Journal of Technology-Integrated Lessons and Teaching
(2024) Volume 3, Issue 2; DOI: 10.13001/jtilt.v3i2.8993

Building Math Skills with Computational Thinking: CT-Enhanced Addition Strategies

Rosalind Ali, Central Michigan University

Overview

This elementary math intervention lesson plan integrates computational thinking (CT) and generative AI tools, focusing on addition strategies. It combines tech-enhanced experiences with hands-on activities to develop CT skills and content knowledge. This three-part lesson includes reviewing addition facts, engaging in interactive games, and creating digital content. Students practice pattern recognition, abstraction, problem decomposition, and step-by-step solution development. The plan emphasizes CT connections, engagement, and deepening understanding of addition strategies. This adaptable, multimedia approach offers a comprehensive learning experience blending traditional math instruction with modern tech tools across various grade levels and content areas.

Topics: Addition within 20, AI Tools, Computational Thinking, Content Creation, Digital Learning, Technology Integration

Time: Minimum of eight 20-minute intervention sessions (2 hours, 40 minutes)

Materials

- Whiteboard and markers
- Magnetic ten-frames and counters
- Opening Sentences
- Recording device
- Chart paper and markers
- Chat GPT Generated Openers and Script Text
- Steve Wyborney's (2023) - Mystery Number
- Desmos Classroom (n.d.) - What Sum Do You See

Context-at-a-Glance

Setting
Fifth grade Tier-3 math intervention at a suburban, public, Title 1 elementary school in the Southeastern United States.

Modality
Face-to-face

Class Structure
Students worked in pairs, facilitated by math interventionist.

Organizational Norms
Classes met 4 days/week for 25 minutes each. This was the school's first year with full-time Interventionist.

Learner Characteristics
The learners were 5th graders with math scores two or more grades below level. The students were unfamiliar with CT, video creation, social media content, or generative AI for learning.

Instructor Characteristics
The lesson was designed by the math interventionist pursuing EdTech doctorate, focusing on CT in elementary math. Instructors should be tech-proficient, familiar with sensemaking routines and evidence-based resources for developing foundational math skills.

Development Rationale
Created as math intervention resource to engage upper elementary students in primary concepts while introducing CT and AI learning tools.

Setup

Six 5th grade math intervention students worked in pairs to complete activities culminating in the

creation of videos demonstrating addition within 20 using ten-frames and counters. Students were permitted to choose partners, resulting in the formation of three pairs. The classroom environment was spacious, allowing each pair to work at separate tables and converse at a voice level that did not disturb others. Each session began with a sense-making or number sense routine to review CT and addition strategies and encourage student discourse. Prior to the students' arrival, materials were prepared and accessible to maximize time on task during brief intervention sessions. During each session, the facilitator circulated the room addressing questions and guiding students through productive struggles by highlighting their use of CT elements and skills. Before implementing this activity, instructors should create necessary accounts, access all sites for number sense and sense-making routines, and review the latest developments in integrating CT concepts (see We Are Teachers Staff, 2023, for concepts).

Standards

Multiple standards were met in this three-part lesson.

International Society for Technology in Education (2016) Student Standards:

> 1.3.b Evaluate Information - Students evaluate the accuracy, perspective, credibility and relevance of information, media, data or other resources.
>
> 1.5.c Decompose Problems - Students break problems into component parts, extract key information and develop descriptive models to understand complex systems or facilitate problem-solving.
>
> 1.6.b Original and Remixed Works - Students create original works or responsibly repurpose or remix digital resources into new creations.
>
> Common Core State Standards Initiative ([CCSS], n.d.) Math Content Grade 1:
>
> CCSS.MATH.CONTENT.1.OA.C.6 - Add and subtract within 20, demonstrating fluency for addition and subtraction within 10. Use strategies such as counting on; making ten (e.g., 8 + 6 = 8 + 2 + 4 = 10 + 4 = 14); decomposing a number leading to a ten (e.g., 13 - 4 = 13 - 3 - 1 = 10 - 1 = 9); using the relationship between addition and subtraction (e.g., knowing that 8 + 4 = 12, one knows 12 - 8 = 4); and creating equivalent but easier or known sums (e.g., adding 6 + 7 by creating the known equivalent 6 + 6 + 1 = 12 + 1 = 13) (CCSS, n.d., p. 15).
>
> CCSS.MATH.CONTENT.1.NBT.B.2.B - The numbers from 11 to 19 are composed of a ten and one, two, three, four, five, six, seven, eight, or nine ones (CCSS, n.d., p. 15).

