Exploring Children’s Online Summer Camp Adventures through Creativity and Problem Solving

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Abstract: Summer camps can help children continue to learn beyond school, build knowledge, keep their learning skills sharp, and help them prepare for the following school year. This paper presents participants’, facilitators’, and researchers’ experiences in a “Problem Solvers Camp” held in the Maker Lab at an Ontario University. A total of 12 junior students participated in a one-week summer camp, during which the participants developed plausible solutions for mathematical and instant problems using their creativity while learning some mathematical concepts. The creative learning spiral (CLS) model was adopted while designing the learning activities. Throughout the camp, children had the opportunity to work with virtual tech tools to design, create, and play to complete their challenges. Afterward, they shared their work for feedback and generated new ideas to promote their creative learning. The data were collected through observations, participants’ work, and their portfolios to highlight the campers’ experiences throughout the camp. On the last day of the camp, the researchers also ran focus group interviews. Data analysis showed that CLS might offer engaging environments that enhance children’s creative and reflective thinking skills to solve real-life problems. This study enabled children to engage in all stages of the CLS during problem solving, encouraging the exchange of ideas and opinions. The implementation of the CLS model also has the potential to inspire creativity and enhance learners’ fluency and elaboration skills, especially when complemented by technological or coding tools.

Keywords: STEAM education; mathematics; global competencies; spiral model; coding

1. Introduction

The Council of Ministers of Education, Canada (CMEC) declared six global competencies (critical thinking and problem solving, communication, collaboration, creativity and innovation, learning to learn/self-aware and self-directed, and global citizenship and sustainability) that play significant roles in preparing the next generations for their unknown future [1]. According to the World Economic Forum, these competencies also take place among the trending skills for the future labour market. In addition, competencies like problem solving and creativity are still essential for developing and bringing innovation to life and were identified among the top five skills for 2025 [2]. Problem solving and creativity are two of the critical global competencies that are necessary for children’s future lives. Both formal educational settings such as schools and informal educational programs (e.g., out-of-school time programs and summer camps) focus on developing these kinds of competencies.

Various camp programs are accessible for students of different ages to support the involvement of children in informal learning environments. Moreover, these kinds of programs significantly contribute to learners’ understanding of STEM/STEAM subjects and their future careers as STEM majors [3], as well as promoting the development of important skills, such as problem solving [4]. Furthermore, STEM experiences that require
creativity and problem-solving skills can also positively impact children’s STEM-related learning and career choices [5]. Especially after the pandemic, the need for STEM-related jobs such as AI and machine learning specialists, data analysts and scientists, software and application developers, mathematicians, and engineers in Canada has dramatically increased [2]. Therefore, improving global competencies like creativity and problem solving might support young generations’ future STEM careers.

Mathematics is one of the subjects that support children’s development of skills. According to Khalid et al. (2020) [6], mathematics is an appropriate platform to promote creativity in which children can develop unique or insightful solutions or tactics for solving problems. The new Ontario mathematics curriculum for grades 1–8 aims to improve mathematics performance, prepare children for their future careers, and help children solve everyday math problems. It also includes coding topics starting in grade one to spark children’s creativity and promote their problem-solving skills and fluency with technology [7]. Recently, coding has been widely used in a variety of academic and professional settings. With the help of the new Ontario mathematics curriculum, this literacy could be extended to students in various grades to create opportunities and new ways to transform mathematics education [8], to prepare students for future jobs that require coding.

Engaging in robotics and coding activities significantly enhances problem solving, creative thinking, and digital citizenship skills, all of which are essential components of 21st century skills [9]. With the help of appropriate tech tools and teaching approaches, learning to code could be easier and more accessible. In recent years, rapid changes and developments have emerged in a variety of user-friendly learning tools for coding, especially for children.

While children learn how to code by using tech tools, they could increase their creativity [10] and problem-solving skills [11]. Incorporating creativity into the classroom through integrated technology provides teachers the flexibility to embed course content within instructional methods. This student-centred approach fosters the development of problem-solving skills, effectively preparing students for the future [12]. Although there are many studies based on the encouragement of creativity in the teaching environment, the examples of teaching for creativity are rare [13]. Therefore, it is crucial to explore how teachers might design a wide variety of learning environments and activities to teach for creativity.

It is important to foster children’s developmental skills and make mathematics content applicable in real-life contexts through active engagement. Therefore, this research aimed to present a learning environment for children to use their creativity to handle challenges and understand children’s perspectives, attitudes, and experiences with coding and tech tools.

2. Literature Review

2.1. Problem Solving and Creativity

According to the Council of Ministers of Education [14], critical thinking and problem solving require “addressing complex issues and problems by acquiring, processing, analyzing and interpreting information to make informed judgments and decisions” (para. 2). Therefore, it is essential to provide meaningful, real-life problems and authentic experiences to support students’ active learning and to promote making connections to apply and transfer their knowledge to achieve their potential when they face real-world and authentic experiences [14].

Innovation and creativity are particularly important skills for 21st-century problem solving [15]. Creativity involves “the ability to turn ideas into action to meet the needs of a community” (para. 2) and enables children to make discoveries, use their imaginations, and generate or improve original ideas and strategies [14]. As the world experiences rapid changes, creativity helps individuals to constantly adapt to new and unprecedented challenges. Creative thinking in mathematics also equips students with the skills necessary to meet the challenges of the world of the future [16].
Sternberg (2006) [17] described the multifaceted nature of creativity, which includes abilities, knowledge, thinking styles, personality attributes, motivation, and environmental factors. Creativity can be hindered when individuals are reluctant to take reasonable risks or lack a supportive environment, so fostering a conducive environment, particularly within educational settings, is imperative for supporting creativity [17]. To become successful in life, having knowledge is not enough anymore; people need to think and act creatively [18]. Although creativity requires the ability to tackle problems by generating innovative solutions, it is necessary to focus on the process of problem solving rather than just reaching the solution [19]. Activities that require problem solving have the potential to be an effective instrument to engage children in active learning. Yen and Lee (2011) [20] stated that problem-solving activities could change the focus of lecturing to student-centred instruction in which students become more active and engaged learners. Samson (2015) [21] examined the impact of creative problem solving (CPS) teaching methodology on engagement and motivation by linking real-life experiences to inspire children to work in complex situations. The author suggested that CPS could be an effective teaching method, especially for transferring the developed skills, such as problem-solving skills, to the real-life environment [21].

