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Go Game and Mathematics Learning in Third-Grade Elementary Classrooms: An Explorative Study

Xiuwen Wu
(National Louis University, United States)
Xinming Guo
(Math and Go Academy, United States)

Abstract

This article presents findings from a classroom-based research project examining the innovative integration of the ancient board game Go in third-grade classrooms within a suburban U.S. school district. The study involved six teachers and over 100 students. In Phase 1, the Go teacher provided six weekly on-site lessons and four monthly lessons in Phase 2. Each lesson consisted of approximately 10-15 minutes of instruction and 20 minutes of gameplay. The research sought to answer three key questions: 1) What adaptations are necessary for implementing Go as a game-based learning tool in classrooms? 2) What natural opportunities for learning and using mathematics arise from playing Go? 3) How do teachers and students perceive the game of Go?

Adapting the Go game was essential to make it better suited to the practical demands of the classroom setting. Smaller boards allow Go to fit easily within class periods and match students' beginner levels. Emphasizing the "natural" objective of the game — ensuring stones survive forever on the board — along with a simplified scoring rule based on counting surviving stones provided a student-friendly, concrete approach to gameplay. Additionally, rearranging the remaining stones into recognizable number shapes helped students count, recognize numbers quickly, and easily calculate and verify scores. These key adaptations also created a low-pressure, interactive way for students to practice foundational math skills in a game-based learning environment.

Data analysis revealed that students employed essential math skills aligned with the Common Core State Standards for Mathematics (CCSS-M) during Go games. Students with varying mathematical abilities demonstrated high levels of engagement and focused attention during Go lessons and games. As the project progressed, students moved away from counting stones individually and using skip counting to more efficient approaches to calculating their final scores, such as using number shapes and arrays for multiplication. This practice allowed students to engage in perceptual and conceptual subitizing - critical number sense skills that promote mastery of arithmetic. Arrays also helped students grasp the critical concepts of commutative and distributive properties of multiplication, which are visually evident on the Go game board.

This research provided empirical support for the connections between Grades K-3 CCSS-M standards and Go. Teachers observed that their students

frequently applied math skills during Go gameplay and experienced valuable opportunities to reinforce concepts from their ongoing math curriculum. Students reported using their math skills while playing Go. For example, when asked how to introduce Go to their friends, they noted that it can help them learn how to be a good leader and help them practice math skills. Some students described Go as "a cool, fun strategy game that's sometimes challenging and uses a lot of math skills." Notably, students with special needs, including those with Attention Deficit/Hyperactivity Disorder and Autism Spectrum Disorder, actively participated in Go games with their peers without disabilities, without needing their classroom aides. Teachers noted that Go games created an alternative low-anxiety math learning space in their mathematics classrooms. In addition to its mathematical benefits, teachers recognized that Go improved students' attention, engagement, collaborative learning, and decision-making.

Keywords: Go game, game-based learning, mathematics education, numbers, learning standards, all learners.

I. Background

The struggle with mathematics is a pervasive problem in schools in the United States. Between 5% and 14% of all school-age students have significant math deficits and persistent difficulty with mathematics that impact their abilities to solve fundamental math problems (Hott et al., 2014; Mazzocco et al., 2011). At the heart of these difficulties are issues with numbers, a core characteristic of mathematical learning challenges, including math learning disabilities like dyscalculia (Chinn & Ashcroft, 2017). Besides experiencing a lack of mastery of number facts, students with math learning difficulties and disabilities might also have deficits in working memory functioning, visuospatial thinking, poor number sense, and math anxiety (Berch & Mazzocco, 2007). Starting from early elementary, students experience math anxiety and a low self-concept in their mathematical abilities—both significant factors influencing math achievement (Gurganus, 2017). Early interventions to improve children's understanding of the relationships among numerals should start as soon as possible in schools to improve their math skills and reduce math anxiety (Geary, et al., 2013; Ramirez et al., 2017).