Alabama State Department of Education (2019) Standards:

> MA19.1.6c - Demonstrate fluency with addition and subtraction facts with sums or differences to 10 by decomposing a number leading to a ten.

Alabama Learning Exchange (2018) Grade 5

> DLCS18.5.R6 - Produce, review, and revise authentic artifacts that include multimedia using appropriate digital tools.
>
> DLCS18.5.17 - Publish organized information in different ways to make it more useful or relevant.

Context and Setting

This lesson was implemented in a math intervention classroom at a public, Title 1 elementary school in a rapidly-growing suburban school district in the Southeastern United States. The district serves over 20,000 students.

The Tier 3 intervention classroom is designed to fill gaps in foundational math concepts using individual and collaborative hands-on learning experiences. Students selected to receive Tier 3 intervention are those whose scores on diagnostic assessments fall at least two years below their current grade level. The classroom space is large enough to allow flexible seating configurations that are ideal for individual or partner work, whole group discussions, direct instruction, and inquiry-based learning activities.

Older students often resist foundational concepts and strategies from elementary computation progressions once they've been exposed to traditional algorithms. This resistance leads to an

over-reliance of count-by-one strategies that become inefficient with larger magnitudes. By introducing elements of computational thinking, we can enhance students' abilities to understand and apply multiple addition strategies and strengthen their foundational understanding for future mathematics coursework. This lesson was designed to develop students' ability to use decomposition to apply a non-count-by-one strategy to add within 20 while fostering collaboration, creativity, and a deeper understanding of CT concepts and their application in computation strategies.

Students are challenged to create a video demonstrating addition using the "make ten" strategy, enhancing their comprehension of how pattern recognition and decomposition aid in calculating sums within 20. Students also explore the use of AI-generated text to craft scripts for their videos. Additionally, this lesson offers students the opportunity to synthesize and present their learning through a creative presentation. This exercise not only reinforces mathematical and CT concepts but also integrates modern technology and public speaking skills, providing a holistic educational experience.

Learning Representation

During this lesson, italic text identifies questions or prompts provided to the learners.

Activity Learning Objectives

Upon completion of this lesson, students were able to:

- Describe CT concepts.
- Model adding within 20 using a ten-frame.
- Justify breaking apart an addend to create a ten.
- Identify two addition sentences for sums within 20 based on representation in ten-frame.
- Analyze addition sentences to identify and describe patterns.
- Work effectively with a partner to brainstorm and develop a script for a video that details a set of steps to add within 20 using a ten-frame.
- Prepare a 2-minute presentation that communicates how to use a ten-frame to model addition.
- Understand the process of creating and uploading a video on the YouTube platform.
- Understand the real-world applications of the CT, mathematical, generative AI and technology principles used in the lesson.
- Analyze and evaluate text generated by AI.
- Understand how AI text can spark creativity for original ideas and innovation.

Lesson Structure

The lesson consists of three parts. Part 1 draws from the EngageNY (n.d.) curriculum (Grade 1, Module 1, Lesson 7) focusing on counting from embedded numbers. Students use concrete and pictorial methods to decompose numbers 6-10 (1.OA.5; CCSS, n.d.), emphasizing CT concepts such as recognizing patterns and decomposing numbers. Part 2 is based on the Do the Math curriculum - Number Core (Burns, 2008), which encourages flexible thinking in addition. Students engage in interactive, game-based activities and use manipulatives to model addition within 20. In Part 3, students become content creators, developing materials for a fictitious YouTube channel to demonstrate addition within 20 using ten-frames. The sessions in any part of the lesson may span multiple days. Suggested timing is provided for each session.