Constructionism [22] is grounded in Piaget’s work on constructivism, emphasizing that children make meaning through daily relations with others and objects. Papert’s constructionism theory added another angle, which states that constructing one’s knowledge becomes most successful and effective when they are actively engaged. Moreover, with the help of inquiry and creativity, this theory allows learners to build their knowledge of the various disciplines [23].

The creative learning spiral (CLS), in other words, the “kindergarten approach to learning,” was proposed by Resnick (2017) [24]. While children are working on their projects, they engage in the CLS. This approach repeats the process of the imagining, creating, playing, sharing, and reflecting stages (see Figure 1). First, children can spark an idea (imagine), and based on this idea, they can work on their project (create), then experiment with their creations (play). Then it is time to show their projects to others to get feedback and suggestions (share and reflect). In the end, children can think about it more and develop new ideas or strategies based on all those interactions (imagine). Thus, CLS enables children to learn from their experiences by repeating the same procedure (developing ideas, trying and testing them, finding alternative ways, receiving feedback, and creating new ideas) repeatedly [24].

![Creative Learning Spiral](image-url)
Resnick (2007) [18] shared that, to become successful in a “Creative Society”, children “must learn to think creatively, plan systematically, analyze critically, work collaboratively, communicate clearly, design iteratively, and learn continuously” (p. 22). He suggested that using technologies such as Crickets (programmable toys or bricks in which children can connect lights, sensors, or motors) and Scratch (https://scratch.mit.edu/ (accessed on 15 October 2020)) could help children form the “Creative Society” [18]. In other words, he emphasized creating and sharing new educational strategies and technologies to contribute to children’s creative learning experiences.

Tsutsui and Takada (2018) [25] conducted workshops using Scratch to teach programming and promote creative thinking. They also introduced a classroom social networking service that allowed children to share and reflect on their projects by posting comments. This system significantly increased children’s motivation to reflect and facilitated knowledge sharing among peers. Similarly, Sayavaranont et al. (2018) [26] proposed a CLS-based spiral model to enhance Thai students’ creative thinking skills using Scratch. The study highlights the importance of preparing children for 21st-century challenges through skills such as creative thinking, and the results showed positive expert reactions, indicating the model’s potential for improvement. Furthermore, Liu et al. (2013) [27] utilized CLS in a robotic course for kindergarten using Topobo, the programmable brick tool. The study analyzed teacher–student interaction patterns, finding that teacher feedback and questions prompted student reflections, problem solving, and increased willingness to share thoughts.

As stated in the literature, providing learners with meaningful real-life problems and authentic experiences is important to support their active learning and knowledge transfer in real-world scenarios. With the help of the CLS model, tools such as Scratch that allows users to imagine, create, play, share, and reflect, learners’ creativity and motivation could be boosted, and a collaborative learning environment could be fostered.

2.2. Virtual Tech Tools and Coding

Nowadays, especially after the lingering impact of the COVID-19 pandemic, virtual tech tools have shown their assistance in online learning. A plethora of tech tools can contribute to and support students’ learning environment and also spark their creativity and problem-solving skills [28]. In this paper, we used three digital tools as vehicles for the main learning process: Tinkercad, iRobot, and CoSpaces Edu. These tech tools provide 3D design and coding elements for their users.

- **Tinkercad** (https://www.tinkercad.com/ (accessed on 15 October 2020)) is an online platform for 3D design, electronics, and coding. The 3D design features were used for this study, enabling users to design and create digital versions of their ideas.
- **iRobot** (https://code.irobot.com/ (accessed on 15 October 2020)) provides an online environment to present a digital coding environment to support their learning with easy coding and various coding levels.
- **CoSpaces Edu** (https://cospaces.io/edu/ (accessed on 15 October 2020)) enables users of any age to design and build 3D worlds. Moreover, users can animate the characters using coding and discover several features of CoSpaces, such as virtual and augmented reality.

Some studies [9,29–33] demonstrate that learning and using coding could positively impact creativity and problem-solving skills. Among these studies, Çakır et al. (2021) [9] tried to find the impact of robotic and coding instruction on kindergarten children’s problem solving and creative thinking skills. After four weeks, children exposed to robotic and coding instruction using the WeDo 2.0 kit showed significantly improved problem solving and creative thinking skills compared to a control group engaged in traditional pen and paper activities. Murcia et al. (2020) [32] stated that children’s creativity could improve when they learn coding with the help of tech tools and an appropriate pedagogical approach.

Jagust et al. (2017) [30] provided robotics and programming workshops for children in grades 2–4 who were identified as gifted. Their lessons were organized to present some challenges that could be solved by creative thinking. After the qualitative analysis, the
researchers concluded that participants were more “creatively productive” after 90-min sessions that required the use of LEGO Mindstorms robotic sets. Other researchers have designed interventions for children using Scratch (Kim et al., 2013) [31] or unplugged robotic kits (Sullivan and Bers, 2018) [33] and robots (Cavas et al., 2012) [29] that demonstrates that creative problem solving based on coding can strengthen children’s abilities to tackle real-life problem fluency using tech tools.

As previously stated in the literature, engaging in coding activities through robotics and virtual tools such as Scratch and LEGO Mindstorms could facilitate children’s growth in creativity and problem-solving skills. Experiencing errors while executing their code could provide a valuable opportunity to engage in the learning process. This prospect is compelling with a carefully crafted pedagogical framework, as it could provide children with increased motivation and equip them with practical problem-solving insights applicable to real-life scenarios.

