Informal Learning Opportunities - Neurodiversity, Self-Efficacy, and Motivation for Programming Interest

Ella Kokinda[1][a], Makayla Moster[1][b], Paige Rodeghero[1][c], and D. Matthew Boyer[2][d]
[1] *School of Computing, Clemson University, Clemson, SC, USA*
[2] *Department of Engineering & Science Education, Clemson University, Clemson, SC, USA*
{ekokind, mmoster, prodegh, dmboyer}@clemson.edu

Keywords:
informal learning, neurodiversity, self-efficacy, coding camp

Abstract:
We explore how using Scratch in a three-week game programming camp impacts students' interests, motivation, and perceived self-efficacy in programming. In this study of high school students, we use pre- and post-camp surveys to measure interest in STEM and perceived self-efficacy. Additionally, we use a pre- and post-skills assessment test to understand how informal learning affects campers' abilities. We found that when analyzed as a group, self-efficacy and motivation did not statistically change for the campers. However, individually, campers trended towards increased self-efficacy and motivation in their skills. Our work extends current research regarding informal learning opportunities for neurodiverse individuals and situates the effectiveness of informal learning for programming and STEM motivation and interest.

1 INTRODUCTION

As technology advances and we search for the limits of what we can accomplish with software development and other technical sciences, considering diverse perspectives becomes evermore important to help drive innovation and solve complex problems. Researchers have called for introducing STEM education at an early age for more long-term interest in STEM topics and to promote creative and critical thinking (Bagiati et al., 2010; Campbell and Speldewinde, 2022). Early software and game development exposure often happens through Scratch[1], a browser-based block programming language for game development. K-12 Scratch programming has shown to be beneficial for students to develop computational thinking, code construction, and coding patterns (Fagerlund et al., 2021). Students who were exposed to programming concepts through Scratch at an early age may also find it easier to transition to non-visual-based programming languages (Armoni et al., 2015).

As we continue to push for greater participation numbers in STEM education and earlier introductions to STEM concepts, there is a growing need to recognize that neurodiverse students, those with ADHD, autism, and other learning needs, have much to offer in higher education and within the STEM field as a whole (Chrysochoou et al., 2022). However, many of these students often face barriers in their educational journey that would otherwise enable them to embrace their strengths (Syharat et al., 2023; Clouder et al., 2020). Emerging research shows that we need to move away from traditional pedagogy, leverage and embrace universal design standards, encourage students to focus on their strengths, and encourage divergent thinking chrysochoou2021redesigning, moster2022can. Using informal learning, project-based learning, and multi-model instruction methods, this camp aims to provide students the opportunity to pursue their strengths, encourage divergent thinking, and

[a] https://orcid.org/0000-0001-6951-6433
[b] https://orcid.org/0000-0002-0661-0550
[c] https://orcid.org/0000-0002-3859-6239
[d] https://orcid.org/0000-0002-4191-260X
[1] https://scratch.mit.edu/about

allow for the students to learn at their own pace.

Building on previous research, we explore the positive impacts of informal STEM learning opportunities through a three-week summer camp. In this paper, we make several contributions to software engineering education and broaden the understanding of STEM informal learning by:

- investigating and reporting findings on the perceived interest and value of informal learning opportunities like summer camps
- investigating and reporting findings on campers' self-efficacy with game development pre- and post-informal learning opportunity
- discuss the outcomes of a three-week summer camp and derive recommendations from our key successes and suggest areas for improvement

Researcher positionality helps frame the work as a whole and also shape how and why certain research decisions were made (Secules et al., 2021). As a research team, we are motivated to understand how informal learning opportunities impact neurodiverse individuals, particularly in STEM-forward situations. All four authors are White, middle-class, and able-bodied; the first three authors are female, and the last author is male. Two authors identify as neurodiverse individuals; all four have had prior experience working with neurodiverse groups. Our positionalities and personal experiences help shape our research approach and motivate us to understand how we can best support individuals like ourselves in STEM.

2 BACKGROUND

In this section, we discuss informal learning opportunities, student self-efficacy, and the use of future time perspective.

2.1 Informal Learning Opportunities

Informal leaning opportunities, like summer camps, provide students with more agency and autonomy in their educational choices and opportunities for positive teamwork engagement (Furlong, 2012; Jizat, 2021; Heidari et al., 2021). Particularly in STEM education, prior research shows that informal learning opportunities may increase student interest in STEM topics and careers, improve self-efficacy in related areas, and motivate students to explore STEM in a formal education setting (Nite, 2014; Dailey, 2018; DiSalvo, 2014; Maiorca et al., 2020). In particular, computer science or programming focused summer camps have been shown to be a positive influence for high-school students and provide opportunities outside of school to interact with STEM professionals (Lira et al., 2022; Roberts et al., 2018). These opportunities afford students invaluable time to develop necessary skills that could lead to STEM degree retention and relevant employment within their desired field of study (Espinosa, 2011).

Little research has been conducted with regard to neurodiversity and STEM or programming related summer camps for high school students. Additionally, there is little research on informal learning opportunities and neurodiverse students. Our research aims to explore how a game development summer camp, an informal learning opportunity, affects neurodiverse students motivations and interests in STEM, as well as measure how much they learn about game development.

2.2 Motivation and Interest

Research indicates that motivation and interest play a key role in gaining and retaining student interest in STEM topics and careers (Saleh et al., 2019). Students' motivation and interest in STEM can be self-derived, promoted or encouraged by their parents, being offered STEM classes in school, or through motivated teachers who provide and encourage a students' growth and interests (Christensen et al., 2015; Lee et al., 2018; RAFANAN et al., 2020). While research shows that a main motivator for STEM interest is student preference, efforts like informal learning can spark interest in students who may not have self-derived STEM interests.