Part 1: Sums of 6-10

Part 1 includes one, 20-minute session.

Session 1

Introduction. At the beginning of the session, invite students to analyze an image projected on the screen as they enter the classroom (Figure 1). Ask for volunteers to share information about what they notice or wonder about in the displayed image. During the discussion, record the number sentences that students identify (e.g., "there are seven children, two are at the board, three are on the couch, and two are at the table", 2 + 3 + 2 = 7) and facilitate the

sharing of ideas about numeric patterns in the images. These conversations present numerous opportunities to connect to CT concepts. It's important to acknowledge when students use patterns or decomposition to solve problems, as this reinforces their CT skills.

Figure 1. "Picture Cards" by Eureka Math. Creative Commons Attribution-NonCommercial-ShareAlike 3.0 Unported License.

As students examine the image and share their observations, highlight examples of composing and decomposing. For example, "I see 10 people on the playground, 3 are playing jump rope and 7 people are not playing jump rope." This statement describes decomposing 10 into 3 and 7, one of many possible decompositions.

If needed, prompt students with questions about different attributes that decompose the images:

- How many people are seated?
- How many people have gym shoes?
- How many people are wearing blue?
- How many people have black hair?

This approach reinforces decomposition by helping students examine a complex scene (in this case, a playground), and naturally leads students to break down the whole (total number of people) into smaller parts based on various attributes. Prompting students to consider different attributes reinforces that decomposition can occur along various dimensions which broadens students' understanding of the concept. This introduction is approximately five minutes.

Ten-Frames. Ten-frames with red/yellow counters can be used to reconstruct the decompositions of the images (Figure 2). In approximately 10 minutes, record new number sentences, or review the number sentences created in the introduction, to facilitate students recognizing patterns:

3 + 7 = 10
4 + 6 = 10
5 + 5 = 10
6 + 4 = 10
8 + 2 = 10

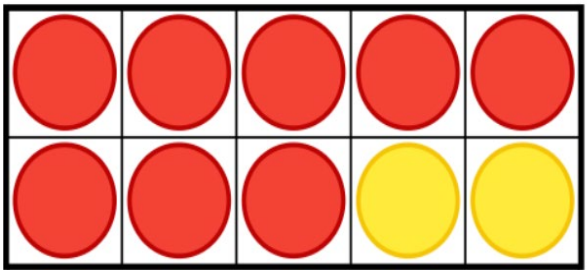

Figure 2. "Ten-frames and counters" (Burns, 2008).

Reinforce pattern recognition by asking students questions to identify patterns in the equations. Students should recognize all equations equal the same number (e.g., 10) and notice increasing/decreasing patterns in addends (Figure 3). If needed, pose questions like:

- What do you notice about the sum in each equation?
- What number sentence would come before 3 + 7 = 10?
- What's happening to the first number as we move down the list? What about the second number?

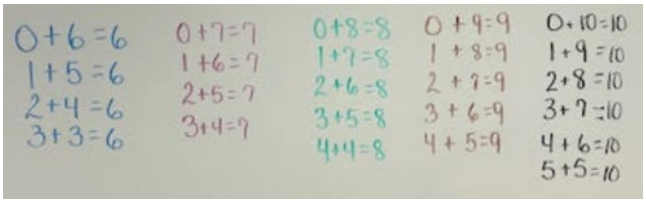

Figure 3. "Patterns in addition" by Rosalind Ali. CC BY 4.0.

Closure. To close the lesson:

- Look at the ways a number (e.g., 10) is made. Ask students, *What patterns do you see?*
- Direct students to the other sums previously discussed (e.g., 7, 8, 9; see Figure 3), and ask them, *What do you see is the same and different about showing ways to make 9 and showing ways to make 10?*
- Give students time to talk with a partner about each question.

