. Students:

1.7.a. use digital tools to connect with learners from a variety of backgrounds and cultures, engaging with them in ways that broaden mutual understanding and learning.
1.7.b. use collaborative technologies to work with others, including peers, experts or community members, to examine issues and problems from multiple viewpoints.
1.7.c. contribute constructively to project teams, assuming various roles and responsibilities to work effectively toward a common goal.
1.7.d. explore local and global issues and use collaborative technologies to work with others to investigate solutions.

Appendix C: ISTE Standards for Educators

SECTION 2: EDUCATORS

Empowered Professional

2.1. Learner

Teachers continually improve their practice by learning from and with others and exploring proven and promising practices that leverage technology to improve student learning. Teachers:

2.1.a. Set professional learning goals to explore and apply pedagogical approaches made possible by technology and reflect on their effectiveness.

2.1.b. Pursue professional interests by creating and actively participating in local and global learning networks.

2.1.c. Stay current with research that supports improved student learning outcomes, including findings from the learning sciences.

2.2. Leader

Teachers seek out opportunities for leadership to support student empowerment and success and to improve teaching and learning. Teachers:

2.2.a. Shape, advance and accelerate a shared vision for empowered learning with technology by engaging with education stakeholders.

2.2.b. Advocate for equitable access to educational technology, digital content and learning opportunities to meet the diverse needs of all students.

2.2.c. Model for colleagues the identification, experimentation, evaluation, curation and adoption of new digital resources and tools for learning.

2.3. Citizen

Teachers inspire students to positively contribute and responsibly participate in the digital world. Teachers:

2.3.a. Create experiences for learners to make positive, socially responsible contributions and exhibit empathetic behavior online that build relationships and community.

2.3.b. Establish a learning culture that promotes curiosity and critical examination of online resources and fosters digital literacy and media fluency.

2.3.c. Mentor students in the safe, ethical and legal practice with digital tools and protection of intellectual rights and property.

2.3.d. Model and promote management of personal data and digital identity and protect student data privacy.

Learning Catalyst

2.4. Collaborator

Teachers dedicate time to collaborate with both colleagues and students to improve practice, discover and share resources and ideas, and solve problems. Teachers:

2.4.a. Dedicate planning time to collaborate with colleagues to create authentic learning experiences that leverage technology.
2.4.b. Collaborate and co-learn with students to discover and use new digital resources and diagnose and troubleshoot technology issues.
2.4.c. Use collaborative tools to expand students' authentic, real-world learning experiences by engaging virtually with experts, teams and students, locally and globally.
2.4.d. Demonstrate cultural competency when communicating with students, parents and colleagues and interact with them as co-collaborators in student learning.

2.5. Designer

Teachers design authentic, learner-driven activities and environments that recognize and accommodate learner variability. Teachers:

2.5.a. Use technology to create, adapt and personalize learning experiences that foster independent learning and accommodate learner differences and needs.
2.5.b. Design authentic learning activities that align with content area standards and use digital tools and resources to maximize active, deep learning.
2.5.c. Explore and apply instructional design principles to create innovative digital learning environments that engage and support learning.

2.6. Facilitator

Teachers facilitate learning with technology to support student achievement of the 2016 ISTE Standards for Students. Teachers:

2.6.a. Foster a culture where students take ownership of their learning goals and outcomes in both independent and group settings.
2.6.b. Manage the use of technology and student learning strategies in digital platforms, virtual environments, hands-on makerspaces or in the field.
2.6.c. Create learning opportunities that challenge students to use a design process and/or computational thinking to innovate and solve problems.
2.6.d. Model and nurture creativity and creative expression to communicate ideas, knowledge or connections.