2.3 Self-Efficacy

Self-efficacy refers to an individual's belief in their ability to successfully perform a specific task or achieve a desired outcome (Bandura, 1997). In the context of computer science education, self-efficacy relates generally to a person's beliefs about their ability to learn and succeed in computer science (Lin et al., 2013). It plays a significant role in shaping students' motivation, engagement, and learning outcomes. Research suggests that self-efficacy can be influenced by various factors, such as goal types and learning environments (Eccles and Wigfield, 2002). Creating opportunities for students to engage in informal learning experiences can potentially enhance their self-efficacy in programming skills. In computer science education, self-efficacy beliefs play a significant role in students' preference for teacher authority and their overall satisfaction with e-learning experiences (Lin et al., 2013). Furthermore, self-efficacy has been found to be a strong predictor of engagement and achievement in various learning contexts, including computer skills, English language learning, and science education (Pintrich and De Groot, 1990). Studies have shown that students with higher self-efficacy beliefs are more likely to engage in learning activities, persist in the face of challenges, and achieve better learning outcomes (Rosson et al., 2011).

2.4 Neurodiversity

Neurodiversity, as defined by Clouder *et al.*, is an umbrella term encompassing various neurotypes, e.g., individuals with Dyspraxia, Dyslexia, Attention Deficit Hyperactivity Disorder (ADHD), Dyscalculia, Autistic Spectrum, or Tourette Syndrome, that deviate from the norm, i.e., neurotypical (Clouder et al., 2020). This concept recognizes and celebrates the inherent differences in the structure and functioning of the brain, resulting in neurological variations (Roy and Jain, 2021). In the context of this research with neurodivergent learners, neurodiversity matters because it acknowledges and values the unique strengths and perspectives that neurodivergent individuals bring to the virtual learning environment. Rappolt-Schlichtmann *et al.* advocate for a strengths-based approach, including Universal Design for Learning[2], to support the overall well-being and development of students with Dyslexia (Rappolt-Schlichtmann et al., 2018). This approach aligns with the aim of this study exploring the impact of informal learning on students' interests and motivation, taking into account their neurodivergent traits. By acknowledging neurodiversity, educators can create inclusive learning environments that cater to the diverse needs of students, including those with autism, ADHD, dyslexia, and other specific learning difficulties.

[2]https://udlguidelines.cast.org/

3 METHODOLOGY

In this section, we describe our methodology for how we examined campers coding skills and interest in computing including our research questions, camp design, participant description, and data collection and analysis processes. We utilized surveys and observations throughout the camp to explore the impacts of the summer camp as an informal learning opportunity in the field of game development.

3.1 Research Questions

The objective of this research and this camp is to enhance understanding of how informal learning opportunities affect campers' interest in computing and perceived self-efficacy in game development, particularly for neurodiverse campers. Therefore, we ask the following Research Questions (RQs):

RQ_1: How does participation in a three-week summer camp utilizing project-based learning affect campers' interest in computing?

RQ_2: How does participation in a three-week summer camp utilizing project-based learning affect campers' self-efficacy in game development?

In RQ1, we aim to understand the campers' interests in various aspects of computing, whether or not these interests are career driven, and how three weeks of informal learning may influence their computing interests. In RQ2, we examine campers' perceived self-efficacy in game development and computing. Using a self-efficacy scale and a short knowledge pre- and post-assessment of Scratch skills, we are interested in the impact of the camp on campers' computing abilities. The research questions along with their corresponding data are presented in Table 1.

3.2 Camp Design

We strategically developed the design of our summer camp to facilitate a virtual three-week

Table 1: Research question methodology table

Research Question	Methods	Data Collected	Use
RQ1: How does project based learning in a three-week summer camp influence students' perceived interest in computing?	Computing Interest Survey Future Time Perspective (FTP) Survey	Individual student interests in computing, future time perspective, and value of learning game development	Aggregate and analyze students' pre-and post-surveys for computing interest. Use FTP to situate if campers considered a career in computing or value in a computing related career
RQ2: How does project based learning in a three-week summer camp influence student perceived self-efficacy in game development?	10 question Scratch skills assessment, pre- and post-camp self-efficacy survey, participant observation video transcripts	Individual student self-efficacy assessments and skill assessments and memoed observations	Aggregate and analyze campers' self-efficacy before and after camp, using the scratch assessment to consider results from perceived self-efficacy.

program conducted through Zoom. Each student was required to have an adequate computer that could run Zoom and a web browser simultaneously. The first week of camp focused on getting the campers the correct software and extensions they need to work collaboratively in Scratch and teaching the campers basic elements of game development and how to brainstorm the story of their own game. On the first day of camp before any instruction, the research team administered both the initial skills assessment and computing interests surveys. Then, using demonstrations of a premade game and providing short videos on each concept needed to build the premade game from the ground up, the campers built two timing based games throughout the rest of the first week. Campers would check-in with instructors every few videos to ensure the task was completed or receive assistance when needed. The next two weeks, campers were divided into teams of four to five and tasked with collaboratively building a game from the ground up based on their own ideas and gaining consensus from their teammates. Each day of the second and third week of camp campers would work in teams in breakout rooms with instructors who would call a stand-up meeting every 15 to 20 minutes to ask the campers what they have been working on, what they may have completed, and what they plan on working on next. Finally on the last day of camp before show-casing each teams game, campers were given the skills assessment and computing interest surveys for a second time. A comprehensive timeline of the camp is provided in Table 2.

TABLE 2 Camp Instruction Timeline

Day 1	Welcome session
	Meet and greet instructors and campers
	Initial research surveys
	Install and check required materials and software
Day 2	Technology check for campers
	Introduction to game story types
	Brainstorm in groups favorite game story types
	Building first example game
Day 3	First example game continued
Day 4	Building second example game
Day 5	Creating music and sound effects
	Brainstorming game ideas
Day 6	Assign teams
	Team brainstorming
Day 7-12	Game development
Day 13	Game development continued
	Invited guest speaker
	Practice presenting game to the other campers
Day 14	Final touches on game
	Practice presenting
Day 15	Re-administer research surveys
	Game presentations

3.3 Participants

Per university human-subjects research requirements, the research team obtained approval from our Institutional Review Board (IRB) to conduct this study, and the camp is offered for free for all students participating, regardless of participation in the research study. We obtained participant consent from both parents and students using IRB-approved forms and documents. A total of 22 campers participated the IRB approved research portion

Table 3: Camper demographics with programming experience and self-reported career interests at the start of camp.