To help students become aware of using CT skills, use explicit language like "we used decomposition to break apart 10 into 4 and 6 or 3 and 7" or "we used pattern recognition when we identified the number sentence that would come before 3 + 7 = 10." Use phrases like these to emphasize instances of CT to increase student awareness of their use of CT skills and help them understand its practical application in everyday problem-solving contexts. Closure is approximately five minutes.

Part 2: Modeling Addition Within 20 Using Ten-Frames

Part 2 includes one, session that may take multiple days.

Session 2

The Session 2 activity was adapted from a lesson in Marilyn Burns' (2008) *Do the Math Number Core* book and emphasizes patterns in addends and decomposition.

Introduction. Use a ten-frame to model 8 + 7. Show 8 red counters and then use 2 yellow counters to fill in the ten-frame. Place 5 more yellow counters under the ten-frame (Figure 4). Prompt students to write two number sentences representing the counters. Use questioning to help students generate number sentences and record several student responses.

Sample student response:

8 red and 2 yellow makes 10 plus 5 more yellows make 15.

So, 8 + 2 = 10 and 10 + 5 = 15

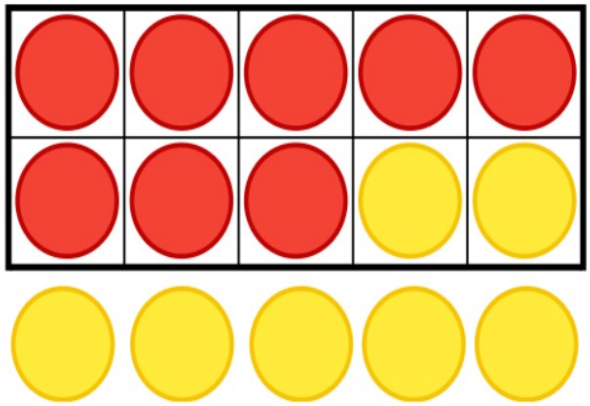

Figure 4. "Ten-frames and counters" with eight red counters and seven yellow counters. (Burns, 2008).

Other number sentences that students might notice are 8 + 7 = 15 and 8 + 2 + 5 (Figure 5). Discuss how decomposing 7 into 2 + 5 helped to make 10 which they can easily then add 10 + 5 to make 15. Compare this strategy to other strategies that students use to help them begin to see the benefits of decomposing numbers including efficiency and accuracy.

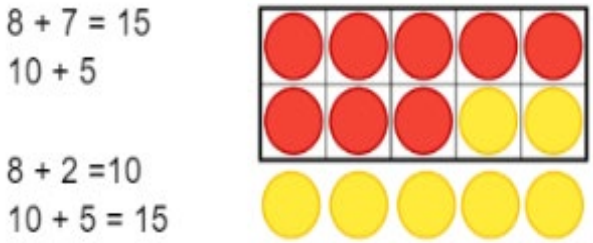

Figure 5. Other number sentences that students might notice.

Model for students the decisions that must be made when considering the addends in a problem. How can addends be decomposed to make the quantities easier to work with? Encouraging students to think about and articulate the steps they take to solve problems fosters the development of algorithmic thinking, a key component of CT.

Guide students to see that 8 + 7 = 15 and 10 + 5 equals 15. One number sentence is based on the colors of the counters (8 + 7 = 15) and the other represents counters inside and outside of the ten-frame (10 + 5 = 15). The latter lays the foundation for

understanding patterns in teen numbers composed of a ten and some ones.

Dice Game. Following this introduction, provide students with custom dice designed to more frequently yield sums up to 20. Students will take turns rolling the dice and represent the resulting quantities using red and yellow counters on ten-frames using decomposition to make ten. They will then write two corresponding number sentences that match their representations. To support language development and reinforce key concepts, provide sentence frames, to allow students to practice articulating their representations using both computational thinking and mathematical vocabulary (Figure 6). This hands-on activity aims to enhance students' understanding of CT skills, number relationships, and promote active engagement in learning.