Games, including both digital and board games, can provide alternative learning spaces for students to enhance their cognition and academic skills (Steinkuehler & Squire, 2014). A critical factor in designing effective game-based learning environments is finding the right balance between teaching the subject and explaining how to play the game (Plass et al., 2010). Another important factor is selecting "good games" that strike a balance—neither too simple and boring nor too difficult and frustrating. These games allow students to play within their Zone of Proximal Development (ZPD) (Vygotsky, 1978) and gain the most from the instruction and feedback teachers or peers provide.

Teachers may use games for various purposes that are conducive to learning: enjoyment, motivation and engagement, the development of social skills, higher-level thinking, and improvement of mathematical knowledge (Bragg, 2012). Playing board games can create opportunities for children to practice their numeracy and spatial skills (Ramani & Eason, 2016) and provide them with "visual and spatial analogs of number representations that children can actively explore in a hands-on fashion" (p.292, Griffin, 2005). Games can also allow students to "encounter many opportunities to use numbers to make sense of quantity representations" (p.42, Griffin, 2005). Incorporating number-relevant board games can help children link math concepts and develop a positive attitude toward math (Petersen & Hyde, 2017).

Several neuroimaging studies have revealed that playing board games like Go relates to executive function and problem-solving skills. In a study by Kim et al. (2014), the researchers found that, after playing Go for 16 weeks, the students in the ADHD group showed notable improvement in inattention and executive function. The study also indicated the possible therapeutic effects of playing Go with students who have ADHD.

Go originated in China over 3,000 years ago, and Japan played a crucial role in introducing the game to the Western world in the late 1800s. It is "the oldest game still played in its original form" (American Go Association, https://www.usgo.org/brief-history-go). Over 46 million people worldwide know how to play Go, and an increasing number of Go fans in about 75 member nations across five continents (International Go Federation, https://www.intergofed.org/).

This groundbreaking classroom-based research aims to empirically investigate the benefits of playing Go in elementary classrooms, particularly for learning mathematics. It is the very likely first study in the U.S. to explore Go's connection to mathematical learning in the classroom. This study addresses the following questions: 1) What adaptations are necessary for implementing Go as a game-based learning tool in classrooms? 2) What natural opportunities for learning and using mathematics arise from playing Go? 3) How do teachers and students perceive the game of Go? The following sections of the article address each of the three questions in turn.

II. Research Methods

The study included six teachers and around one hundred third-grade students at a suburban elementary school in the Midwest, with the teachers working across four different classrooms. In the first phase, the Go game instructor conducted six weekly on-site lessons for students in their math classrooms. The second phase consisted of four monthly lessons, two held remotely via Zoom. In total, the study included ten game sessions. The Go instructor used "Go" and "Weiqi" interchangeably during instruction to refer to the game.

The five classes of students were split into two smaller groups of about 45 students each, who received Go game lessons at different times according to a pre-arranged schedule. Each lesson included approximately 10 to 15 minutes of direct instruction on Go strategies and 20 to 25 minutes of gameplay. The lessons followed a consistent structure, beginning with the lesson

objective, one or two focal strategies, and a cumulative review of previously learned strategies.

The Go instructor used slides projected on a screen and a mini whiteboard for demonstrations, illustrating authentic game situations in each session that were directly related to school math concepts. For instance, after a demo game, he would ask students to share their scores and explain how they calculated them. While students played, he circulated the room, offering feedback and asking prompting questions that encouraged them to think critically about and apply math skills.