To provide insight into children’s learning activities, this study examined 12 junior students’ problem-solving experiences, creativity, engagement, and motivation with new virtual tech tools throughout a summer camp. The online summer camp program took place over five days. Drawing on various data sources, such as a presurvey, observations, participants’ portfolios, and audio recordings, the researchers investigated the questions below within the Problem Solvers summer camp context.

RQ1: What are junior students’ learning and motivational experiences in various problem-solving activities involving math and coding in a summer camp?

RQ 2: How do junior students experience creative thinking through the lens of the “Creative Learning Spiral” framework?

3. Materials and Methods

This study focused on comprehending junior students’ problem-solving and creativity experiences and their engagement and motivation with online tech tools. Therefore, qualitative research methods were the ideal tactic, and a case study approach was used. Creswell (2012) [34] defined a case study as the detailed exploration of an activity, event, process, or individual based on comprehensive data collection. Because this study aimed to provide insight into a particular issue, it can also be described as an instrumental case study [35]. An instrumental case study enables the conduct of an in-depth examination of the experiences of campers during their participation in summer camp. The case study also uses comprehensive data collection through various methods and multiple sources, contributing to the triangulation of data and the study’s validity.

3.1. Participants

The “Problem Solvers” free summer camp was designed to allow children to form connections between the math curriculum content and the math required to tackle real-life challenges and was open to students going into 4th to 6th grade in Ontario. Canadian participants’ parents filled in the online registration form and gave consent for their children to participate in this research. Although there were 14 registrations for the camp, only 12 children completed the camp program. Participants ranged in age from 9–11 years old; there were six gifted children in the summer camp program (see Table 1).

Two facilitators were included in the study to run the sessions throughout the camp to ensure minimal researcher intervention. These facilitators also engaged in the design process by sharing their thoughts on the camp content and making suggestions. The researchers collected data and recorded field notes as they observed the children during the camp.
Table 1. Participants’ descriptive information.

<table>
<thead>
<tr>
<th></th>
<th>Grade 4</th>
<th>Grade 5</th>
<th>Grade 6</th>
<th>Total # of Children</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Girl</strong></td>
<td>Maya</td>
<td>Ayra</td>
<td>Sara</td>
<td>4</td>
</tr>
<tr>
<td><strong>Boy</strong></td>
<td>Ryan</td>
<td>Dev</td>
<td>Andrew</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Amir</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Jason</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rohan</td>
<td></td>
</tr>
<tr>
<td><strong>Total # of children</strong></td>
<td>2</td>
<td>7</td>
<td>3</td>
<td>12</td>
</tr>
</tbody>
</table>

* A pseudonym was assigned to each participant

3.2. Procedure

The camp took place from Monday to Friday on Google Meet (due to COVID-19 restrictions), and each day started at noon and ended at 3:00 p.m. to limit screen time. Prior to the first session, participants answered online presurvey questions (10–15 min) about their experience using technology and their understanding of math, coding, motivation, attention, and engagement by replying to questions such as “What are your strategies while solving problems?”, “In what ways do you use technology at home/school?”, “Is it easy for you to develop new ideas, especially when you face a problem”, and “Do you have any prior experience with coding?”. During the camp, the facilitators presented camp content based on patterns and their reflections and usages in real life. Through structured activities, children could identify, describe, extend, generate, and formulate predictions regarding different patterns and their representations, especially in real-life contexts such as nature, daily habits, music, and landscaping. Children could also determine pattern rules and translate patterns using a range of representations. Several tech tools (Tinkercad, iRobot, CoSpaces Edu) were introduced to children to design, create, and play. During the camp, children created logos and mascots for the camp, drew various flowers/shapes through coding, created virtual gardens by considering real life contexts, and shared many examples from their lives and nature (see Table 2).

Two factors were considered while designing and creating the content of the summer camp. Firstly, the content was planned to create low-floor, high-ceiling tasks to allow every child to find a way to engage with patterns activities at their own pace and level. In other words, the activities were designed to be accessible to beginners while offering significant potential for growth. The summer camp was open for students from 4th to 6th grades; therefore, it was necessary to provide grade-appropriate tasks for all the children. Secondly, adding an extra dimension, wide walls, and creating summer camp content based on real-life examples related to patterns could provide the exploration of multiple pathways for engagement through the use of different technologies. Resnick and Silverman (2005) explained that providing a single path from the low floor to the high ceiling is not enough. It is crucial to provide wide walls that allow children to explore multiple pathways from the starting point to the advanced level.

After providing brief instructions, children were provided with some daily challenges involving creativity and problem-solving strategies from day one. Table 2 shows the detailed camp content.

In this study, the CLS model was adopted while designing lesson activities. In the imagine phase, facilitators provided fundamental knowledge to the participants before providing the daily challenges or real-life problems. Then, the participants were expected to imagine and express their solutions. Next, children started to construct and program their plans using mostly virtual tech tools based on their ideas in the creation phase. During the play phase, children tried and tinkered with their creations and had a chance to observe their mistakes. Then, in the sharing phase, the participants shared their work with their
peers and facilitators. After the interaction among the children and the facilitators, the peers were encouraged to reflect on their experiences and give feedback or brief comments. In the final stage (imagine), children proposed new ideas or made revisions (see Figure 2) and wrote in a portfolio to reflect their daily camp experiences at the end of each day.

Table 2. Content of camp days.