ID	Age	Gender	Grade	Programming Exp.	Career Interest
C1	15	Male	9th	None	Culinary
C2	16	Male	10th	Some - C++, Python	Computer Science
C3	15	Male	9th	None	Journalism
C4	16	Male	11th	Some - JavaScript, C++	Game Development
C5	16	Male	11th	None	Game Development
C6	16	Male	9th	None	Game Development
C7	14	Male	9th	Some - Unspecified	Computer Science
C8	17	Male	12th	None	Game Development
C9	16	Male	11th	Some - Python	Computer Science
C10	15	Male	10th	Some - Scratch, Python	Automotive/Robotics
C11	16	Female	12th	Some - C++	Zoology
C12	16	Male	11th	None	Animation
C13	16	Male	11th	Some - Unspecified	Game Development

of the camp. However, over the course of three weeks 8 campers dropped out and one was asked to leave due to conflicts with the camp's behavior expectations, leaving us with 13 total campers who participated in all three weeks of camp and had both parent and camper consent to participate in the research. The ages of the campers ranged from 14 to 17 years old, and 12 were male and 1 was female. Four campers were in 9th grade, two in 10th grade, five in 11th grade, and two were in 12th grade. All campers resided in the United States and attended camp remotely from their respective locations. Six of our thirteen campers indicated at sign up that they did not have programming experience in the last year or at all, while seven indicated varying levels of coding experience. Eight campers indicated interest in a software or game development career, while others had other STEM interests or interests outside of STEM completely - culinary, journalism, automotive/robotics, animation, and zoology. A visual of camper demographics can be found in Table 3.

3.4 Data Collection

To collect data, we employed two surveys using using Qualtrics[3] and conducted observations of the campers during camp activities. We used Qualtrics' built in ExpertReview system to ensure accessibility and readability during the survey, as well as breaking out into small groups with instructors if students needed assistance during any portion of the survey.

The first student survey consisted of researcher-adapted questions using a 5-point Likert scale on computing interest and knowledge (for Women amp; Information Technology, 2020), self-efficacy (Tsai et al., 2019), and future time perspective (Husman et al., 2007; Husman and Shell, 2008) for computing, art, and music. Questions for this survey can be found Appendix A. The second student survey was a 10 question Scratch skills assessment developed by the research team with inspiration from skills assessment questions from De Lira *et al.* and found in Appendix B (Lira et al., 2022). Skills assessment questions asked campers to look at code blocks and answer what code blocks would produce, complete code blocks for a specific outcome, and general knowledge of programming concepts. Overall the Scratch coding skills assessment investigated campers abilities in conditionals, operators, user interaction, code interpretation, synchronization, loops, object interaction, and debugging. A full breakdown of questions and their related concepts can be found in Table 4. We administered both surveys twice - once on the first day of camp, and again on the last day of camp after three weeks of instruction.

[3]https://www.qualtrics.com/

Table 4: Breakdown of skill assessment questions by computing concepts.

Q#	Computing Concepts
Q1	Conditionals
Q2	User interaction, conditionals, code interpretation
Q3	Conditional, operators, code interpretation
Q4	Synchronizaiton
Q5	Loops, operators
Q6	Object interaction, conditionals
Q7	Operators
Q8	Debugging
Q9	Debugging
Q10	Object Interaction

3.5 Analysis

We initiated the analysis by evaluating surveys that exclusively featured quantitative data. We crafted questions on a 5-point Likert scale to measure computing interest, self-efficacy, computing knowledge, and future time perspective, and implemented a point-based system for skills assessment, awarding one point for correct answers and zero for incorrect ones. For the Likert scale questions, each category was isolated and standard statistical tests were run on each category. Due to our smaller sample size (less than 20), we opted to also use Hedge's g to estimate our effect size (NIST, 2017). Additionally, we performed the Benjamini-Hochburg adjustment for p-values to account for any false discovery rates (Benjamini and Hochberg, 1995). Using corrections to paired-sample t-test results, we improved our statistical understanding of the data.

3.6 Limitations

We acknowledge that several limitations exist in this study. One limitation is our sample size. Due to the nature of our study we anticipated a smaller sample size, but did not anticipate the number of campers to drop the camp, thus we chose to accommodate our statistical analyses using Hedge's *g*. Second, survey studies can be limited by response bias. The idea of taking surveys for our population may not be considered exciting or fun and take away time from working on programming. This may result in campers wanting to get through the survey quickly or answer in an uninterested way. We have provided the duration of each of the surveys administered to accommodate this. However, given these limitations, we aim to target transferability of our results for informal STEM education at the K-12 level for less represented group rather than generalizability for neurodiverse individuals as whole.

4 RESULTS

In this section, we present the results of our pre- and post-surveys for skills assessment, self-efficacy, and motivation.

4.1 Skill Assessment Analysis

As part of understanding campers' perceived self-efficacy (RQ_2), we investigated campers' actual Scratch coding skills pre- and post-camp using an identical 10-question survey. Pre-camp descriptive statistics for 21 initial campers show that the overall average score on a 10-question skills assessment was 6.54, and the median score of 7 out of 10 possible points. The average time to complete the initial skills assessment was 10.74 minutes, with a median time of 5.7 minutes. Several campers dropped out throughout the three weeks of camp, leaving us with 13 campers for the final assessment who participated in the initial assessment. Post-camp descriptive statistics for the 13 campers show an overall average score of 6.84 and a median score of 7 out of the 10 possible points. The average time to complete the final skills assessment was 8.69 minutes with a median time of 6.11 minutes. Overall, 6 campers (46.2%) improved their assessment score by 1 point, 5 campers (38.5%) scores stayed the same, and 2 campers (15.4%) reduced their assessment score by 1.

Questions one, three, five, eight, and nine all saw improvements from 7 campers who improved their scores. The two most common questions improved upon related to conditionals and debugging, questions one and nine, respectively. Questions two and eight saw 3 campers answer incorrectly regarding user interaction, conditionals, and code interpretation, question two and debugging in question eight. To note, only one camper improved their score in two areas while decreasing their score in another.