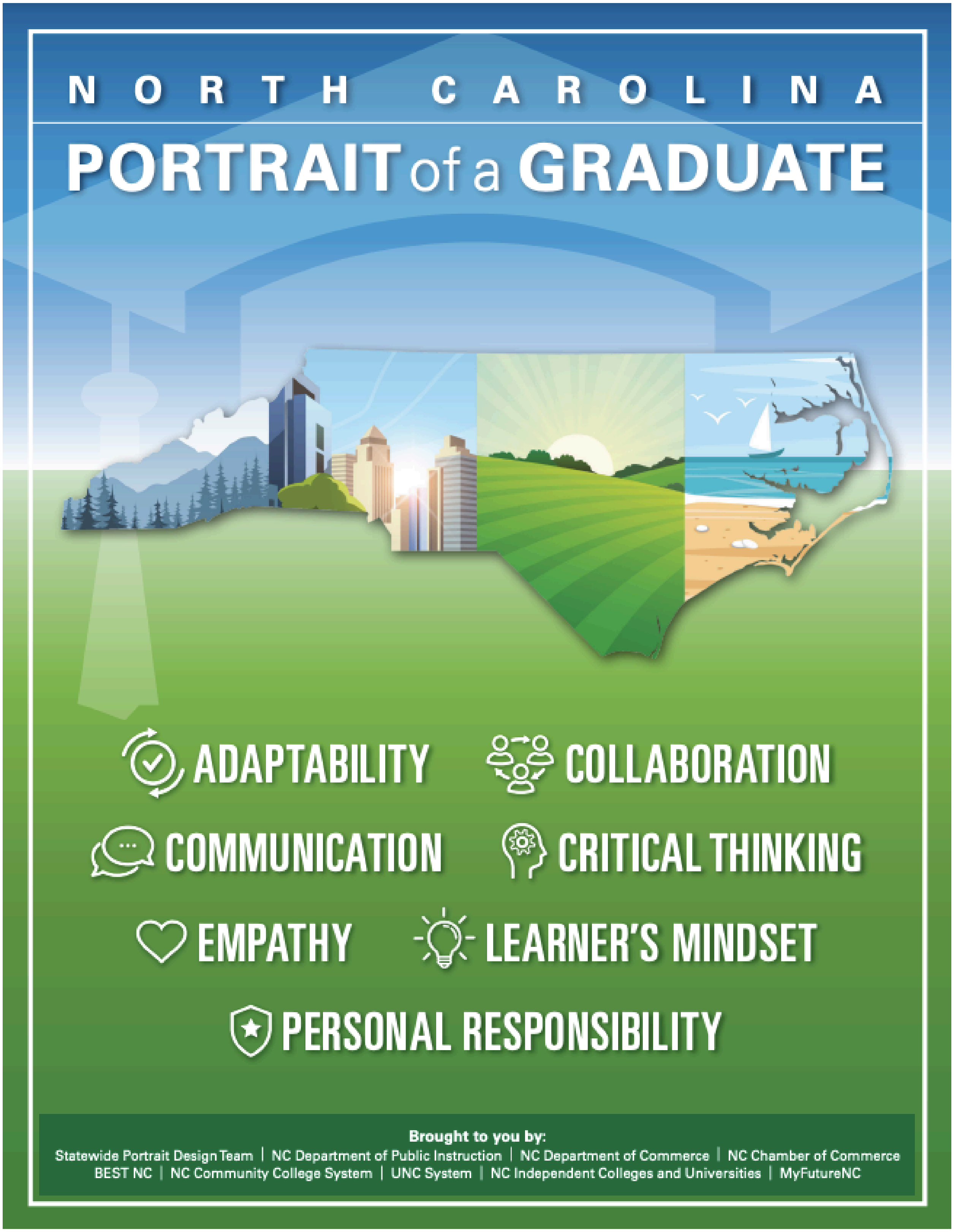
2.7. Analyst

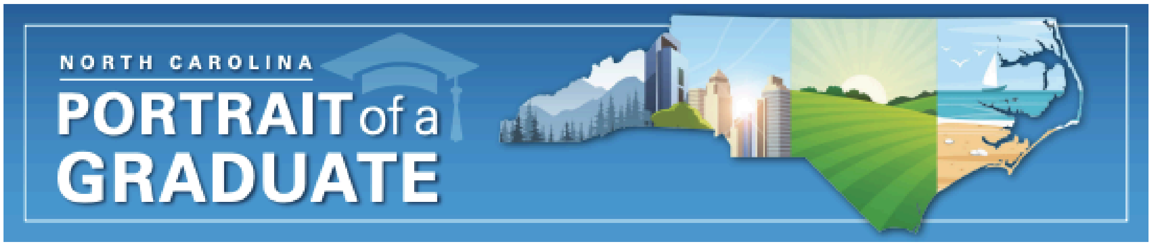
Teachers understand and use data to drive their instruction and support students in achieving their learning goals. Teachers:

2.7.a. Provide alternative ways for students to demonstrate competency and reflect on their learning using technology.
2.7.b. Use technology to design and implement a variety of formative and summative assessments that accommodate learner needs, provide timely feedback to students and inform instruction.
2.7.c. Use assessment data to guide progress and communicate with students, parents and education stakeholders to build student self-direction.

Crompton, H., & Sykora, C. (2021). Developing instructional technology standards for educators: A design-based research study. Computers and Education Open 2 https://doi.org/10.1016/j.caeo.2021.100044

Appendix D: North Carolina Portrait of a Graduate





NORTH CAROLINA COMPETENCY SET

ADAPTABILITY

North Carolina Graduates…

- Demonstrate agility in thought processes and problem-solving.
- Accept feedback, praise, setbacks, and criticism.
- Balance diverse viewpoints and beliefs to reach workable solutions.
- Demonstrate flexibility when navigating challenging situations.
- Exhibit steadfastness despite difficulty, opposition, and/or failure.

COLLABORATION

North Carolina Graduates…

- Contribute and respond to diverse perspectives to achieve a common goal.
- Leverage strengths to resolve conflict and foster teamwork.
- Interact respectfully with others in digital and in-person interactions.
- Embrace a variety of roles in a group as a participant and a leader.

COMMUNICATION

North Carolina Graduates…

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills.
- Listen to decipher meaning, values, attitudes, and intentions.
- Ask questions and synthesize messages to seek understanding.
- Engage in productive discourse to resolve disagreements.
- Craft communication for a range of purposes and audiences.
- Use storytelling and public speaking to express ideas and connect with others.