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Tech Tools</th>
<th>Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creating a logo for the summer camp by using patterns</td>
<td>Tinkercad</td>
<td>Patterns in natures, Growing patterns, Shrinking patterns, Repeating patterns, Design</td>
</tr>
<tr>
<td>Creating a mascot prototype for the camp</td>
<td>Tinkercad</td>
<td>Pattern in mathematics, Fractions, Growing patterns, Shrinking patterns, Design/3D modelling and printing</td>
</tr>
<tr>
<td>Drawing shapes with iRobot and writing a code for a flower</td>
<td>iRobot</td>
<td>Patterns in daily life, Repeating patterns, Coding, Interior and exterior angles</td>
</tr>
<tr>
<td>Creating a flower garden with a particular shape and decorating using patterns</td>
<td>CoSpaces Edu</td>
<td>Gardening, Design, Repeating patterns, Symmetry, Coding, Interior and exterior angles</td>
</tr>
<tr>
<td>Extending the flower garden by adding more characters and coding them to interact with each other</td>
<td>CoSpaces Edu</td>
<td>Repeating patterns, Design, Coding, Debugging code</td>
</tr>
</tbody>
</table>

![Figure 2. Visualization of CLS model adaptation.](image)

For each challenge activity or project, children were divided into two breakout groups in Google Meet, with one facilitator in each group to create a learning environment with peer and mentor support. To provide a break from screen time and virtual tech tools, some warm-up and hands-on activities were provided during the sessions. The warm-up
activities included basic questions about their background and some stretching activities (based on patterns). The hands-on activities included brain teaser activities, such as building a bridge that holds 20 tiny objects using one sheet of paper or creating a paper column that could hold the most books. With these kinds of community building activities, children were relaxed and comfortable and could use their creativity and problem-solving skills without feeling anxious.

At the beginning of the last session, the researchers conducted focus group interviews, with three students in each group. Children turned off their cameras during the interview, so the researchers only had audible data. Those who did not consent to be audio-recorded filled out an online questionnaire with the same interview questions. At the beginning of the interview, one researcher typed the questions into the chat and gave some time for the children to go through them. The interviews took approximately 15–20 min.

3.3. Data Collection and Analysis

Data were collected from several sources to explore the junior students’ learning and motivational experiences in math and coding. The online presurvey explored children’s interests, understanding, and perceptions in the following areas: technology, math, coding, problem solving, and creativity skills. The researchers took screen captures from children’s work while taking notes on their reactions, engagements, attitudes, and behaviours during various activities in the summer camp.

The data were analyzed through thematic content analysis by the researchers. The analysis process involved several systematic steps. First, the researchers immersed themselves in the data through a thorough review of data sources such as interview transcripts, facilitator and researcher observation notes, presurvey questions, and participant portfolios. A coding framework aligned with the research objectives was then developed, and the coded data were compared and organized into higher-order themes through an iterative process to ensure quality and consistency. The themes were rigorously reviewed and refined, considering the broader research context.

4. Results

4.1. Problem Solving and Creativity

According to the presurvey answers, campers used various strategies while solving problems, such as mathematical analysis by using mathematical models, persistent review by revisiting previously learned material or strategy, iterative problem solving process, which involves refining and improving solutions through cycles of trial, error, and adjustment, applying real-life examples, reviewing and debugging, and breaking down by dividing it down into smaller, more manageable components or subtasks. Creativity often emerges when engaging with problems, and these strategies can stimulate creative thinking and problem-solving processes.

When asked to describe or define creativity and being creative, the participants gave various answers. Here are some examples:

“Creativity is being able to think of something that’s not normal and sort of outside the box.” (Andrew)

“Creativity is being or doing something unique.” (Dev)

“Creativity is coming up with different ideas in different ways.” (Kiara)

The children’s first-day challenge was to create a logo using Tinkercad for the summer camp to show their understanding of patterns (repeating, growing, and shrinking patterns). Next, they started designing their logos using different kinds of patterns (see Figure 3). Some shared their work, asked questions, and got immediate feedback from facilitators and their friends during that process. In addition, children shared their strategies and how to create these designs with their camp friends.
In addition, after receiving feedback, some of them revised their work to show patterns in their logos. Some of the designs were detailed, neat and thematically relevant.

The second-day challenge was creating a mascot prototype for the camp, and children were divided into breakout groups to work on the mascots to scale. Some spent a while planning their designs and then described their conceptualization to the facilitator and explained that they were looking through the shapes to see what might be possible to use. While children were sharing their screens to show their progress and design, they got immediate comments from their peers and facilitators. Some finished much earlier and wanted to share their work with their group. After showing their creation, they got feedback from their friends and facilitators and made a few changes to finalize their work. Also, whenever children needed help, facilitators and their peers were there to guide and offer suggestions. Here are some examples from their final mascot designs (see Figure 4).

During the camp, some hands-on activities were provided to campers. One of these brain teaser activities required building a bridge that holds 20 marbles using one sheet of paper. Children shared their bridge ideas; Amir folded one piece of paper four times to strengthen it. He explained that it was necessary to distribute the weight evenly. Andrew came up with an accordion example of using one piece of paper to create his bridge. The campers figured out that it was necessary to increase the folding pattern for a stronger bridge.

While campers were working on drawing a flower challenge with iRobot, some of them shared their final works and received feedback from their peers and facilitators. Andrew shared his flowers and the code for this creation, indicating that he used trial and error to determine the angles and number of repetitions. His peer, Rohan suggested drawing more realistic five- or seven-petal flowers by changing the angles, variables, and repetitions. The facilitator also suggested using different colours. Figure 5 includes some examples from their creations.
Figure 5. Samples of iRobot designs.

The campers’ last challenge was to create a flower garden on CoSpaces Edu. First, they prepared the draft of their gardens in Jamboard and then created it on CoSpaces. While working on this project, some tried to create their garden by sticking to their preplanned designs. However, some randomly added objects to the scene to play around. At the end of the session, some shared their unfinished work and got some feedback, and they decided to make some revisions the next day. Table 3 shows some drafts and final versions of campers’ CoSpaces projects.

Table 3. Participants’ descriptive information.