This qualitative study aimed to uncover natural moments during Go lessons where students applied their math skills and reasoning. In addition, it sought to explore participants' perceptions of how this strategy board game supports students' mathematics learning. To achieve these objectives, the researcher collected the following data:

- Beginning and end-of-project teacher surveys
- End-of-project teacher interview
- End-of-project student survey
- Student artifacts related to Go game (e.g., completed score tables)
- Videos of gameplay
- Observational notes

These diverse data sources ensured data triangulation and a more comprehensive understanding of the phenomena (Miles & Huberman, 1994; Silverman, 2022). The initial and end-of-project teacher and student surveys pro-

vided insights into how teachers' views on the game evolved and allowed for comparing teacher and student responses. End-of-project teacher interviews, conducted via Zoom, offered an in-depth look at teachers' perceptions of the mathematical learning opportunities presented by Go and their observations on student engagement across high, average, and low math achievers. The teacher surveys included matching questions to help identify whether teachers' observations of student engagement and math use during gameplay aligned with students' reported experiences. Classroom observations and video clips further documented significant instances of student interactions and discussions about Go, especially moments that organically linked the game to mathematics.

Both deductive and inductive approaches were used to analyze and code the data. This process revealed themes and patterns related to students' engagement and mathematical learning through gameplay. As the analysis progressed, data were recoded to refine and clarify these emerging themes, offering deeper insights into how Go supported students' mathematical reasoning, skill application, and other aspects of learning.

III. Results

1. Adaptations to Go Game-Based Learning in Classrooms

Designing effective game-based learning begins with selecting good games. Go is an excellent example, which is inherently engaging and increasingly challenging. It embodies four key characteristics: Simple, Elegant,

Profound, and Abstract (SEPA). Although Go is easy to learn, it offers depth and complexity suitable for players of all skill levels, from novice to expert. However, even great board games like Go require some adaptation to fit the unique demands of classroom settings, such as curriculum requirements, time constraints, students' knowledge levels, and other factors.

1.1 Adapting the Go Classroom Set

Go is a strategy board game in which two players take turns placing their pieces—black and white stones—on the vacant intersections of a 19 x 19 board/grid. However, this format is more suited to adult and skilled players rather than meeting the needs of novice players in U.S. elementary classrooms.

With each mathematics class typically lasting 30 to 50 minutes at the school of study, it is essential to adapt the game using smaller boards: 6 x 6 or 7 x 7. The 6 x 6 board is typically used for teacher demonstrations and introductory gameplay, while the 7 x 7 boards are used as students progress to the next level.

We also created Go classroom sets to make it a low-maintenance game for busy teachers. Each classroom set includes a handled plastic storage container holding Mini-Go sets (pairs of small, transparent boxes for black and white stones) for the students in the classroom. Additionally, teachers receive a magnetic demo board with magnets to facilitate quick game demonstrations.

1.2 Adopting the "Natural" Rule for Go Gameplay

To introduce Go to absolute beginners in the classroom, we reframed the game's goal and introduced the "natural" rule to make it more accessible and engaging. Each player takes on the role of a country's leader, with their stones representing their people, aiming to keep as many of their people on the board as possible. The final score, or "population score," is determined by the number of stones surviving at the game's end. Techniques to achieve this include making two eyes, capturing the opponent's stones, and building up territories.

Figure 1 below illustrates the progression of a Go game, from an empty board at the start to the end, when both players pass, leaving two eyes for their groups of stones to ensure survival forever. The two eyes protect them from being captured by their opponents.

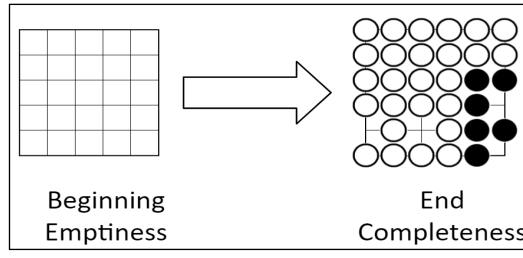

Figure 1. From an Empty Board to Completion

Aligned with the adapted game goal is a natural counting rule: a player's final score is the total number of surviving stones, or "population," remaining on the board at the completion of the game. This absolute counting method is more straightforward for elementary students new to Go, as counting

stones is more concrete than calculating territories, defined by empty intersections surrounded by the player's stones. To assist with score calculation, students learn the "rearrange" method to organize their surviving stones into easy-to-recognize shapes to facilitate instant number recognition and cross-verification with their opponents. Figure 2 shows how a group of ten black stones in the left image can be rearranged into a rectangular shape representing the number ten in the right image.