Sample Sentence Frames

My ten frame represents 8 + 7

To show 8 + 7 on my ten frame I used ____ red counters and need ____ more to complete the ten frame.

I can decompose or break apart ____ to fill my ten frame and put the remaining ____ counters under the ten frame.

Now I see that ____ + ____ = ____ and ____ + ____ = ____.

Figure 6. "Sample Sentence Frames" by Rosalind Ali is licensed under CC BY 4.0.

Part 3 - Video Content Creation

Part 3 includes Sessions 3 through 8. Each session will take a minimum of 20 minutes.

Session 3

The purpose of Session 3 is to tap into students' prior knowledge about YouTube videos. Start by asking them to share their experiences of learning something from a video. Spend about 10 minutes letting students talk about how they've used videos, which platforms they prefer, and a time when a video helped them learn something new. Select a video to demonstrate the typical format of video content. Highlight how its style and format relate to writing: start with an attention grabber, use clear and concise language for the target audience, and conclude with a call to action.

Explain to students that their task is to create a video for a hypothetical YouTube channel aimed at teaching other students how to use ten-frames for addition within 20. Allow students time to brainstorm considerations for creating video content and to select an addition problem for their instructional video. To wrap up this session, summarize progress and set goals for the next session.

Session 4

During Session 4, introduce Chat GPT (or some other generative AI platform) and discuss how it can be used as a tool for learning and boosting creativity. Students will begin developing their script for the video. In developing the script, students will utilize the Chat GPT Generated Openers and Script Text to create opening and closing lines for their script and develop additional script content. Print the opening and closing statements on different colored paper and cut into strips. This helps students manipulate the sentences as they consider remixing text from the AI generated sentences, merged with their own ideas, to begin creating their video scripts. Students recorded their work in a google doc which facilitated collaboration, editing, and timely feedback. By the end of this session, each pair should have created text for the beginning of their video. Facilitate this session as many times as needed until the script for the beginning of the video is created.

Session 5

Before Session 5, the teacher should review students' scripts to provide timely feedback before they continue creating their scripts and practicing with ten-frames and counters to model their chosen addition problem. Encourage students to create concise step-by-step directions for their video. Support the use of CT language and content-specific vocabulary by providing a list of essential terms to be incorporated into their video scripts. Include words

such as decompose, pattern, or sum. At the end of this session, students will turn in a completed draft script. If scripts are hand-written, it is suggested that they are typed before Session 6 to prepare for a read-through and editing.

Session 6

Session 6 focuses on ensuring the scripts include appropriate, correct math and computational thinking vocabulary, as well as clear, concise, and age-appropriate language.

The read-through and editing process can be conducted either with the entire group or with pairs of students, depending on what works best for the class dynamic. To minimize distractions, consider working with each pair individually in pull-out form, instead of gathering the entire group at once. If needed, this session can be spread over multiple days to ensure quality review and engagement.

Session 7

In Session 7, students practice recording their videos. Before they arrive, set up an area for recording in the classroom. Use self-adhesive chart paper to create cue cards to help students remember the lines from their scripts. Use stacks of plastic containers on tables or whatever is available in your space to hang the chart paper at eye-level for students to read, if needed. These practice sessions help students get comfortable being recorded, reading from cue cards (chart paper), timing, speaking clearly, and using the whiteboard and manipulatives to model addition with ten-frames. Students record, watch their recording, discuss adjustments, and then record again, repeating this cycle several times.

Session 8

In Session 8, students recorded their videos (Figure 7). Rather than meet with the entire group, meet with student pairs individually to record their videos and eliminate possible distractions from others in the room. Afterwards, upload the videos and share the links with other teachers to use with their students.