<table>
<thead>
<tr>
<th>Draft Version</th>
<th>Final Version</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Draft Image 1" /></td>
<td><img src="image2.png" alt="Final Image 1" /></td>
</tr>
<tr>
<td><img src="image3.png" alt="Draft Image 2" /></td>
<td><img src="image4.png" alt="Final Image 2" /></td>
</tr>
<tr>
<td><img src="image5.png" alt="Draft Image 3" /></td>
<td><img src="image6.png" alt="Final Image 3" /></td>
</tr>
</tbody>
</table>
Kiara created not only a garden but also a story. Her CoSpace has two scenes and a dialogue, so one of the facilitators wanted to narrate her story. After their narration, the reaction of the children was excellent, and some shared their feedback:

“That was cool. That was really cool, I like that.” (Andrew)

“It was funny; it was a pure comedy, code of comedy!” (Andrew)

“It sounds natural, the way that they reacted to each other.” (Arin)

When the debugging activity (see Figure 6) was presented by the facilitator, most of the children were able to finish quickly and shared their solutions. In this activity, children had to fix the code to move the other characters around the garden by passing through each tile, similar to Alan’s, the first character’s, movement. By using the same strategy, the majority debugged the other characters, and their code worked smoothly. However, a few of the campers fixed the code without animating their characters. One of the campers, Ryan, used purposely different code blocks because he “wanted to make it special”. He said, “I did it uniquely from everybody”. He changed the direction from clockwise to counterclockwise for the third character and changed the degree from 90 to 270 degrees. So, his character completed her walk in the right direction by spinning in the corners (see Figure 7).

**Figure 6.** Debugging activity.

**Figure 7.** Samples from different solutions.

During the summer camp, participants sometimes faced challenges, especially technical problems, because of the virtual session. Besides these technical issues, some campers had difficulties using the application because it was their first experience with those tools. Maya shared, “… when we have been in CoSpaces, I could not understand how to make a garden, …, I tried a lot of times, and then I still could not make it. But then after, I kept on trying, and I had a great nice garden.”, and Kiara declared, “In iRobot, I had some trouble. I could not find the blocks that I needed to make my iRobot move. So, I went to level two and tried some of the things there.” However, some successfully overcame these challenges using strategies such as trial and error or finding alternative ways by learning from their mistakes, such as Ayra, who shared that “… when we were practicing on iRobot, and I had to figure out the angles for the shapes that were a bit harder than squares and rectangles. …to overcome that, I just experimented with different angles…”.

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“It was funny; it was a pure comedy, code of comedy!” (Andrew)

“It sounds natural, the way that they reacted to each other.” (Arin)

When the debugging activity (see Figure 6) was presented by the facilitator, most of the children were able to finish quickly and shared their solutions. In this activity, children had to fix the code to move the other characters around the garden by passing through each tile, similar to Alan’s, the first character’s, movement. By using the same strategy, the majority debugged the other characters, and their code worked smoothly. However, a few of the campers fixed the code without animating their characters. One of the campers, Ryan, used purposely different code blocks because he “wanted to make it special”. He said, “I did it uniquely from everybody”. He changed the direction from clockwise to counterclockwise for the third character and changed the degree from 90 to 270 degrees. So, his character completed her walk in the right direction by spinning in the corners (see Figure 7).

**Figure 6.** Debugging activity.

**Figure 7.** Samples from different solutions.

During the summer camp, participants sometimes faced challenges, especially technical problems, because of the virtual session. Besides these technical issues, some campers had difficulties using the application because it was their first experience with those tools. Maya shared, “… when we have been in CoSpaces, I could not understand how to make a garden, …, I tried a lot of times, and then I still could not make it. But then after, I kept on trying, and I had a great nice garden.”, and Kiara declared, “In iRobot, I had some trouble. I could not find the blocks that I needed to make my iRobot move. So, I went to level two and tried some of the things there.” However, some successfully overcame these challenges using strategies such as trial and error or finding alternative ways by learning from their mistakes, such as Ayra, who shared that “… when we were practicing on iRobot, and I had to figure out the angles for the shapes that were a bit harder than squares and rectangles. …to overcome that, I just experimented with different angles…”. 
The participants showed numerous problem-solving strategies during the summer camp sessions. Sometimes they solved their own problems by using strategies or thinking of different ways such as “… to understand what the problem was, and then think of possible ways to solve it” (Andrew), “… to use creativity to find the right answer for the problem” (Amir), or using trial and error: “I kept on thinking of different ways to create the garden… Tried to add squares, and tried to add stuff like I did in the Jamboard. Kept on trying and trying to do the same things” (Maya).

While answering the question about problem solving strategies, the participants also shared their thoughts about the relationship between problem solving and creativity. Most of them stated that to solve problems, they should be creative, especially with tricky problems: “When we are solving problems, we are doing creative stuff” (Maya) and “… because some of the problems are a little complicated, so I had to think out of the box and give them solutions” (Kiara).

4.2. Motivation for Learning and Collaborative Support

Most children (10 out of 12) reported that it was easy to concentrate in math class at school. According to their replies, enjoyable, fun, exciting classes and face-to-face education made it easier to stay focused. Most of them believed that they put much effort into math lessons, and some of their motivations came from learning new things, accomplishing something new, challenging what they already know and finding math fun and valuable. The majority stated that math skills are essential for their future career and life and to live up to their potential; therefore, they wanted to do well in math classes.

On the first day of the camp, the children immediately turned on their microphones and cameras and started chatting, so it was easy for them to use the online communication tools. Some knew each other from school or after-school programs, and all participants were excited to share information about themselves. In addition, they were all very friendly and polite. Therefore, they effortlessly adapted to the camp atmosphere and looked forward to coding activities. When the campers were asked to provide pattern examples from nature, they filled the document eagerly (see Figure 8).

![Image of pattern examples]

Figure 8. Sample of children’s replies.