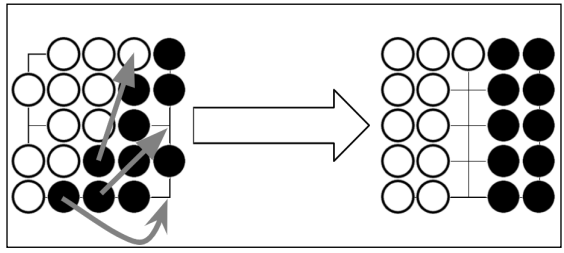

Figure 2. Rearrangement Stones into Number Shapes

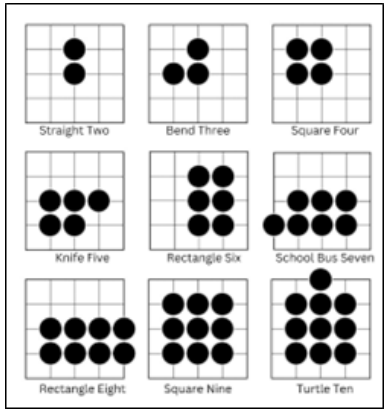

Figure 3 displays the names of the basic number shapes used in the classroom version of Go:

Each number shape is assigned a unique name, making it easier for students to remember and communicate them to each other. One activity linked to these shapes is the "flash and tell" exercise, where the Go instructor quickly displays a number shape, hides it, and asks students to identify the number they saw. This activity aligns well with the CCSSM standards, particularly those related to counting objects arranged in different configurations. However, unlike basic counting tasks, the number-shape activity in Go is aimed at efficiency. Instead of counting one by one, students subitize and recognize groups of objects, particularly by tens.

The number shapes are designed to enhance students' perceptual and conceptual subitizing abilities, which are crucial for mastering number operations (Clements, 1999; Sarama & Clements, 2009; Starkey & McCandliss, 2014). "Directing children's attention to patterns through perceptual and especially conceptual subitizing helps children develop abstract number and arithmetic strategies" (Institute of Medicine and National Research Council, 2015, p.123). This skill is essential because many students with mathematical difficulties rely on immature counting strategies to solve simple arithmetic problems. A lack of these foundational competencies has been linked to mathematics learning disabilities and difficulties (Berch & Mazzocco, 2007; Butterworth, 2018). The number shape activity not only supports Go gameplay through efficient score calculation but also provides students with a practical opportunity to practice and strengthen their math skills.

1.3 Adapting How Core Strategies Are Introduced

The key concept in this game is *Qi or liberty*. For a stone to stay on the board, it must have at least one Qi, which is any vacant intersection directly

connected to the stone (up, down, left, or right, but not diagonally). Qi is introduced to students as an energy source, similar to an air supply, with supporting visuals illustrating this idea. Simple, memorable phrases like "No Qi, No Life" reinforce this concept for students. The instruction on Qi is effectively conveyed using diagrams, such as those shown in Figure 4.

In image A of Figure 4, the black stone near the center of the board has four vacant points adjacent to it, connected by vertical and horizontal lines. These represent four Qi points. In image B, the black stone positioned at the edge has three Qi points, while the white stone in the lower right corner has only two Qi points. The Go instructor used the Qi concept, as shown in these diagrams, to guide students in thinking strategically about where to place their stones at the start of the game.