Using paired sample t-tests, we analyzed the difference between the pre- and post-camp assessment for the 13 campers who stayed through the entirety of camp. We found that the pre-camp assessment showed an average score of 6.54 with a standard deviation of 0.97, and the post-camp assessment showed an average score of 6.85 with a standard deviation of 0.90. A descriptive statistics table is found in Table 5. Skills assessment results indicate no significant mean increase in campers' skills, $t(12) = -1.48$, $p = 0.08$, BH corrected $p > 0.20$.

Additionally, we asked campers within the computing interests and self-efficacy survey their perceived confidence in their current abilities and knowledge in various computing areas. Pre-camp confidence in computing knowledge for the thirteen campers who completed camp averaged to being somewhat confident in their abilities, with an average score of 18.54 out of 35 total confidence points being completely confident. Post-camp confidence in computing knowledge improved slightly, with an average score of 20.6 out of 35 total confidence points. Using a paired sample t-test, we found no significant mean increase in campers' perceived confidence in computing skills, $t(12) = -0.82$, $p > 0.20$, BH corrected $p > 0.30$. These descriptive statistics can be found in Table 5.

4.2 Computing Interest and Self-Efficacy Analysis

As part of understanding campers' interest in computing (RQ_1), we investigated campers' interests in what they wanted to learn in a three-week summer camp, understanding the campers' future time perspective, and perceived self-efficacy of their coding, music, and art abilities. For the campers who completed all three weeks of camp, the descriptive statistics are found in Table 5.

Perceived computing interest pre-camp averaged to being moderately interested in various computing topics with an average score of 39.23 out of 65 total points. Post-camp interest increased slightly and averaged to moderately interested, with an average score of 40.31 out of 65 points. Computing interest group results indicate no significant mean increase in campers' computing interests, $t(12)$ = -0.21, p > .40, BH corrected $p > 0.40$. The largest change in interest by specific questions surrounded an increase in interest in computer networking and thinking of new ways to apply computer science, and found a decrease in interest in a college degree.

We also asked camp-specific questions surrounding interest in making games, music, art, learning about college opportunities, and making new friends. Pre-camp survey for camp-specific interest averaged to being moderately to very interested, with an average score of 24.31 out of 35 total points. Post-camp survey for camp-specific learning interests decreased slightly and averaged to being moderately to very interested with an average score of 23.80 of 35 points. Camp-specific computing interest group results indicate no significant mean increase in camp-specific computing interests, $t(12)$ = 0.25, p > .40, BH corrected $p > 0.40$. The largest change in interest by topic was a decrease in interest in learning more about computer science and software development and increased interest in creating a videogame.

For our research purposes, future time perspective (FTP) is used to help situate computing interests and better understand the campers' outlook on a career and interest in programming as a whole using the value sub-scale from FTP literature. The value sub-scale included 7 questions regarding use of the information gained in the camp, skills or concepts learned in camp being used in future projects or class work, and the importance to campers of understanding computing concepts. Pre-camp FTP value averaged to moderate agreement in having positive value to the campers' future with an average of 26.80 out of 35 total points. Post-camp FTP value stayed about the same, with a marginal decrease with an average of 26.46 out of 35 total points. FTP value group results indicate no significant mean increase in campers' value of what they will learn within the camp being useful in the future, $t(12)$ = 0.17, p > .40, BH corrected $p > 0.40$. The largest change in FTP value for campers was an increase in believing they would use information from the camp in the future and a decrease in believing what was learned in camp to be important for career success.

To understand campers' perceived capabilities with programming, we asked computing-specific self-efficacy questions to the campers. Pre-camp student self-efficacy scores averaged to being somewhat confident that they had the capabilities to program or understand certain programming concepts, with an average score of 48.62 out of 80 total points. Post-camp student self-efficacy scores increased their belief in programming capabilities, with an average score of 57.23 out of 80 total points. Computing self-efficacy group results indicate no significant mean increase in camp-specific computing interests, $t(12)$ = 0.25, p = 0.09, BH corrected $p > 0.20$. The largest change in self-efficacy surrounded the ability to edit and revise programs in an editor, not needing others' help to solve a problem, opening and saving code in an editor, and running and testing code in an editor. The least amount of change seen in self-efficacy surrounded knowing that work can be subdivided into smaller tasks, predicting the outcome of code with logical conditions, and learning more about programming through debugging.

Finally, to understand campers' perceived capabilities with art and music, we asked music composition and art creation self-efficacy questions to the campers. Pre-camp student art and music self-efficacy averaged to being somewhat confident that they had the capabilities to make music and art for their games with an average score of 47.69 out of 80 total points. Post-camp student art and music self-efficacy scores increased slightly to 53.84 out of 80 total points. Art and music self-efficacy group results indicate no significant mean increase, $t(12)$ = 0.25, p = 0.01, BH corrected $p = 0.08$. The largest change in self-efficacy for art and music surrounded an increase in understanding the basic elements of digital animation and drawing in Scratch and understanding the basic elements of digital music creation.

Table 5: Descriptive statistics for thirteen (13) campers with Hedges' correction to Cohen's *d*, Benjamini-Hochberg (BH) adjusted p-values for self-reported computing interest, perceived self-efficacy in computing, music, and art, perceived computing knowledge, future time perspective

	Pre-Camp		Post-Camp					
Section	**Mean**	**SD**	**Mean**	**SD**	**Cohen's *d***	**Hedges' *g***	**p-value**	**BH p-value**
Skills Assessment	6.54	0.97	6.85	0.90	-0.41	-0.38	0.08	0.21
Computing knowledge	18.53	8.03	20.62	7.24	-0.23	-0.21	0.22	0.35
Computing Interest	39.23	13.68	40.31	12.11	-0.06	-0.06	0.42	0.42
Computing interest - camp specific concepts	24.31	5.94	23.80	5.70	0.07	0.07	0.40	0.42
FTP Value	26.80	6.07	26.46	5.13	.05	.04	0.44	0.44
Self-efficacy	48.62	18.15	57.23	11.10	-0.40	-0.37	0.09	0.21
Self-efficacy art + music	47.69	7.78	53.84	7.05	-0.73	-0.69	0.01	0.08

4.3 Individual Student Results

We analyzed each student before and after three weeks of camp to understand where their skills, self-efficacy, and motivation were. Analyzing each student individually helps to guide where aspects of the camp impacted the campers the most and if those impacts reflect changes we need to make or aspects to keep in the camp. Table 6 includes campers with their respective differences in scores in all survey sections.