CRITICAL THINKING

North Carolina Graduates…

- Analyze, assess, and reconstruct personal thought processes.
- Apply thinking that is clear, rational, and evidence-based.
- Evaluate and prioritize solutions to difficult or complex problems.
- Employ creative improvements to systems, processes, and organizations.

EMPATHY

North Carolina Graduates…

- Demonstrate understanding, sensitivity, concern, and respect.
- Share in others' feelings, opinions, and experiences through personal and digital connections.
- Value and embrace diverse cultures and unique perspectives.
- Foster belonging and trust through mutual respect and dialogue.

LEARNER'S MINDSET

North Carolina Graduates…

- Possess an ongoing desire to learn, unlearn, and relearn.
- Embrace curiosity to experience new ideas, demonstrate growth, and persist through challenges.
- Translate knowledge to provide different contexts to drive change and innovation.
- Develop positive attitudes and beliefs about learning.

PERSONAL RESPONSIBILITY

North Carolina Graduates…

- Adhere to a set of core values that are evident in choices and actions.
- Earn trust and respect through honest, principled behaviors.
- Honor commitments.
- Recognize how personal decisions and actions have impacts beyond self.
- Take ownership of decisions and persevere through challenges.
- Demonstrate self-control and composure.

Brought to you by:
Statewide Portrait Design Team | NC Department of Public Instruction | NC Department of Commerce | NC Chamber of Commerce
BEST NC | NC Community College System | UNC System | NC Independent Colleges and Universities | MyFutureNC

Policy Code: 3220 Technology in the Educational Program

In alliance with the North Carolina Digital Learning Plan, the board is committed to establishing and supporting effective digital teaching and learning practices supported by contemporary information and communications technology systems to foster globally competitive students prepared for modern life. The board recognizes the benefits of digital and technology-enabled and -enhanced teaching and learning resources that provide the ability to make data more accessible, personalize learning, easily customize curriculum, provide access to current information, and enable access to quality materials at a lower cost than traditional materials. To that end, the board supports classroom digital and technology-enabled and -enhanced teaching and learning resources that are aligned with the current statewide instructional standards. In addition, to the extent funding permits, the board will endeavor to ensure that all students have access to personal digital and technology-enabled teaching and learning devices to foster the skills necessary for future-ready learners.

The board expects that information and communications technologies will be integrated seamlessly across the curriculum and used to support student achievement and to prepare students to be successful in college, in careers, and as globally engaged, productive citizens. The curriculum committee should provide suggestions in the curriculum guides referenced in policy 3115, Curriculum and Instructional Guides, for integrating technological resources (as defined in Section A below) into the educational program. School administrators and teachers are encouraged to develop additional strategies for integrating technological resources across the curriculum and utilizing the power of technology to personalize learning and improve learning outcomes while making more efficient use of resources. The strategies should be included in the school improvement plan if they require the transfer of funds or otherwise relate to any components of the school improvement plan.

The superintendent shall oversee development of the school system's digital teaching and learning vision as part of the school system's strategic plan and a yearly action plan that aligns to the vision. The development and ongoing review of the vision and the action plan will include various stakeholders such as curriculum leaders, teachers, administrators, students, parents, and representatives from technology services, instructional technology, finance, and other departments as required. The action plan will include adequate data privacy protections to secure student data and will take into account the level of out-of-school Internet access for students.

The superintendent may establish relationships with businesses and seek grants and other funding sources in an effort to acquire additional technological resources for the educational program and to support continuous out-of-school Internet access for students.

A. Selection of Technological Resources

Technological resources are information and communications technologies including, but not limited to, the following: (1) hardware, including both fixed and mobile technologies and devices such as desktop computers, laptops, netbooks, tablets, e-readers, smartphones, and gaming devices; (2) software, including cloud-based and web-based applications, programs, and platforms; (3) network and telecommunications systems and services; (4) Internet access; (5) multimedia equipped classrooms; (6) computer classrooms and laboratories; and (7) other existing or emerging mobile communications systems. All technological resources must be purchased and used in a manner consistent with applicable law and board policy, including laws and policies related to copyright, public records, bidding, and other purchase requirements, accessibility for students with disabilities, staff duties, and standards for student behavior.

Technological resources must meet or exceed the following standards before they may be considered for implementation.

1. Technological resources must support the current statewide instructional standards or the programs of the school system.

2. Technological resources must support the current use of learning and instructional management technologies in the school.

3. Technological resources must be compatible with the condition of the network and other infrastructure resources. The technology director shall set minimum standards for technological resources that are purchased or donated. Upgrading, hardware conditions, and similar requirements must be maintained to the highest standards.

4. There must be sufficient staff to operate and maintain the technological equipment, programs, and systems.

5. There must be adequate funds budgeted to implement and support the technological resources and to train instructional staff to use the resources to improve educational outcomes.

Procurement of technological resources should be done in collaboration with teachers and technical support staff, as appropriate. Whenever possible, a pilot period to test the resource should occur prior to full purchase.

B. Deployment of Technology to Schools

The superintendent shall oversee the development of the school system’s technology deployment and refresh plan. The plan will be designed to ensure organized, effective, efficient, and sustainable means of deploying and maintaining technology resources and will establish appropriate refresh/replacement cycles. The superintendent shall develop procedures that outline the strategy of the technology deployment and refresh plan.