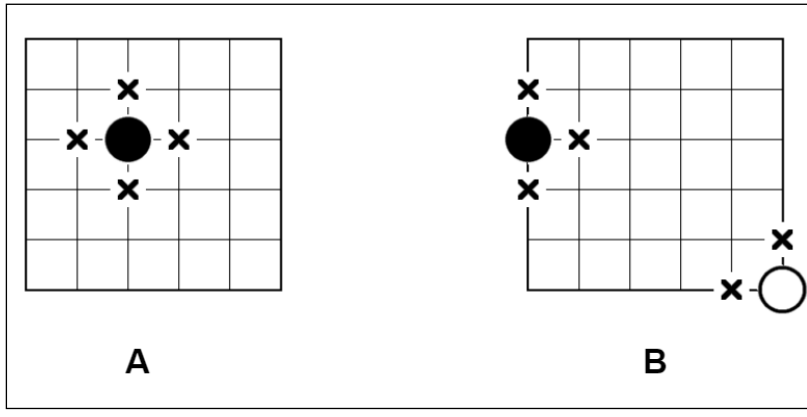

Figure 4. Concept of *Qi (liberty)*

Another key concept introduced to the students is the capture rule. Capture consists of three steps: 1) Discover that your opponent's stone or group of

stones has only one Qi remaining, 2) place your stone to take away the last Qi, and 3) remove all Qi-less stones from the board. In Figure 5 below, image A shows a black stone with only one Qi left (indicated by the cross sign). The white stone player spots this opportunity and places a white stone there to eliminate the black stone's final Qi. The black stone is captured and removed instantly from the board, as shown in image C. Similar scenarios with a string of stones are also introduced during the instruction.

The instructor also introduces strategies, such as connecting stones to increase Qi, the concept of groups, and other techniques, throughout the instructional periods and as opportunities for incidental teaching arise during students' gameplay. One guideline for recruiting students' interest in the game is to enable them to start playing as soon as possible, usually within 15 minutes of the introduction in the first class.

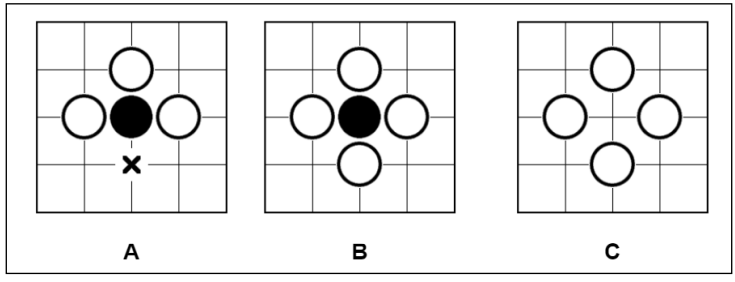

Figure 5. Steps of Capture

2. Natural Opportunities for Learning and Using Mathematics

2.1 Correlation Between Go and Math Learning Standards

In our implementation of Go in educational contexts, we highlight that it is not merely a game of strategy but, more importantly, a game of numbers that can assist teachers in helping students achieve the Common Core State Standards for Mathematics (CCSSM). Adopted by most states in the United States, these standards outline what students should know and be able to do in mathematics from kindergarten to 12th grade.

An item-by-item analysis of CCSSM, using the following Correlation Model, found that Go addresses roughly 60% of the K-3 mathematics learning standards across three key domains: Counting & Cardinality, Number & Operations in Base Ten, and Operations & Algebraic Thinking. This model generates five scores that show how each math standard is represented in Go gameplay.

Score	Definition	Explanation	CCSSM Standards
4	Inherent connection	Directly applied in Go game (e.g., counting temporary and final scores, identifying scores through subitizing -- instant recognition of the number of stones on the board.)	K.CC.2 Count forward beginning from a given number within the known sequence (instead of having to begin at 1). K.CC.5. Count to answer "how many?" questions about as many as 20 things arranged in a line, a rectangular array, or a circle, or as many as 10 things in a scattered configuration; given a number from 1–20, count out that many objects. K.CC.6 Identify whether the number of objects in one group is greater than, less than, or equal to the number of objects in another group, e.g., by using matching and counting strategies