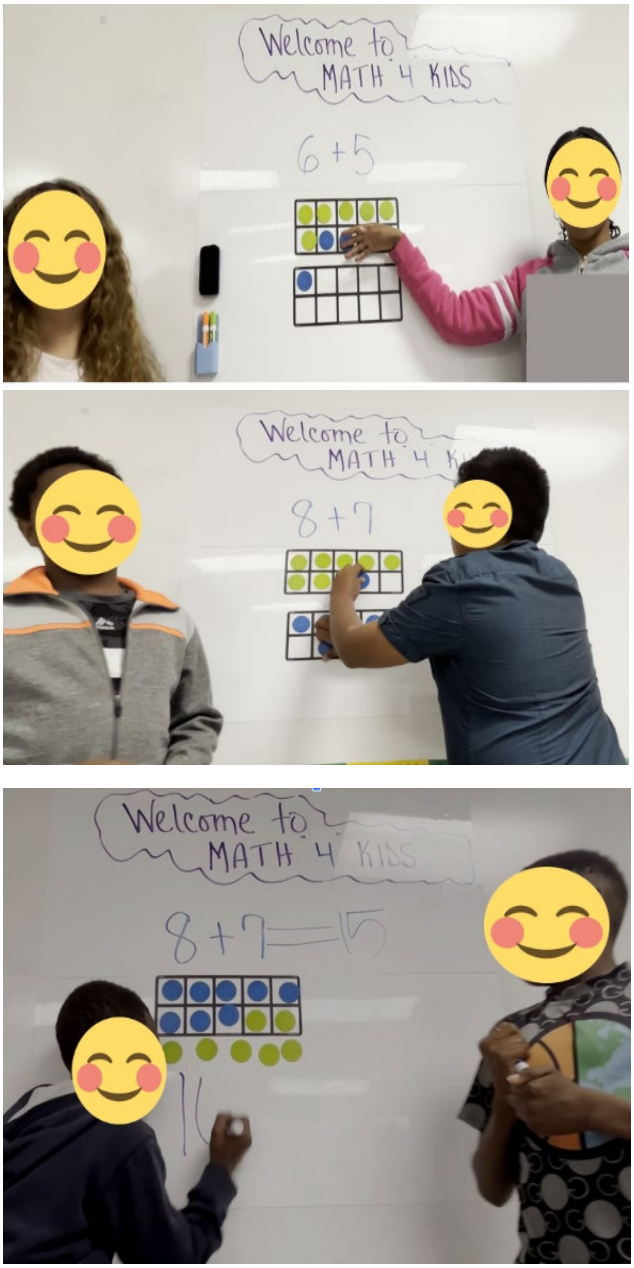

Figure 7. Students recording their videos. Photos by Rosalind Ali. CC BY 4.0.

Assessment

Various tools and strategies can be used for students to demonstrate their understanding. Facilitating reflective conversations with each student pair allows students to analyze and critique their work while reflecting on the learning process. These discussions give students the opportunity to demonstrate their grasp of the learning objectives

and explore how CT concepts connect to problem-solving. Number sense routines, such as Desmos Classroom (n.d.) *What Sum Do You See?* (Figure 8) or Steve Wyborney's (2023) *Mystery Number*, encourage rich mathematical discourse and provide valuable data for assessing progress toward proficiency in standards.

Throughout the project, taking anecdotal notes, observing, and listening to students as they use decomposition, identify patterns, and apply CT concepts can offer important insights into their learning. Additionally, documenting students' progress in using strategies (e.g., "make ten" to solve addition problems within 20) during subsequent Tier 3 intervention activities can provide further opportunities for them to demonstrate proficiency in standards related to this project.