C1, male, age 15, no programming experience and with a career interest in the culinary field, saw the largest increase in his computing interest scores with a positive change of 17 points. C1 also saw slight increases in camp-specific computing interests, computing knowledge, FTP, and self-efficacy (both general and art/music categories). He had no change in his skills assessment.

C2, male, age 16, some programming experience in C++ and Python, and a career interest in computer science, saw the largest increase in computing knowledge scores with a positive change of 12 points. C2 also saw small increases in FTP and self-efficacy for music/art. C2 saw a significant decrease in general self-efficacy with a decrease of 11 points. Additionally, C2 had decreased scores in both general and camp-specific computing interests. He had no change in his skills assessment. The team observed that C2 had an interest in music composition and other music-related interests that he shared with the team.

C3, male, age 15, no programming experience and with a career interest in journalism, saw the largest increase in his self-efficacy scores with 17 points in art/music and 11 points in general self-efficacy. C3 saw small a small increase in his camp-specific computing interest scores. Additionally, saw the largest decrease in FTP scores, decreasing by 9 points. C3 also decreased scores in general computing interest and computing knowledge, both by one point each. He had an increase of 1 point in his skills assessment. The team observed that this student often had some confidence issues and would be hesitant to speak up unless called on, but toward the end of camp, he shared more about what he was working on even when facing issues with the collaboration software the team used to facilitate collaboration.

C4, male, aged 16, some programming experience in C++ and JavaScript, and a career interest in game development, saw the largest increase in scores with a positive change of 3 points in FTP. C4 saw some decrease in scores in general computing interest by 7 points, and a decrease in self-efficacy by three points. He saw no net change in camp-specific computing interests, computing knowledge, art/music self-efficacy, or in the skills assessment.

C5, male, age 16, no programming experience, and a career interest in game development, saw significant increases in his general self-efficacy with a positive increase of 23 points and in computing interest with positive 22 points. C5 saw small increases in art/music self-efficacy by 8 points, in computing knowledge by 6 points, and camp-specific computing interests by 3 points. He had no change in FTP and decreased his skills assessment by 1.

C6, male, age, 16, no programming experience, and a career interest in game development, saw significant increases across the board with positive 58 points in self-efficacy, 31 points in computing interest, 19 points in computing knowledge, 17 in art/music self-efficacy, and 14 points in camp-specific computing interests. C6 saw a decrease of 3 points in FTP. He also saw an increase of 1 point in his skills assessment.

C7, male, age 14, some programming experience reported but unspecified, and a career interest in computer science, saw significant decreases in all sections of the survey except for the skills assessment with no change. C7 decreased by 27 points in general computing interests, 17 points in camp-specific computing interests, 16 points in computing knowledge, three in FTP, 18 points in self-efficacy, and 10 pints in art/music self-efficacy.

C8, male, age 17, no programming experience, and a career interest in game development, saw the largest increase in his general self-efficacy score with an increase of 14 points. C8 also saw an increase in his camp-specific computing interests with an increase of 7 points. He saw a decrease in both computing knowledge and computing interest by 5 and 4 points. He saw no difference in FTP. Additionally, C8 increased his skills assessment by 1. C8 was observed to be very quiet, but diligently working when given a task, and typically needed no extra guidance or intervention when working.

C9, male, age 16, some programming experience in Python, and a career interest in computer science, saw the largest increase in art/-music self-efficacy with a positive change of 17 points. C9 also saw an increase in FTP scores by 7 points. He saw decreases in computing interest by 14 points, camp-specific computing interest by 8 points, self-efficacy by 5 points, and in the skills assessment by 1 point. He saw no change in FTP scores.

C10, male, age 15, some programming experience in Scratch and Python, and a career interest in automotive engineering or robotics, saw the largest increase in art/music self-efficacy with a positive change of 14 points, followed by an increase in general self-efficacy by 8 points. C10 also saw small increases in FTP by 5 points, computing knowledge by 3 points, and camp-specific computing interests by 1 point. He had a decrease in computing interest scores by 5 points. Additionally, he increased his skills assessment score by 1 point.

C11, female, age 16, some programming experience in C++, and a career interest in Zoology, saw the largest increase in general computing interest with a positive change of 11 points. C11 also increased her FTP and general self-efficacy scores by 9 points each, computing knowledge by 6 points, and skills assessment by 1 point. She saw a decrease in camp-specific computing interests by 4 points. C11, towards the end of the camp, increasingly ran into issues and bugs with the software the camp used to facilitate collaboration.

C12, male, age 16, no prior programming experience, and a career interest in animation, saw the largest increase in self-efficacy with a positive change of 39 points. C12 also increased scores in computing interest with a 22 point increase, in computing computing with a 9 point increase, and in the skills assessment test by 1 point. He saw a slight decrease in camp-specific computing knowledge and FTP, both decreasing by 2 points. C12 had no change in art/music self-efficacy.

C13, male, age 16, some programming experience reported but not specified, and a career interest in game development, saw his only score increase in art/music self-efficacy with a positive score increase of 9 points. C13 saw decreases in all other categories by 23 points in computing interest, one point in camp-specific computing interests, 10 points in computing knowledge, four points in FTP, and 16 in self-efficacy. He saw no change in his skills assessment.

Of campers who indicated that they had no prior programming experience in the last year - C1, C3, C5, C6, C8, and C12 - all saw score improvements in general self-efficacy. C1, C3, C5, C6, and C8 also all saw improvements in art and music self-efficacy, while C12 saw no change. C3, C6, C8, and C12 also improved on their Scratch skills assessment after three weeks of camp. C1 saw no change in their skill assessment, and C5 had a decrease of one.