3	Big connection	Applied in Go with minimal adjustments (e.g., rearranging stones into number shapes for score identification and verification, using a scorecard, calculating a running total, referring to the Go gameplay manual, recording with Go kifu, etc.)	K.CC.3 Write numbers from 0 to 20. Represent a number of objects with a written numeral 0-20 (with 0 representing a count of no objects). 1.OA.3-- Apply properties of operations as strategies to add and subtract. Examples: If 8 + 3 = 11 is known, then 3 + 8 = 11 is also known. (Commutative property of addition.) To add 2 + 6 + 4, the second two numbers can be added to make a ten, so 2 + 6 + 4 = 2 + 10 = 12. (Associative property of addition.) 1.OA.7 -- Understand the meaning of the equal sign, and determine if equations involving addition and subtraction are true or false. For example, which of the following equations are true and which are false? 6 = 6, 7 = 8 – 1, 5 + 2 = 2 + 5, 4 + 1 = 5 + 2. 4.OA.1 Interpret a multiplication equation as a comparison, e.g., interpret 35 = 5 x 7 as a statement that 35 is 5 times as many as 7 and 7 times as many as 5. Represent verbal statements of multiplicative comparisons as multiplication equations.

2	Small connection	Applied in Go with moderate adjustments or specifically designed stone-based activities (e.g., using Go stones as math manipulatives to teach base ten, place value concepts, and number operations)	1.NBT.2.a Understand that the two digits of a two-digit number represent amounts of tens and ones. Understand the following as special cases: 10 can be thought of as a bundle of ten ones—called a “ten.” 1.NBT.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. 3.NBT.3 Multiply one-digit whole numbers by multiples of 10 in the range 10-90 (e.g., 9 × 80, 5 × 60) using strategies based on place value and properties of operations.
1	Little connection	Applied in Go with significant modifications	K.G.2 Correctly name shapes regardless of their orientations or overall size.

Table 1. CCSS-M and Go Game Correlation Model

Figure 6 illustrates this correlation, showing that 60% of the 96 K-3 standards naturally align with Go gameplay. This means that, through playing Go, students can actively apply and reinforce key foundational math skills such as counting, recognizing number patterns, and number operations in an engaging, hands-on way.

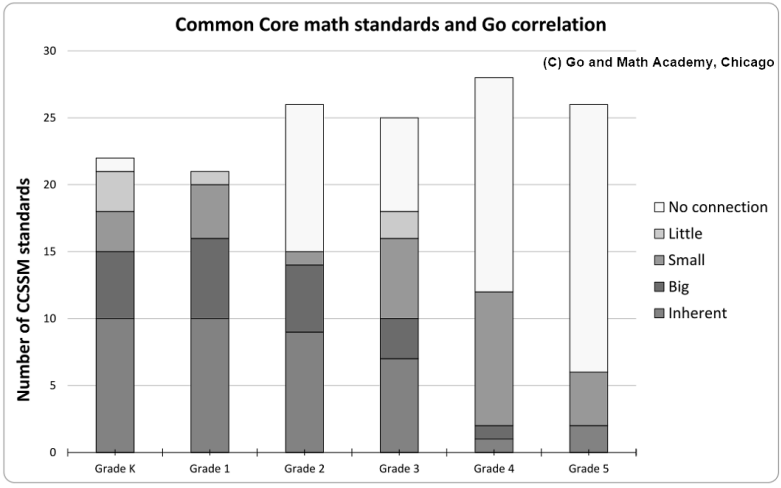

Figure 6. Common Core Math Standards and Go Game Correlation

2.1 Math Skills and Concepts in Go Gameplay

Qualitative data analysis revealed that students utilized essential math skills and strategies while playing Go, including skip counting, counting on, near doubles, single- and multi-digit addition, equal groups, arrays for multiplication, and subtraction.