C. Bring Your Own Technology (BYOT) Initiative

The superintendent is authorized to investigate and develop a plan to allow staff and students the option to use their personal electronic devices in place of or along with their school system assigned devices. The plan should address, at a minimum, the instructional use of personal devices, compatibility requirements, access limitations or requirements, content filtering, security, and other issues as recommended by the technology director. The plan should assign personal responsibility to the user for repair and replacement of damaged or stolen devices and for any data or other charges arising from use of a personal device. The plan should require a written agreement for the use of personal technology devices from each student and staff member who wishes to participate in the BYOT initiative. The plan should ensure that students who are unable to bring in outside technology will be able to access and utilize school equipment so that no student is excluded from instruction due to lack of access to technology.

D. Electronic Communication and Other Collaborative Tools

The superintendent is authorized to permit instructional personnel to incorporate email, social networking sites, blogs, wikis, video sharing sites, podcasts, video conferencing, online collaborations, instant messaging, texting, virtual learning environments, and/or other forms of direct electronic communications or Web 2.0 applications for educational purposes to the extent the superintendent deems appropriate and in accordance with policy 7335, Employee Use of Social Media. The superintendent shall establish parameters and rules for use of these tools and shall require instruction for students in how to use such tools in a safe, effective, and appropriate way. Instructional personnel shall make all reasonable attempts to monitor student online activity and shall otherwise comply with the requirements of policy 3225/4312/7320, Technology Responsible Use, when using these tools.

E. Technology-Related Professional Development

The superintendent shall plan a program of professional development for digital teaching and learning that prepares administrators, teachers, coaches, school library media coordinators, and technical support staff to utilize digital tools and resources in accordance with the N.C. Digital Learning Competencies for Teachers and Administrators. Professional development shall emphasize technology integration and continuous improvement, including the use of ongoing technology-integrated online-learning activities throughout the course of study and the provision of personalized learning. Professional development shall also address the ethical, legal, and practical issues related to social networking and mobile devices in the classroom and other topics deemed necessary by the superintendent or technology director. To the extent possible, job-specific professional development opportunities should be made available, as well as professional development that is personalized to meet the needs of individual staff.

School improvement teams should identify any staff development appropriations for technology-related professional development in their school improvement plans. The superintendent and technology director should assist schools in coordinating staff development needs as provided in policy 1610/7800, Professional and Staff Development.

Legal References: G.S. 115C-522, -528; 143B-1341; State Board of Education Policy SBOP-018

Cross References: Professional and Staff Development (policy 1610/7800), Curriculum and Instructional Guides (policy 3115), Technology Responsible Use (policy 3225/4312/7320), Internet Safety (policy 3226/4205), Copyright Compliance (policy 3230/7330), School Improvement Plan (policy 3430), Integrity and Civility (policy 4310), Public Records – Retention, Release, and Disposition (policy 5070/7350), Network Security (policy 6524), Staff Responsibilities (policy 7300), Employee Use of Social Media (policy 7335), Gifts and Bequests (policy 8220)

Other Resources: North Carolina Digital Teaching and Learning Competencies for Teachers and Administrators, available at https://www.dpi.nc.gov/districts-schools/districts-schools-support/digital-teaching-and-learning/digital-teaching-learning-standards#digital-learning-competencies-for-educators; The North Carolina Digital Learning Plan (2022), available at https://www.dpi.nc.gov/districts-schools/districts-schools-support/digital-teaching-and-learning/digital-learning-initiative#:~:text=The%20North%20Carolina%20Digital%20Learning%20Plan%20describes%20the,Learning%20Initiative.%202022%20North%20Carolina%20Digital%20Learning%20Plan

Adopted: March 17, 2009; June 28, 2017; August 21, 2018; November 15, 2022

Mount Airy City Board of Education

Appendix F: Implementation Timeline

GOAL: Improve sense of belonging in technology engagement for girls in order to break down stereotypes and psychological barriers to participation in technology and STEM learning.	**Dec. 2023**	**Jan. 2024**	**Feb. 2024**	**Mar. 2024**	**Apr. 2024**	**May 2024**	**June 2024**	**July 2024**	**Aug. 2024**
(Step 1) **PLAN:** Develop a design team and set meetings for the duration of implementation. Team leaders build the capacity of the design team to do the work.	by 12/1								
(Step 2) **PLAN:** Design team identifies problem; conducts causal analysis; research potential improvement initiatives; designs intervention; designs implementation plan; and creates measures for assessing process and outcomes connected to the problem and its causes.	by 12/31								
(Step 3) **PLAN:** Scholar-Practitioner and 2-3 facilitators of Girls Tech adapt Girls Tech curriculum materials from Girls Who Code to align with ISTE Standards for students and the specific needs of the community.		by 1/31							