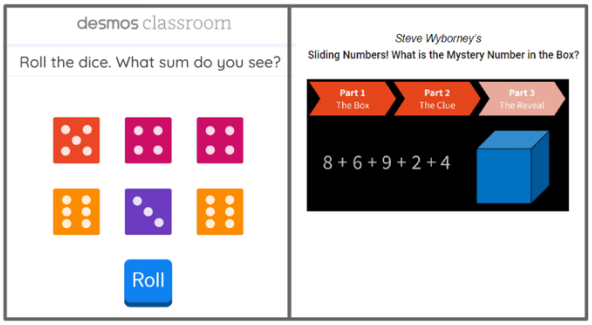

Figure 8. Image of Desmos Classroom (n.d.).

Critical Reflection

This was my first time implementing this lesson with a 5th grade math intervention group. It has been a few years since I led intervention groups, so I was excited to take on this role. Since starting as an interventionist this year, I've seen many discussions on social media highlighting the struggles of addressing unprecedented gaps in foundational math skills, largely due to disruptions caused by the pandemic. The abrupt shift to virtual learning and the gradual return to in-person classes created significant inconsistencies in students' learning experiences.

For my 5th graders, the data revealed they were missing foundational concepts typically mastered in first grade. To engage them effectively, I knew I couldn't simply present the curriculum as-is; it would likely lead to resistance from these pre-teens. Over the years, I've learned strategies that capture students' interest without making them feel embarrassed. Many students feel self-conscious about their skills, particularly if they've been labeled as "low." At this age, peer relationships and social-emotional development are critical, so I wanted to create lessons that respected their dignity while showing them the relevance of concepts they consider "stuff for little kids".

Despite knowing traditional algorithms, many students lacked a strong understanding of place value and the ability to analyze numbers for more efficient strategies. This math intervention lesson focused on helping them develop skills in decomposing numbers and using non-count-by-one strategies to find sums within 20. My goal was to guide them toward flexibility and proficiency in these strategies while preserving their self-esteem and building their confidence as mathematicians.

Recently, the leadership in my school district issued new guidance on promoting four key areas of CT in elementary math. They emphasized the importance of blending CT with mathematical discussions to enhance number sense and problem-solving skills. This math objective in this lesson, grounded in foundational number sense, was a perfect fit to introduce and develop CT concepts. After exploring different creative ideas for integrating computational thinking and mathematics, I decided students would become content creators.

The number progression curriculum in my district includes the use of ten-frames, number tracks, and number lines to build number sense and model addition and subtraction. I told the intervention students that our first graders are learning to use ten-frames and number lines to add within 20, and their help is needed to create instructional videos because sometimes we learn better from each other. They all recalled instances where a classmate helped them solve a problem or learn something, both inside and

outside of school. One student shared a memory of learning something new on the playground from another student.

Every student could recall a time when they watched a video to learn something new, whether it was about a video game, a hairstyle, dribbling a basketball, or putting together an outfit. One student mentioned her sister making hairstyling videos to advertise her cosmetology services and another talked about a cousin who was inspired by social media videos to create her own instructional videos on her favorite hobby. I could tell the students were getting excited about becoming content creators and creating videos to model addition problems for first graders. Initially, I planned for intervention students to create videos using ten-frames, number tracks, and open number lines, but we could not finish before the school year ended. Instead, they chose a representation and kept each video under 2 minutes. Our initial conversation sparked many questions from the students, and I assured them that in the following sessions, they'd have time to create scripts, rehearse, and record their videos.

I used ChatGPT to generate phrases and sentences to spark ideas for opening and closing sentences for their scripts (see Chat GPT Generated Openers and Script Text). I printed them on different colored paper—green for openings and blue for closings—and cut them into strips so students could easily piece together their presentations with their partners. They quickly began remixing some of the text and adding their own ideas to hook viewers and consider important details needed to best communicate their message. Once students created opening sentences, they were asked to talk through steps they were taking to find the sum using ten-frames. Vocabulary related to CT to reinforce ideas of pattern recognition and decomposition was included in AI-generated sentence stems available to students to help them articulate their processes.