As the project progressed, students shifted from primarily relying on skip counting at the beginning to increasingly employing arrays and multiplication

for score calculation by the middle and end. This change can be attributed to the emphasis the Go game teacher placed on moving and reorganizing stones at the end of the game to form arrays. By doing so, students actively created visual representations of numbers that facilitate quick recognition of scores for each other. Throughout the project, they discovered that multiplication was the most efficient method for accurately and swiftly determining their final score, rather than relying on skip counting by ones, twos, etc.

Figure 7 illustrates how two students reorganized their stones into arrays at the end of the game. When asked to determine the final score for the white stones, the students quickly identified the array as 6 x 4, answering that the score was 24. Similarly, the students used the array of black stones to show the final score as 4 x 2 = 8 for black. Through authentic gameplay, students connected to the curricular focus on the array model for multiplication. They applied their multiplication skills efficiently to calculate the score, rather than counting stones one by one or skip counting.

This approach also minimizes errors when calculating final scores. Additionally, the game motivated students to collaborate, as they were invested in achieving accurate scores. Rearranging their stones into number shapes gave students a shared standard to display the results. They checked each other's arrangements to ensure accuracy, emphasizing precision in score verification. This process encouraged clear communication about numbers and mathematical procedures, also crucial skills addressed in the math standards.

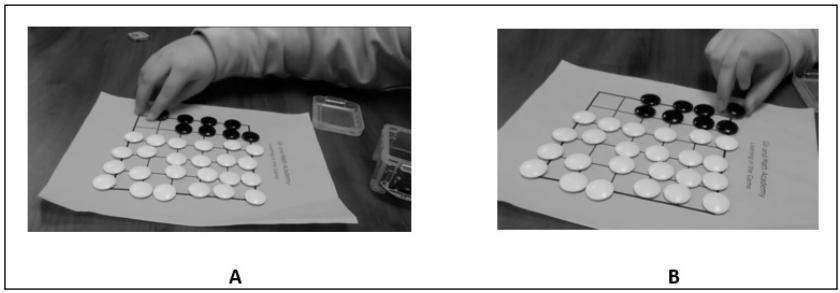

Figure 7. Reorganize Stones with Arrays

The students quickly caught on to a number shape called Turtle 10, which gets its name because it looks like a turtle with its back and head. Counting by Turtle 10s was easy for students to set up, enjoyable to create, and enabled them to display scores in multiples of ten.

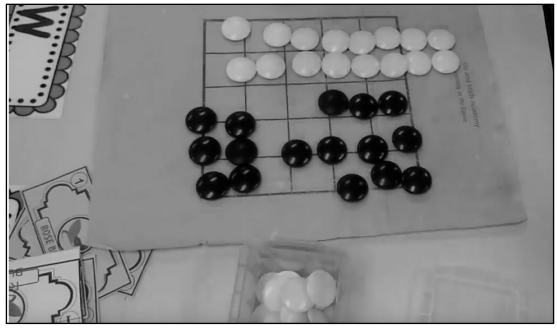

Figure 8. Turtle Ten and Arrays

Figure 8 illustrates the final score of white stones: a Turtle 10 plus six more stones, which is 16. Saying, “So here’s a turtle, a 10. Sixteen!” the student instantly recognized that he had 16 stones.

Go games were conducive to learning the distributive property of multiplication. In image A of Figure 9, the student reorganized his white stones into an array of 3 by 6. When asked for the score, the student answered: “3 times 6, 18. I mean 21” (Counting the three stones in his hand). In image B, the Go instructor showed how to rearrange the 21 white stones into a 3 by 7 array, demonstrating the connection between 3 x 7 and 3 x 6, where 3 x 7 equals 3 x 6 + 1. This scenario frequently occurred during gameplay, providing opportunities to connect Go with the distributive property of multiplication.