When participants were asked about what they thought the most engaging parts of the camp were, the researchers again received various replies. Some stressed that learning and experiencing new tech tools was extremely interesting, engaging, and enjoyable, as some stated: “In the camp, I felt was, like, interesting, and it was easy to focus because, like,
all the time I was learning something new, and it just felt nice and interesting, so it was easy for me to focus” (Andrew) and “… because everything is really interesting and it is really fun to learn. So like you want to focus more on interesting things” (Jason). However, some also mentioned that the warm-up and brain teaser activities were the most engaging part: “I also really like doing the marble bridge, and I am trying to make the book stand on the paper. I thought that was really fun” (Kiara).

Campers were also very supportive of each other; whenever they faced a challenge, if the rest knew the solution, they helped each other. For example, when one student asked how to undo things in iRobot, her friend showed how to use an erase tool step by step. Moreover, campers shared their ideas to turn code for drawing a hexagon into code for drawing an octagon or creating flowers. Even though the younger ones did not conceptualize the exterior angle for hexagons and octagons, they used strategies like using different random angles and discussing with others.

4.3. Technology Usage and Coding

At the beginning of the camp, through presurvey questions, participants provided a range of responses when asked how they use technology at home and school. While participants most commonly reported using technology at school to complete assignments and some learning activities, they also mentioned using it at home for fun, homework, engaging activities such as video games, taking pictures, learning code, watching movies, and doing research as a source of enjoyment and a valuable tool for learning and productivity. Moreover, although most of them had coding experience (especially block coding) before, a few had just tried Tinkercad. They had not heard of the other applications (CoSpaces Edu and iRobot) used during the summer camp.

During the sessions, when one of the campers had tech problems, others tried to help them. For example, after introducing Tinkercad, one camper had difficulty moving items, and another child explained to their friend how to move the cube at the top of the object.

The facilitator introduced iRobot on the third day and explained the interface and its features. Although most children were familiar with block coding (level 1), iRobot was a new tool for them. They started to explore iRobot and experienced different levels of coding. For example, one of the campers showed how to build a triangle using level 2 coding (hybrid coding), which they found similar to Scratch. In order to provide some coding exercises, the session was continued with an interactive Nearpod (https://nearpod.com/) activity. Most children found this activity fun and engaging, and most could reply correctly. However, a few children had difficulty playing the game and answering the questions, which might be the result of using a new tech tool.

On the fourth day, while the children were creating their gardens on Jamboard, they used several types of plants and flowers, some of which were detailed. However, when they began to work on CoSpaces, the choices were limited for plants, but they found some other appealing features, such as animating objects.

During the interviews, when the participants were asked about their likes and dislikes about the camp, the researchers had various answers and mostly got positive feedback about the summer camp. The participants had fun and liked learning how to use new applications. Maya said, “The camp went awesome; it was really fun. I liked every program, and everything we learned is really interesting. I liked all the apps we used, especially Tinkercad”, and Kiara stated, “I really liked camp this week. My favourite things are finding new websites and learning how to use them. I really like the coding websites because it was fun doing the activities.” However, some of them stated that they had difficulty discovering these new applications because of some challenging parts. For example, one of the participants found iRobot challenging because of its coding interface, and another did not like Tinkercad because “… it was kind of hard to move everything around” (Ayra).

The campers also mentioned their achievements during the summer camp. The majority mentioned that they gained coding experience and learned new applications. Most of them saw learning these “new tools” as an achievement, e.g., “… some of my
achievements were that I learned how to use different coding sites/applications that I did not exactly know how to use before. And I managed to use them pretty good, so that was an achievement for me” (Ayra). A few mentioned their progress in mathematics, such as “. . . I learned block coding and like in iRobot, and I just learned different kinds of codes” (Amir) and Maya shared “My achievement was, I learned math about the ratio because I did not know that, then I learned it.”

While the researchers asked about participants’ overall learning, the majority mentioned new tech tools and “learned how to use different coding websites” (Mark) they were introduced to during the camp week. Some said that they learned more about coding, e.g., “learned how to use properly now” (Jason), and a few mentioned mathematical progress during the camp, such as “learned the angles for some shapes” (Ayra) and “got a little review on fractions and patterns and ratios” (Andrew).

Lastly, the researchers asked about campers’ experiences and opinions about the applications. All campers had a different favourite tech tool. The ones whose favourite was CoSpaces Edu liked the 3D features and combining design and coding in the same platform. Some shared: “I would say my favourite app was CoSpaces, like, because I liked how you could change the environment and how you can move around and add characters, and it was kind of easy to move things around so I liked CoSpaces.” (Ayra) and “I really like CoSpaces. In CoSpaces, I like that it had a lot of different things involved, like coding, and you can design things. And you can design different things and code other things, I really liked that, and you could use your imagination and, like, you can take what you have in your imagination and just make it, so yeah, that was nice.” (Sara) For the iRobot lovers, navigating the robot and drawing was fun and creative; here is Kiara’s reflection on iRobot: “Mine was iRobot because it is easier to navigate, and I think the fact that the robot draws things is fun. I think the coding is easier to understand. . . . Well, I think there are three levels, and on level one, I think the blocks are sort of specific on what they are about. And I also like the fact that the robot draws things”. Lastly, the Tinkercad lovers mentioned that this application enabled them to make any kind of object they could imagine or want: “My favourite app was actually Tinkercad because I really liked the feeling of being able to make whatever I wanted with, whatever kind of shapes I wanted, and that felt like really nice, and I liked it.” (Andrew).