(Step 4) **DO:** 10-12 students are recruited through facilitator sharing of a short presentation about Girls Tech after school program, distribution and collection of sign up forms and a lottery as needed for selection of girls for the first cycle of Girls Tech			2/19-2/23						
(Step 5) **DO:** Facilitators lead 8 Girls tech after school sessions for 1.5 hours twice a week.				3/12, 3/14, 3/19, 3/21, 3/26, 3/28	4/2, 4/4				
(Step 6) **STUDY:** Facilitators complete checklist (PROCESS MEASURE) at the end of each Girls Tech session meeting.				3/12, 3/14, 3/19, 3/21, 3/26, 3/28	4/2, 4/4				
(Step 7) **STUDY:** Facilitators complete a survey (DRIVER MEASURE) at the end of sessions 2, 4, and 6 to consider the formative impact of the Girls Tech program.				3/14, 3/21, 3/28					
(Step 8) **STUDY:** Summative evaluation (OUTCOME & BALANCE MEASURE) post-survey for girls who participated in the Girls Tech after school program to indicate their comfort and confidence in technology learning.					4/8-4/12				

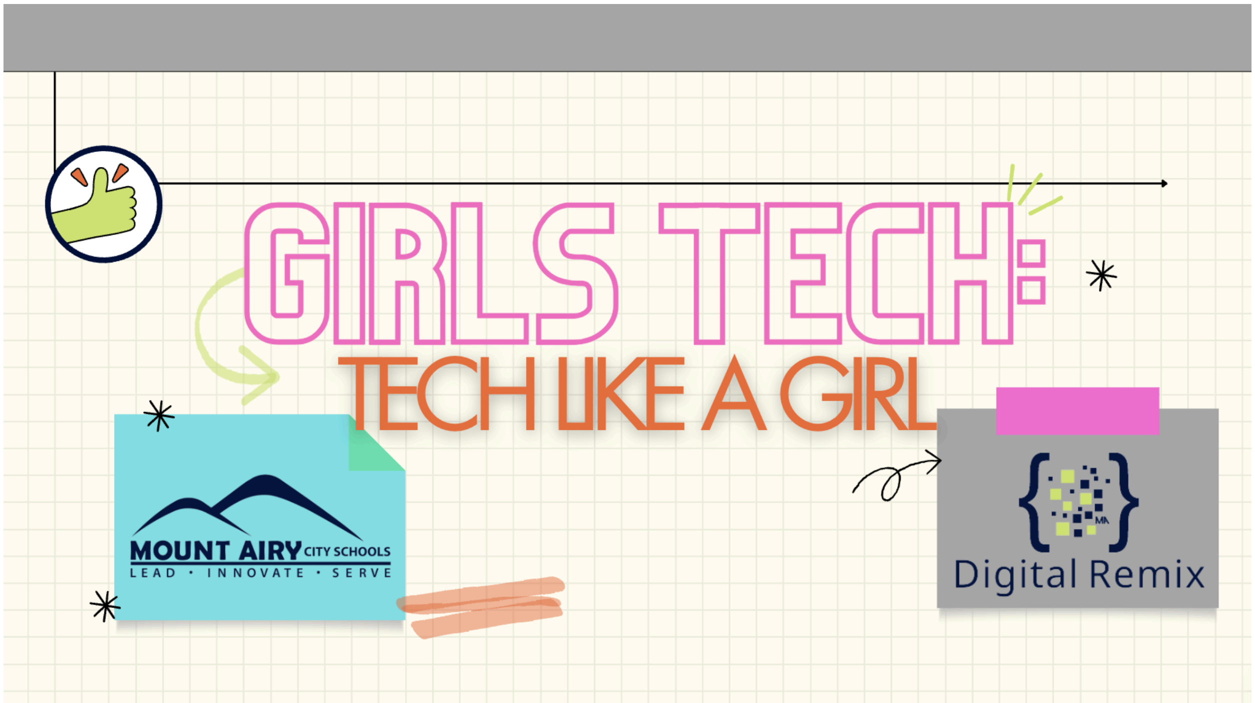
(Step 9) **STUDY:** Summative evaluation (OUTCOME & BALANCE MEASURE) post-interview for facilitators of Girls Tech to evaluate their observations of the program impact.					4/8-4 /12				
(Step 10) **STUDY/ACT:** Analysis of Driver, Process, Outcome, and Balance Measures to determine impact of the Girls Tech program experience for students and changes necessary in future cycles of Girls Tech.						X	X	X	X