In total, 5 of 13 campers saw a positive change in general computing interests, and 7 saw no change or positive change in camp-specific computing interests. Computing knowledge saw 9 of 13 campers have no change or positive change to their scores. Future time perspective (FTP) saw 8 of 18 campers have no change or positive change to their scores. General self-efficacy saw 8 of 13 campers have a positive change to their score and art/music self-efficacy saw the majority, 12 of 13 campers, have no change or positive change to their scores. The skills assessment saw 6 campers with a positive change, 5 campers with no change, and 2 with negative change.

Table 6: Individual student differences between pre- and post-surveys for each section where CI is computing interest, CI-C is camp-specific computing interests, CK is computing knowledge, FTP is future time perspective, SE is general self-efficacy, SE-A/M is art/music self-efficacy, and Skills is the skills assessment test.

ID	**CIΔ**	**CI-CΔ**	**CKΔ**	**FTPΔ**	**SEΔ**	**SE-A/MΔ**	**SkillsΔ**
C1	17	2	4	5	3	2	0
C2	-8	-7	12	5	-11	5	0
C3	-1	5	-1	-9	11	17	1
C4	-7	0	0	3	-3	0	0
C5	22	3	6	0	23	8	-1
C6	31	14	19	-3	58	17	1
C7	-27	-17	-16	-3	-18	-10	0
C8	-4	7	-5	0	14	1	1
C9	-14	-8	0	7	-5	17	-1
C10	-5	1	3	5	8	14	1
C11	11	-4	6	9	9	0	1
C12	22	-2	9	-2	39	0	1
C13	-23	-1	-10	-4	-16	9	0

5 DISCUSSION

In this paper, we posed two research questions aiming to understand how project-based learning in a virtual summer camp can influence high school-aged students' interests (RQ_1) and perceived self-efficacy (RQ_2) in computing topics. In the following sections, we discuss the impacts of the camp on both of our research questions and give recommendations for others who may be interested in similar informal learning opportunities for K-12 students.

5.1 Promoting Interest in Computing

According to our survey on future time perspective and computing interests, there was no significant change in the campers' perceptions or valuation of a computing career following their participation in the camp. While this result is surprising, we might be able to attribute the lack of increased interest in computing to using a block-based programming language. The campers had a wide range of computing skills, with about half of the campers having experience in text-based programming languages, which might have attributed to the lack of change in computing interest and value. Additionally, the camp's daily duration of two hours may not have been sufficient enough to promote and practice various aspects of software and game development.

5.2 Promoting Student Self-Efficacy

Individually, more than half of the campers (8) improved on their general self-efficacy scores, but as a group, this did not achieve statistical significance. More than half of the campers (9) improved on their art and music self-efficacy, but as a group with corrections for a small sample size did not make significance. For the research team, this result was a little unexpected, but for those with prior programming experience, using Scratch could not have been engaging enough or too easy for them. Interestingly, all campers who did not indicate any prior programming experience improved on their general self-efficacy, and three with some programming knowledge also improved. This leads us to believe that for those with little to no programming experience, the camp was successful, in part, at increasing general self-efficacy through informal project-based learning activities. However, for campers with prior programming experience, our camp design may need to be more engaging or complex to engage the campers in ways that they felt were worth the effort to participate. As a research team with prior programming experience in various programming languages like Python, C++, and Java, we note that Scratch proved difficult to work in coming from a non-block-based language. We speculate that campers with text-based language knowledge and proficiency may also have had a difficult time translating programming concepts to a block-based language and led to lower self-efficacy.

5.3 Recommendations

Considering the lack of statistical difference and relatively high pre- and post-skills assessment scores, we must consider whether Scratch or block-based programming is appropriate for high school students. While many campers indicated that they did not have any experience with programming in the last year, block-based languages like Scratch may have been part of their school curriculum in previous years. Using Scratch in the way that we did also may have lead to some of our retention issues with campers throughout the camp. This leads us to our first recommendation for building an informal STEM summer camp:

> **Recommendation:** Clearly specify the target programming experience level for the camp.

Little to no change in motivation or self-efficacy could stem from several causes - lack of feedback, unfamiliar environment, and/or needing more time in teams to form a productive team dynamic. Initially, the research team wanted to focus on having stand-up meetings every 15 minutes when campers were in teams working on their final game. However, adhering to such a quick turnaround time proved challenging for teams who had campers who needed extra assistance, were actively working through an issue or bug with an instructor or teammate, or instructors did not want to interrupt campers who were focused on a task. We felt if campers had a better way to provide feedback to one another that motivation and self-efficacy could be increased through positive peer interactions. From this, we give another recommendation to provide multiple ways to provide feedback.

> **Recommendation:** Provide multiple ways to get inter-team feedback and facilitate peer-to-peer review.

Building a repertoire amongst teammates with positive peer feedback could also alleviate the campers' being in an unfamiliar environment. Online classes have been shown to be challenging environments for campers to form relationships in where campers may not be able to express themselves fully with only text or limited amount of camera use (Symeonides and Childs, 2015). While we facilitate various ice breakers and social games, the online nature of the camp does not afford itself to quick familiarly with instructors and other campers. To combat this, the team implemented a Discord server for campers to utilize during and outside of camp as a way to facilitate discussions and making connections with the other campers. Discord was chosen as it is a popular application for its use in gaming and as a main communication app for many campers. From this, we recommend finding ways to encourage conversation between campers in ways that they would find familiar:

> **Recommendation:** Provide the campers with a familiar way to engage with others.

Along the same vein with having the ability to form working and familiar relationships, the amount of time we spend in camp may not have been adequate enough to begin forming useful or beneficial relationships. This could be increasing the duration of camp each day. Thus, we recommend re-assessing engagement time with campers each day:

> **Recommendation:** Ensure enough time is allocated in camp to let campers familiarize themselves with other campers and staff.

Additionally, increased time in camp could afford finding ways to interact with campers in small groups to get to know each other more. While the research team used introductions on the first day, randomized small-group brainstorming, and having campers move from group to group while making example games, the campers did not have a significant amount of time dedicated to getting to know one another. Adding additional time overall to camp and providing more interactive opportunities could prove beneficial to campers forming teams naturally rather than camp staff trying to pair campers together based on interests and observed interactions. Therefore, to facilitate more natural teaming, we recommend:

> **Recommendation:** Integrate more "ice-breakers" and other team-building exercises into the camp to build repertoire and familiarity between campers.