5. Discussion

The purpose of this study was to gain insight into junior students’ learning, motivational and creative thinking experiences throughout the “Problem Solvers” summer camp, which was based on the creative learning spiral (CLS) model. Children experienced many mathematical, coding, and problem-solving activities in the camp. The campers planned their tasks, designed, created, and experienced their projects, shared comments and feedback, and used feedback to revise or develop their ideas. The findings were analyzed under three titles based on the content analysis: participants’ problem solving and creativity skills and experiences, how they applied the CLS model, and their thoughts on virtual applications and coding. In summary, we explored whether and how the CLS model’s learning environment promoted campers’ creative thinking, motives, and experiences with coding and tech tools.

5.1. Problem Solving and Creativity

During the summer camp, children engaged in problem solving activities and real-life learning contexts and tasks in which they were expected to generate creative and practical solutions and approaches. Making real-life connections is essential for creating a compelling and inclusive mathematics learning environment; therefore, the camp content was embedded in authentic, real-life mathematical contexts. Throughout the camp, children were given challenging, open-ended tasks and daily life problems.

Mayer (1989) [19], emphasized that the process of solving a problem is more important than just arriving at a solution because students develop transferable strategies and creativ-
ity. The facilitators encouraged campers to share how they processed their experience and knowledge to foster problem solving skills. In this way, students can learn to overcome challenges by analyzing possibilities and prioritizing their options while deciding. Treffinger et al. (2023) [38] highlighted that being an effective problem solver requires being creative and focusing on the process as a critical thinker.

Researchers and facilitators observed many problem-solving strategies during the camp while campers were facing a problem. The campers were free to decide how to approach problems and challenges during the camp. They most commonly preferred a trial-and-error approach, breaking down, debugging, asking for their peers’ or facilitators’ help, and applied real-life experiences once they defined the problem and generated the solution. For example, when campers were discussing designing a flower garden, one camper shared that he and his family used an electric toothbrush to get all the pollen off the flower when there were not enough bees. In this way, they helped pollinate the plants. By experiencing and connecting real-life problems as such, children could better understand nature and the importance of animals like bees.

Facilitators and researchers observed that a few female students showed great improvement throughout the camp. For example, one of the campers was reluctant to participate in the problem-solving process for the first two days; however, she soon became more involved in problem solving and began to make contributions to the camp. Another interesting observation was that more campers, especially girls, were willing to ask questions daily. On the last day of the camp, the girls were more comfortable with having open dialogues and sharing ideas. This may be due to the approach used by the researchers and facilitators. Throughout the camp, they provided just-in-time support and walk-through assistance, which the campers seemed to find helpful because they became more vocal. Those who were silent and hesitant earlier became eager to talk and share their thoughts and work. It appears that collaboration among facilitators and campers, sharing perspectives and ideas, and exploring knowledge helped promote learners’ creativity [39].

5.2. Creative Learning Spiral (CLS)

5.2.1. Imagine

To form a learning environment that triggers students’ imagination, many problems and challenging activities were provided to children. Whenever the facilitators asked questions, each student developed different ideas and solutions. As they replied in their presurvey questionnaire, they had different strategies while focusing or working on their problems. Some preferred breaking them apart to plan solutions, some applied real-life examples, and some used trial-and-error methods.

Whenever the facilitators assigned the tasks, the campers not only began to develop some plausible ideas but also thought about what kinds of things they could create with the tech tools. With the help of the prompting questions and guidance from the facilitators and inspiring features and items from the libraries and projects from the galleries of these tech tools, children had a chance to develop their ideas. For example, when campers’ flower garden drafts were considered, some performed very detailed work while planning and visualizing their project (see Table 3). They tried to create a garden as they imagined, but during the process, they had to revise and be flexible to update their projects regarding the features of CoSpaces. This tech tool does not have all the 3D items in its library, so campers found alternatives to build their projects according to their drafts. They solved design problems while creating these CoSpaces, such as uploading photos of items. “Creativity is a step beyond imagination” [24] (p. ix), and the children’s final work showed how much they revised and updated their projects during the camp.

It was also observed that a few children were thinking aloud while planning and finding the solution or explaining their answers in detail. This might be happening because they wanted to get confirmation or because they could be more creative while thinking out loud. Children created their garden drafts based on their daily experiences with their parents’ gardens while designing them. They picked the plants that were most familiar to
them. This stage allowed campers to learn from experience through playful activities by sparkling their imaginations. When learners completed all the stages, they could return to their original idea and modify it to make it more efficient, innovative, and effective in solving the problem.

5.2.2. Create

With the help of different tech tools and activities, children had a chance to create various digital artifacts. As emphasized by Sternberg (2006) [17], supportive environments are crucial for creativity. Each camper created a different project based on their background, motives, and interests. While some created unique products, a few tried to remix others’ projects instead of building from scratch. For example, Ryan remixed the facilitator’s sample project and created new designs by adding new code to change the colours and make it unique. This camper liked to play around by remixing code when it became complex for him, which helped him understand it better. After this camper shared his remix design, he received feedback like “You could stick to the normal” (Andrew) but he replied, “No, I wanted it to be unique!”. Even in a remixed project, students wanted to be unique and different to express their creativity.

Some students created very detailed projects showing their mathematical progress and skills. Especially while designing and creating their gardens, they paid attention to using patterns and mathematical features appropriately. They also tried to create beautiful and unique gardens by integrating their previous knowledge. The authenticity of the sessions allowed campers to create products based on their interests. Although sometimes they were influenced by others’ ideas, they mostly stuck to their own style. For example, when children’s mascot designs were analyzed, it was observed that, in common, the mascots were wearing glasses and holding ice cream (see Figure 4). While they sometimes wanted to be original or unique, they also liked to be inspired by others, for example, by using the same objects.

5.2.3. Play

Play was an important phase for campers experimenting with their projects. Throughout the design process, they tested their creations to see what was working and where the problem or errors existed. Every child used this process efficiently to solve the problems and finish their well-designed projects.