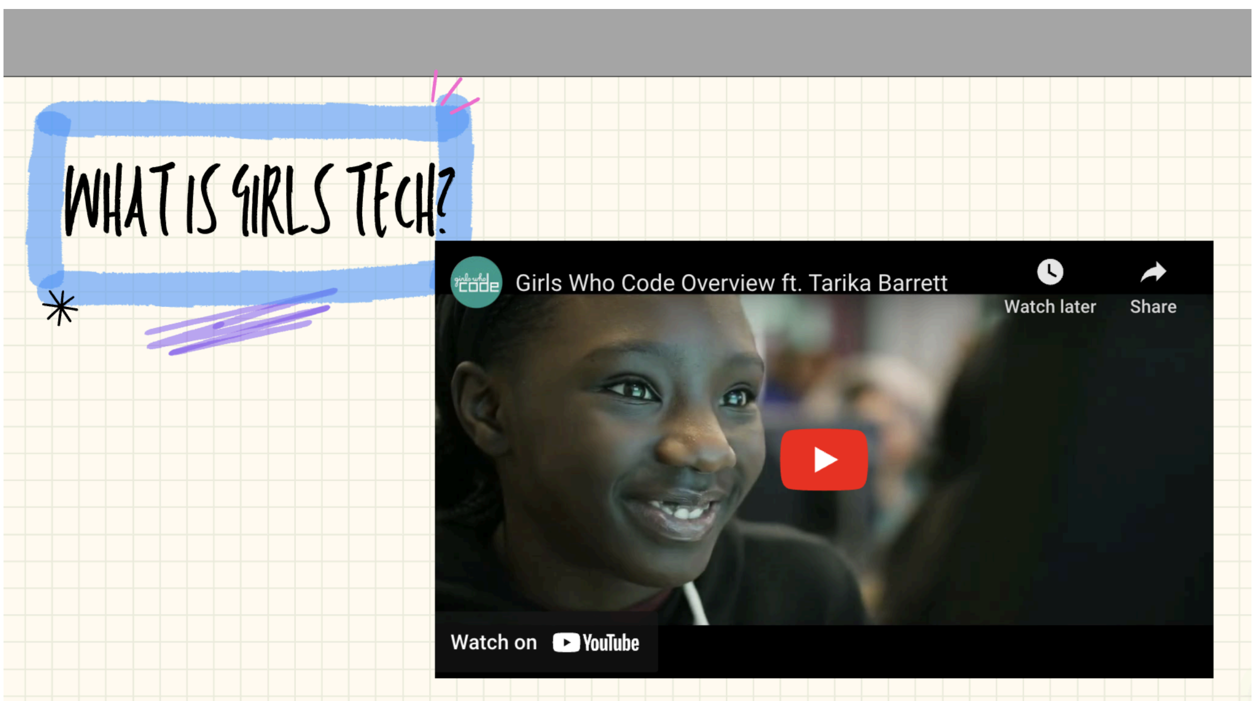
Appendix G: Program Curriculum Map for Tech Girls After School Program

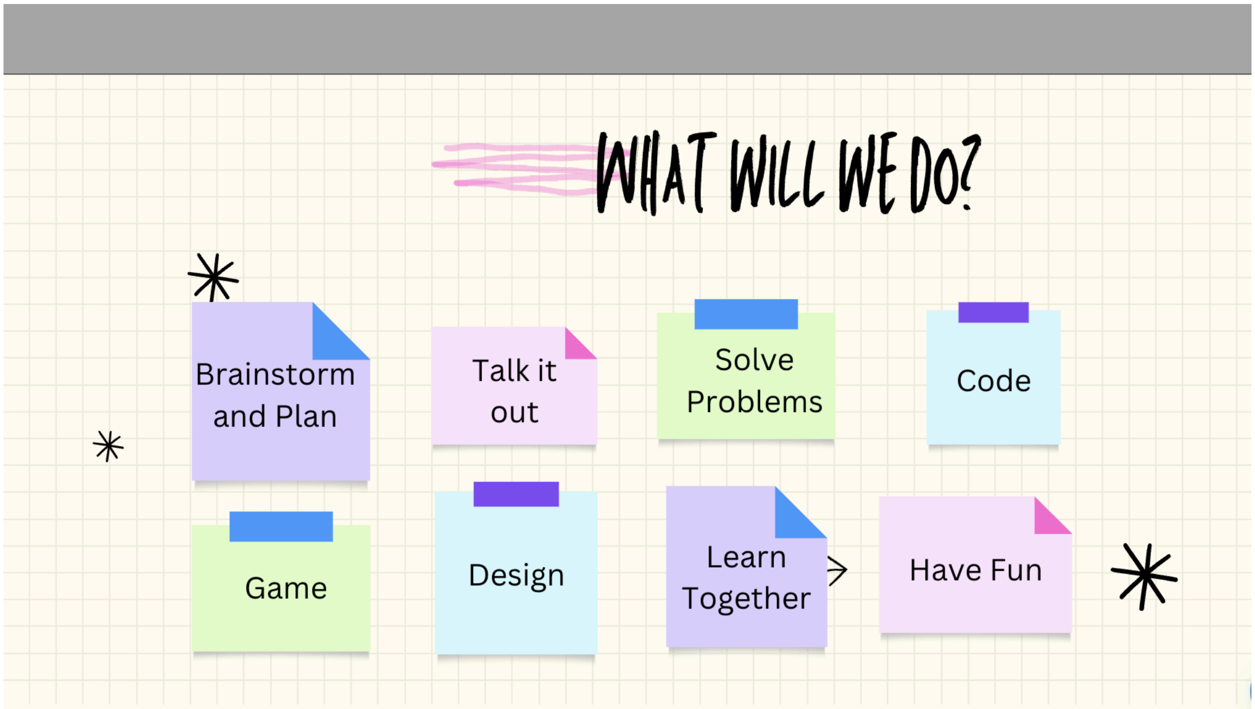
Girls Tech Curriculum Map			
Session	**Lesson**	**ISTE Standard**	**Materials**
1	A place for me: Girls will be introduced to the Girls Tech program, design thinking, and teamwork through unplugged activities. Girls will be introduced to scratch on iPads. (adapted from Girls Who Code, Ch.1-2)	1.1 Empowered learner	iPad Apple Pencil Journal template Scratch app
2	Planning and Decision Making: Girls will practice planning and decision making unplugged in teams to complete a challenge. Girls will practice problem solving and decision making in Scratch. (adapted from Girls Who Code, Ch.3-4)	1.3 Knowledge Constructor	STEM Challenge Kit iPad Apple Pencil Journal Everyone Can Code App
3	Problem Solving: Girls will learn that computer science is more than just code. They will solve problems in teams then present to the group. (adapted from Girls Who Code, Ch. 5-6)	1.5 Computational Thinker	STEM Challenge Kit iPad Apple Pencil Digital Journal
4	Robotics: Girls will explore the world of robots and the way humans create and use machines to help us. (adapted from Girls Who Code, Ch. 9)	1.7 Global Collaborator	iPad Apple Pencil Journal Programmable Robots
5	Digital Art and Design: Girls will learn about and try their hand at the cutting edge ways engineers use	1.6 Creative Communicator	iPad Apple Pencil Journal