Finally, we recommend bringing in speakers who might be similar or relatable to the campers. In our camp, we brought in a neurodiverse software and game developer to speak to the campers about how they navigated school, their job, and their well-being. Campers responded well to our speaker with lively engagement and had many questions after his presentation. Therefore, to give the campers an opportunity to interface with a mentor-like and relatable figure, we recommend:

> **Recommendation:** Invite guest speakers who are similar to your campers to promote representation and inspire the campers.

6 CONCLUSION

In this paper, we highlight where informal learning can be used in K-12 STEM education using a Scratch-based game development summer camp designed for neurodiverse high school students. Using surveys and in-situ observations, we found that campers trended toward increased self-efficacy with programming skills and increased motivation to peruse a STEM related topic. We then discuss recommendations for others looking to implement online informal learning opportunities and recommendations on providing an environment that encourages and facilitates low-stakes learning in a collaborative setting. Through subsequent research we aim to provide additional insights into implementing our own recommendations as well as continuing to investigate self-efficacy and motivation as a result of informal learning in a summer camp setting.

7 Data Availability

For replicability, we have included both an appendix in this paper and an online appendix of both our pre- and post-surveys. The in paper appendix includes all questions related to computing interest and knowledge, future time perspective, and self-efficacy. The online appendix includes all questions and related images for the Scratch skills assessment.

APPENDIX: SURVEY QUESTIONS

Computing Interest
Regardless of whether or not you have actually tried it, how interested are you in:

- Making computers more intelligent (more like people)
- Creating algorithms to make computers faster
- Understanding how computers present data and images
- Designing computer games
- Computer networking (like the internet)
- Thinking of new ways to apply computer science (like new apps or games)
- Programming computers to create new apps
- Finding technological solutions to world problems using computer science

How much do you want to:

- Take a computer science class
- Take a game development class
- Get a college degree
- Get a computer science or technology related college degree
- Get a computing related career as an adult

Computing Interest - Camp Specific
During camp, how interested are you in:

- Learning to code a videogame
- Learning to make music
- Learning to make art
- Learning about college opportunities
- Learning more about computer science and software development
- Making friends
- Learning something you don't know

Computing Knowledge Right now, how confident are you in your ability to:

- Learn computer science concepts
- Make computers more intelligent (more like people)
- Think of new ways to apply computer science
- Find technological solutions to world problems using computer science?
- Design computer games
- Understand how computers present data and images
- Create algorithms to make computers faster?

Future Time Perspective
Please respond to the following:

- One shouldn't think too much about the future
- It is important to have goals for where ones to be in 5-10 years
- One should be taking steps today to help realize future goals
- I don't think too much about the future
- I don't like to plan for the future

Its not really important to have future goals for where I want to be 5-10 years

Planning for the future is a waste of time

I have been thinking about about what I want to do in the future

It is no use worrying about the future

It is no use worrying about the future

What will happen in the future is an important consideration in deciding what to do right now

What might happen in the long run should not be a considerations in making decisions right now

What I do today will have little impact on what happens 10 years from now

Half a year seems like a long time to me

I need to feel rushed before I can work on something

I always Seem to do things at the last moment

I find it hard to get things done without a deadline

In general, six months seems like a very short period of time

I will use the information I learn at this camp in the future

I will use the information I learn in this camp in other classes or projects in the future

What I learn in this camp will be important for my career success

I will not use what I learn in this camp at all

Having an understanding of software and game development is valuable

Understanding software and game development is important to me

What I learn in this camp will be important for personal success

General Self-Efficacy

Please answer the following questions about your programming ability:

I can understand the basic logical structure of a program

I can understand a condition expression such as "if...else..."

I can predict the final result of a program with logical conditions

I can predict the result of a program when given its input values

I know programming work can be divided into sub-tasks for people

I can work with others while writing a program

I can make use of divisions to enhance programming efficiency

I can figure out program procedures without a sample or example

I don't need others help to construct a program

I can make use of programming to solve a problem

I can open and save a program in a program editor

I can edit and revise a program in a program editor

I can run and test a program in a program editor

I can find the origin of an error whole testing a program

I can fix an error while testing a program

I can learn more about programming during the debugging process

Self-Efficacy Art and Music

Please answer the following questions about your digital art and music abilities

I understand the basic elements of digital drawing

I understand the basic elements of digital animation

I understand the basic elements of digital drawing in Scratch

I understand the basic elements of digital animation in Scratch

I am confident I can draw and animate characters for a game

I am confident I can draw and animate background scenes for a game

I understand the basic elements of digital music creation

I understand the basic elements of digital music creation in scratch

I am confident that I can successfully make music for elements of a game

APPENDIX: SKILLS ASSESSMENT QUESTIONS

The skills assessment and its accompanying images can be found via an online appendix: https://figshare.com/s/972dc1457358a0d161f2.

ACKNOWLEDGEMENTS

We would like to thank all of the campers who participated this year, it was amazing to see the amount of creativity and determination everyone had to make their game ideas come to life.

REFERENCES

Armoni, M., Meerbaum-Salant, O., and Ben-Ari, M. (2015). From scratch to “real” programming. *ACM Transactions on Computing Education (TOCE)*, 14(4):1–15.

Bagiati, A., Yoon, S. Y., Evangelou, D., and Ngambeki, I. (2010). Engineering curricula in early education: Describing the landscape of open resources. *Early Childhood Research & Practice*, 12(2):n2.

Bandura, A. (1997). Self-efficacy: The exercise of control. 1997. *Knowledge is necessary but insufficient to change behavior.[BoFe91]*.

Benjamini, Y. and Hochberg, Y. (1995). Controlling the false discovery rate: a practical and powerful approach to multiple testing. *Journal of the Royal statistical society: series B (Methodological)*, 57(1):289–300.

Campbell, C. and Speldewinde, C. (2022). Early childhood stem education for sustainable development. *Sustainability*, 14(6):3524.