They used this approach to create digital products and solve hands-on or brain teaser activities. The researchers observed that while the children were trying to build a bridge, Amir shared his screen and tried different designs to build the strongest bridge. He shared his bridge (folded his paper into two halves) and walked us through his whole process on a webcam. He did indicate that it was a bit unbalanced. He explained the weak points in his idea/design. Then, with the help of the facilitator’s questions, he came up with some solutions on the spot and demonstrated them on the webcam. As Resnick (2007) [18] notes, children can design and build their own creations by experimenting and tinkering, and it is during this phase that children comprehend that their creations should be further developed in an iterative way.

5.2.4. Share

Throughout the camp, all campers were eager to show their projects. Some of them knew each other previously from school or after-school programs, which makes a difference in terms of comfort to share; however, even the students who were strangers were largely willing to contribute. During the sessions, children sometimes shared how they thought and built while creating their projects. It sometimes inspired them to see others’ work so they could make some changes or add new code or images to their creation. Throughout the camp sessions, not only did the facilitators ask questions, as mentioned earlier, but the campers also shared their thoughts and problems, and the results showed that this CLS model could help improve learners’ creative thinking skills [26].
The facilitators tried to motivate the participants with open-ended questions to develop good communication and allow the campers to share their new ideas with others and make suggestions. When we looked at the final work with iRobot on day three, we observed that campers followed the suggestions, such as changing colours or adding more squares inside a bigger square. However, one camper decided to work on a ninja star instead of a flower, and he received some comments from his peers about his code, which could be made more efficient using the repeat function (see Figure 5). In this example, we could see that the campers were not only making suggestions about design or technical issues but also helping each other to improve their coding skills. In addition, the presence of different age groups with different backgrounds in the camp might have allowed the campers to learn from each other by sharing knowledge and supporting community ties.

5.2.5. Reflect

At the beginning of the camp, a few campers were quieter than the other children. However, over the following days, facilitators and researchers observed that these campers started to share and comment more on others’ projects and also reflect on how to improve their projects. As mentioned earlier, social interaction in the learning environment can promote children's motivation to reflect [25]. After this self-monitoring, some said they would start again or make revisions. For example, while working with iRobot, one of the campers, Ryan, said, “I made something that looks super weird and very complex. So, I am going to try to make another one!”.

As Rojas Castillo (2023) [40] stated, implementing CLS in the learning environment can improve learners’ oral skills and promote the exchange of ideas with others due to the ongoing interactions with their peers. During the camp, the campers were motivated to interact with each other and participate in the sharing process. At the same time, campers showed more willingness to listen to others’ reflections and feedback. They also showed well-developed skills in flexibility when they updated their projects considering their peers’ comments. Therefore, CLS might contribute not only to the improvement of creativity but also to the development of learners’ listening, speaking, and flexibility skills.

5.3. Virtual Tech Tools and Coding

After the pandemic, more children became familiar with many technological tools, especially online versions. Throughout the camp, the facilitators and researchers found that these children were very good at using computer, coding, and design tools. At times, they even helped the facilitators navigate, which could stem from the time children allocated to tech tools and coding programs. They also had previous experience with block coding, which might help them adapt effortlessly to new online tools such as iRobot and CoSpaces Edu. For example, children wanted to use different coding levels when they saw the iRobot platform, and some thought the level 2 coding was similar to Scratch, so they could design something easier using their previous experience in this familiar platform.

According to the study results, creativity and problem-solving skills could be enhanced while experiencing coding with tech tools, as Noh and Lee (2020) [10] and Çalışkan (2020) [11] stated. During the camps, children experienced different tools and coding activities for low-floor, high-ceiling, and wide-wall tasks to present each camper a chance to engage with the activities with different tech tools. This approach might make it easier for campers to find the most preferable tech tool to work with to express themselves and create freely.

The current results are similar to previous studies’ [29–32] results, which stated that learning activities that were designed via technological tools and an appropriate pedagogical approach could support and improve children’s creativity and problem-solving skills. There are many virtual tools out there, so it is crucial to take advantage of them at the most appropriate time and with the most appropriate approach without thinking about employing them just for the sake of using them.
6. Conclusions

Today and in the future, skills such as creativity are increasingly important, and the use of teaching tools and strategies that support these skills is also crucial. While many learners’ creativity and problem-solving skills should be encouraged as they move toward higher education, the system may suppress them by shifting teaching norms that are less creative and playful. Therefore, CLS can be an efficient teaching approach in which children can develop these skills through trial and error, applying real-life experiences, and exploring and investigating together. In other words, the CLS model might spark creativity and boost the fluency and elaboration skills of learners, especially when tech tools or coding tools support this approach. In addition, this kind of learning environment could help learners focus and find motivation in subjects like mathematics.

The camp environment designed by the researchers allowed the children to interact during all stages of the CLS while solving problems because the CLS presents an opportunity for learners to exchange ideas and opinions [24]. Challenging mathematical activities [6] with a student-centred approach [20] were presented to promote campers’ creativity, as suggested. While the children were exposed to different sources of technological tools that required them to be innovative and creative, they were motivated and supported by their peers and facilitators. The current study was limited to 12 participants and is not generalizable; however, this case study, which took place in an online environment, may provide a basis for future research with larger groups to observe the effects of the CLS model in a face-to-face learning environment. Moreover, the students who knew each other beforehand might have positively influenced the summer camp dynamic, but this also speaks to the importance of including community building activities so that students feel more comfortable interacting with each other.

Creating effective learning and interactive environments is essential for teachers to nurture creativity [41]. In addition, teachers can use technology to provide more opportunities for creativity while preparing children for future challenges [12]. The implementation of CLS could help educators to provide engaging and interactive environments to enhance the critical, reflective, and creative thinking skills of learners, as well as their motivations, while they are using technological tools to solve real-life problems. Especially when there are gifted learners, as in our summer camp, it is significant to offer instructional options that support and encourage children’s talents and intellectual capabilities. This kind of learning environment is also crucial to promote student agency by empowering their voices and choices in the learning process.


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