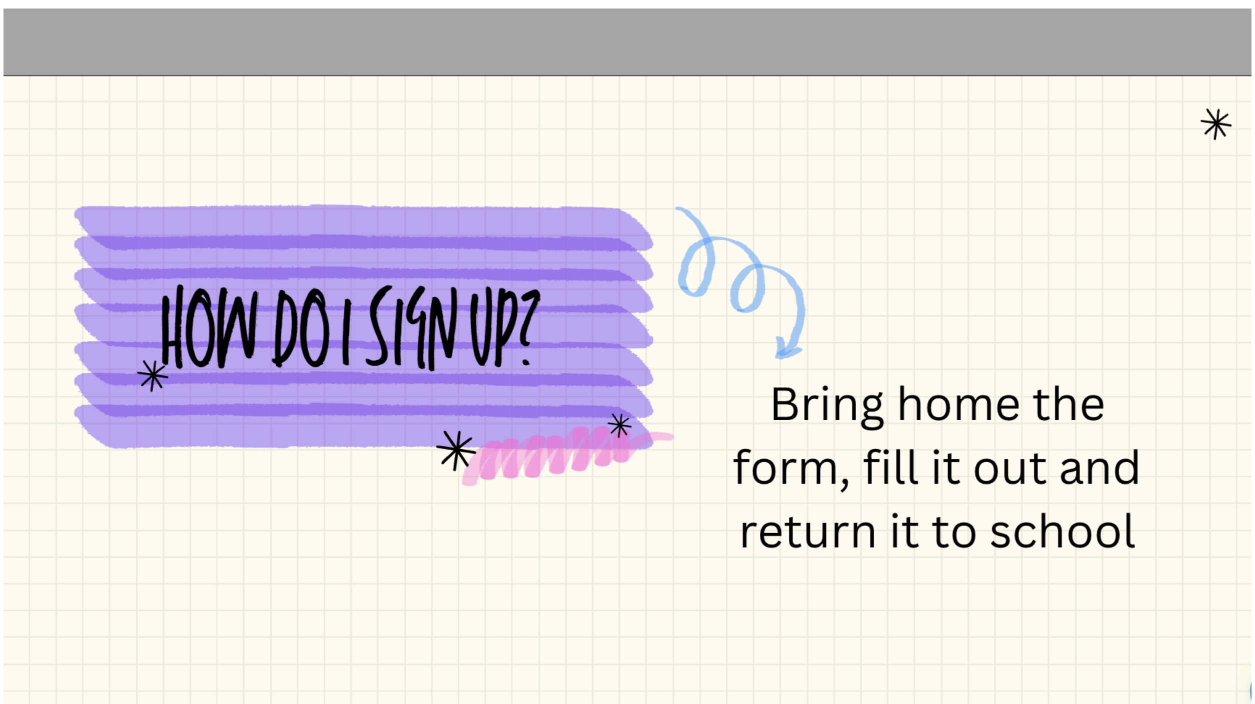
	computers to design fashion, art, music, and more. (adapted from Girls Who Code, Ch. 8)		
6	Websites and Mobile Apps: Girls will learn app prototyping and consider the user experience. (adapted from Girls Who Code, Ch 10)	1.7 Global Collaborator	iPad Apple Pencil Journal Scratch App
7	Gaming: Girls will learn about awesome female game designers and learn about what makes a game so much fun through game design planning. (adapted from Girls Who Code, Ch. 7)	1.4 Innovative Designer	iPad Apple Pencil Journal High Tech Computers
8	The finale: Girls will take on a final challenge	1.2 Digital Citizen/Innovative Designer	iPad Apple Pencil Journal High Tech Computers

Appendix H: Girls Tech Recruitment Information






WHAT WILL WE DO?
Brainstorm and Plan
Talk it out
Solve Problems
Code
Game
Design
Learn Together
Have Fun


HOW DO I SIGN UP?
Bring home the form, fill it out and return it to school

Appendix I: Girls Tech Sign-Up Form

Attention all girls! We would love for you to join Girls Tech! This after school program will take place on Tuesdays and Thursdays from 3:00-4:30 for four weeks. This progrom has space for 12 girls but if more than 12 sign up we will offer a second group! A lottery will take place to establish the groups.