Christensen, R., Knezek, G., and Tyler-Wood, T. (2015). A retrospective analysis of stem career interest among mathematics and science academy students. *International Journal of Learning, Teaching and Educational Research*, 10(1):45–58.

Chrysochoou, M., Zaghi, A. E., and Syharat, C. M. (2022). Reframing neurodiversity in engineering education. In *Frontiers in Education*, volume 7, page 995865. Frontiers.

Clouder, L., Karakus, M., Cinotti, A., Ferreyra, M. V., Fierros, G. A., and Rojo, P. (2020). Neurodiversity in higher education: a narrative synthesis. *Higher Education*, 80(4):757–778.

Dailey, D. (2018). Stemulate engineering academy: Engaging students and teachers in engineering practices. *Roeper Review*.

DiSalvo, B. (2014). They can’t find us: the search for informal cs education. *Proceedings of the 45th ACM technical symposium on Computer science education*.

Eccles, J. S. and Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual review of psychology*, 53(1):109–132.

Espinosa, L. (2011). Pipelines and pathways: Women of color in undergraduate stem majors and the college experiences that contribute to persistence. *Harvard Educational Review*, 81(2):209–241.

Fagerlund, J., Häkkinen, P., Vesisenaho, M., and Viiri, J. (2021). Computational thinking in programming with scratch in primary schools: A systematic review. *Computer Applications in Engineering Education*, 29(1):12–28.

for Women amp; Information Technology, N. C. (2020). Computing interest confidence perception survey.

Furlong, J. (2012). Young people, new technologies and learning at home: taking context seriously. *Oxford Review of Education*.

Heidari, E., Mehrvarz, M., Marzooghi, R., and Stoyanov, S. (2021). The role of digital informal learning in the relationship between students’ digital competence and academic engagement during the covid-19 pandemic. *Journal of Computer Assisted Learning*, 37(4):1154–1166.

Husman, J., Lynch, C., Hilpert, J., et al. (2007). Validating measures of future time perspective for engineering students: Steps toward improving engineering education. In *2007 Annual Conference & Exposition*, pages 12–1581.

Husman, J. and Shell, D. F. (2008). Beliefs and perceptions about the future: A measurement of future time perspective. *Learning and individual differences*, 18(2):166–175.

Jizat, N. A. M. (2021). Lecturer perspective on informal learning activities. *Indonesian Journal of Educational Research and Technology*.

Lee, Y., Capraro, M. M., and Viruru, R. (2018). The factors motivating students’ stem career aspirations: Personal and societal contexts. *International Journal of Innovation in Science and Mathematics Education*, 26(5).

Lin, C.-L., Liang, J.-C., Su, Y.-C., and Tsai, C.-C. (2013). Exploring the relationships between self-efficacy and preference for teacher authority among computer science majors. *Journal of Educational Computing Research*, 49(2):189–207.

Lira, C. D., Wong, R. M., Oje, O., Nketah, G., Adesope, O. O., and Ghods, A. (2022). Summer programming camps - exploring project-based informal cs education in a rural community. *Int. J. Comput. Sci. Educ. Sch.*, 5:20–37.

Maiorca, C., Roberts, T. G., Jackson, C., Bush, S. B., Delaney, A. R., Mohr-Schroeder, M. J., and Soledad, S. Y. (2020). Informal learning environments and impact on interest in stem careers. *International Journal of Science and Mathematics Education*, 19:45–64.

NIST (2017). Hedges g.

Nite, S. (2014). Science, technology, engineering and mathematics (stem) education: A longitudinal examination of secondary school intervention. *2014 IEEE Frontiers in Education Conference (FIE) Proceedings.*

Pintrich, P. R. and De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of educational psychology*, 82(1):33.

RAFANAN, R. J., De Guzman, C. Y., et al. (2020). Pursuing stem careers: Perspectives of senior high school students. *Participatory Educational Research*, 7(3):38–58.

Rappolt-Schlichtmann, G., Boucher, A. R., and Evans, M. (2018). From deficit remediation to capacity building: Learning to enable rather than disable students with dyslexia. *Language, Speech, and Hearing Services in Schools*, 49(4):864–874.

Roberts, T., Jackson, C., Mohr-Schroeder, M. J., Bush, S. B., Maiorca, C., Cavalcanti, M., Craig Schroeder, D., Delaney, A., Putnam, L., and Cremeans, C. (2018). Students' perceptions of stem learning after participating in a summer informal learning experience. *International journal of STEM education*, 5(1):1–14.

Rosson, M. B., Carroll, J. M., and Sinha, H. (2011). Orientation of undergraduates toward careers in the computer and information sciences: Gender, self-efficacy and social support. *ACM Transactions on Computing Education (TOCE)*, 11(3):1–23.

Roy, R. and Jain, S. (2021). Global neurodiverse support systems: Primary research findings on key challenges and optimized solutions in mumbai, india. *The Physician*, 6(3):1–22.

Saleh, S., Ashari, Z. M., Kosnin, A. M., and Rahmani, A. S. (2019). A systematic literature review on the roles of interest and motivation in stem education. In *2019 IEEE International Conference on Engineering, Technology and Education (TALE)*, pages 1–6. IEEE.

Secules, S., McCall, C., Mejia, J. A., Beebe, C., Masters, A. S., L. Sánchez-Peña, M., and Svyantek, M. (2021). Positionality practices and dimensions of impact on equity research: A collaborative inquiry and call to the community. *Journal of Engineering Education*, 110(1):19–43.

Syharat, C. M., Hain, A., Zaghi, A. E., Gabriel, R., and Berdanier, C. G. (2023). Experiences of neurodivergent students in graduate stem programs. *Frontiers in Psychology*, 14:1149068.

Symeonides, R. and Childs, C. (2015). The personal experience of online learning: An interpretative phenomenological analysis. *Computers in Human Behavior*, 51:539–545.

Tsai, M.-J., Wang, C.-Y., and Hsu, P.-F. (2019). Developing the computer programming self-efficacy scale for computer literacy education. *Journal of Educational Computing Research*, 56(8):1345–1360.