To rehearse and record the videos, I worked with student pairs individually for 15-20 minutes. This multi-day process created many opportunities to highlight CT concepts. Students wanted to memorize their scripts, and when someone forgot a line or spoke out of turn, they had to analyze the order of their presentation and debug the sequence of statements to ensure their steps were logical. Multiple recording attempts were needed before the final video, giving students ample opportunity for meaningful practice applying their strategies to find sums within 20.

Occasionally, I asked students to use different addends to observe their ability to transfer and generalize their process using different numbers. This approach was effective, as students were often reluctant to speak in front of the entire group but more willing to articulate their thoughts individually. Considering social dynamics like personalities, maturity, and the ability to give and receive constructive criticism is crucial to fostering an environment where risk-taking and mistakes are encouraged without judgment.

My initial plan was to record ten-frame videos before spring break and then create videos modeling the use of number tracks and number lines after spring break. However, I underestimated the time students needed to prepare their videos and didn't account for interruptions in intervention sessions due to preparations for state-mandated standardized tests. Next time, I'll make sure we have enough time to create more videos with options to use number tracks or number lines for addition and subtraction. I will be sure intervention students have an opportunity to review the work of their peers and offer constructive feedback.

Due to the students' age, the videos were only posted on our school's internal Google Drive. However, I demonstrated how to post videos on YouTube and create a channel. While too young for social media accounts, the students were familiar with platforms and had many questions. I aimed to give them a complete view of the content creation process with connections to CT concepts. I hope they continue this work in middle school, at home, and be able to transfer and apply these skills CT concepts in real-world situations.

Progress monitoring focused on observing students' use of CT concepts and their ability to accurately model addition. Instead of traditional assessments, I kept anecdotal notes documenting their mathematical thinking, behaviors, and mastery of decomposition strategies, particularly the "make ten" method. Evidence of achieving our goals included active participation in number sense routines and comments like, "I can decompose 6 to make a ten" or "I can break apart the second addend to get to 10 and then add the rest." Other evidence of understanding was displayed as students noticed patterns in relationships between number sentences. The Desmos Classroom (n.d.) and Wyborney (2023) digital activities were engaging for students and ideal for facilitating rich, student-to-student discourse to demonstrate learning.

Looking ahead, I plan to introduce this lesson earlier in the school year and utilize CT lesson planning resources from CT4edu (n.d.) to better identify moments where computational thinking can be naturally incorporated into the lesson.

I recognize the critical value of student reflection time. Moving forward, I will allocate sufficient time at the end of each lesson for students to reflect on their learning. This will enhance their understanding of computational thinking skills and their application to everyday problem-solving scenarios.

In conclusion, here are a few key considerations for future implementations of this lesson:

1. **Age-Appropriate Introduction to AI**: Tailor discussions on AI to the students' level and in accordance with district AI policies. Decide if students will directly engage with AI (e.g., crafting prompts) or if AI will remain a behind-the-scenes tool used solely for lesson preparation.
2. **Creative Use of AI-Generated Content**: Explain to students advancing to middle school how AI-generated text can serve as inspiration for their own creative work, particularly in script design.
3. **Manipulatives and Concept Progression**: Engage students with manipulatives to connect AI-supported activities to math concepts.
4. **Incorporation of CT Language**: Emphasize CT concepts like pattern recognition and number decomposition, helping students to connect CT vocabulary to lesson activities.
5. **Consideration of Social and Emotional Factors**: Assess students' comfort with partner work, video recording, presentations, and other collaborative activities to foster a supportive learning environment.

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About the Author

Rosalind Ali, a veteran mathematics educator, recently completed her doctoral studies in Educational Technology at Central Michigan University. Her professional background encompasses roles as a computer scientist, classroom teacher, mathematics resource specialist, math coach, and math interventionist. Dr. Ali's research focuses on enhancing pre-service teacher preparation for the integration of computational thinking into pedagogical practices. Her scholarly work investigates computational thinking attitudes and their practical applications in classroom and small group settings, with an emphasis on improving student engagement and parental involvement.

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