During the program girls will get to design, create, problem solve, code, and game together.

Student Name:____

Grade:_________________________ Teacher:________________________________

WIll your child need transportation home at the conclusion of each session? _________

Parent Name:____

Parent Phone Number: ____

Emergency Contact Name: ____

Emergency Contact Phone Number:_____________________________________

Appendix J: Facilitator Survey

The following questions will be answered using a Likert-type scale (strongly disagree, disagree, somewhat agree, strongly agree).

Collaboration: Students were able to work in pairs or small groups to effectively complete a task in the last two sessions

- ○ Strongly Disagree
- ○ Somewhat disagree
- ○ Somewhat agree
- ○ Strongly agree

Communication: Students were able to communicate their ideas and answer questions using technology and oral skills in the last two sessions.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Somewhat agree
- ○ Strongly agree

Creativity and Innovation: Students were able to come up with problems and test their ideas then work to improve them in the last two sessions.

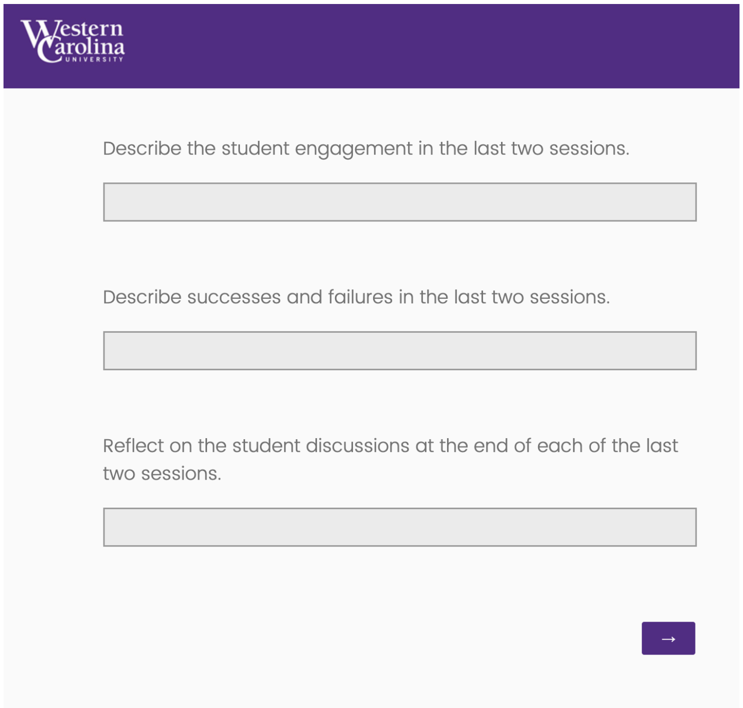
- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Somewhat agree
- ○ Strongly agree

Comfort and Confidence: Students showed confidence and comfort in the program and express this during the end of session group discussions in the last two sessions.

- ○ Strongly disagree
- ○ Somewhat disagree
- ○ Somewhat agree
- ○ Strongly agree

→

The following questions are opened-ended


Western Carolina University

Describe the student engagement in the last two sessions.

Describe successes and failures in the last two sessions.

Reflect on the student discussions at the end of each of the last two sessions.

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Appendix K: Facilitator Checklist

	Attendance: # of students present	**Warm up completed**	**Facilitator directed learning completed**	**Learning challenge completed**	**Whole group discussion completed**
Session 1	1	●	●	●	●
Session 2	1	●	●	●	●
Session 3	1	●	●	●	●
Session 4	1	●	●	●	●
Session 5	1	●	●	●	●
Session 6	1	●	●	●	●
Session 7	1	●	●	●	●
Session 8	1	●	●	●	●

Appendix L: Student Interview

1. Did you attend all 8 sessions?
2. If you missed a session, what was the reason?
3. What would you have been doing during the program time, if you had not attended?
4. What was your feedback on Girls Tech?
5. How does Girls Tech compare to other clubs or groups you have been in?

The following questions will be answered using a Likert-type scale. Please answer these questions (strongly disagree, disagree, agree, strongly agree).

1. Collaboration: I can work in pairs or small groups effectively to complete a task.
2. Communication: I can communicate my ideas and answer questions using technology and oral skills.
3. Creativity and Innovation: I can come up with solutions to difficult problems and test my ideas then work to improve them.
4. Comfort and Confidence: I feel confidence and comfort in learning about technology.
5. I am interested in continuing in this Girls Tech program.
6. I am interested in participating in a similar program with boys and girls.
7. I am interested in participating in a competitive technology club.

6\. I am more interested in technology than I was prior to this program.

Appendix M: Facilitator Interview

The following prompts were prepared to guide the semi-structured interview with the two facilitators of the after school program for girls in technology. Discussion will begin with an overview of the program mechanics.

Questions:

- What did you notice about the girls' confidence throughout the program?
- What did you notice about the girls' skills throughout the program?
- In what ways do you think this program improved or did not improve interest for girls in technology?

Prompts:

- Tell me more.
- Why do you think that is?
- It seems like you are saying...
- So what you are saying is…
- But why?