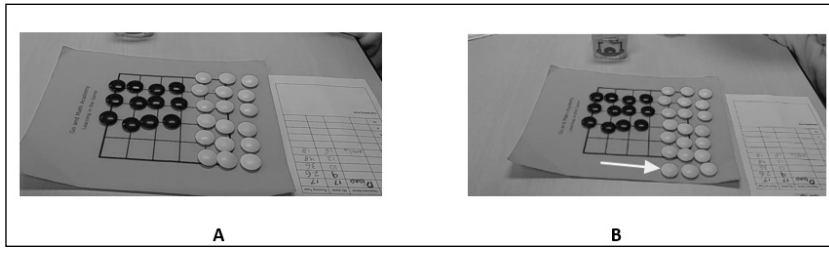

Figure 9. Distributive Property Application

The collected videos feature engaging discussions between the Go instructor and the students. For example, the following transcript shows how the instructor prompted two students to explain their scoring process, particularly how they calculated the number of stones remaining on the board at the end of their game. Figure 10 displays the final scores for the two players.

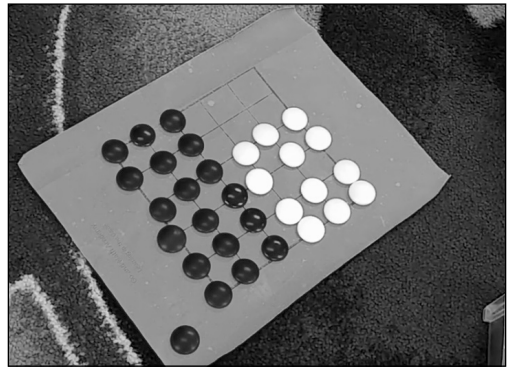

Figure 10. Two Students' Final Scores

GIS (Go instruction specialist): *What is the score for black? Without this one, how many? And then, add this one.*

S1: *Uhm, 19.*

GIS: *How do you know?*

S1: *Because 6 plus 6 is 12, plus another 6, 18*

GIS: *Multiplication*

S1: *And then plus 1*

GIS: (Asking the other student) *How do you know?*

S2: *This is nine, and this is nine. So nine times 2 is 18. And then this one, it's 19*

In this clip, the two students used skip counting by six to determine their final scores. Before moving on to other students, the instructor asked them to verbalize the multiplication expression for 3 x 6 and encouraged them to memorize it: "Three times six is one ten eight, or one ten and eight, the math name for eighteen."

The conversations around the game board in the classrooms resembled incidental “number talks” where students discussed various mathematical concepts and skills, such as counting strategies, arithmetic operations (addition, subtraction, and multiplication), arrays, equal groups, and geometry (e.g., symmetry of shapes). Peers who initially were not focused on applying multiplication skills from their math classes were reminded of the power of multiplication during the games. They saw how their peers used multiplication to gain a clear advantage in efficiently calculating or reporting the final scores.

3. Teachers’ and Students’ Perceptions

3.1 Teachers’ Perceptions of Go Game

Teacher and student surveys and teacher interviews provided evidence of the significant educational potential of incorporating the Go game into mathematics classrooms. Both teachers and students perceived Go positively and noted its strong connections to math learning standards at the project’s beginning and end. Below are some comments from the teachers in their surveys:

- Students asked to play Weiqi after finishing math assignments.
- Weiqi is often the preferred choice of activities when they have free choice.
- They are always eager to play.
- The student with ADHD showed a great interest in Weiqi and was attentive during Weiqi lessons.
- Students arrange the stones in a variety of ways to count the stones.
- Turtle 10 and arrays are such powerful visuals for my 3rd graders.

· The students enjoyed learning how to decompose numbers in new ways.
· The students really benefited from the extra math practice.
· It is a great experience for students to apply math skills naturally and to practice basic math skills repeatedly in the game.

One teacher referenced explicitly the power of rearrangement of stones for math learning:

> My students are asking to play Weiqi after they finish their math assignments. They are enjoying the challenge, and it is often the preferred choice of activities when they have free choice. All the strategies for staying alive are useful but I love it most when it's time to calculate the final score. Students are arranging the stones in a variety of ways to count the stones. Turtle 10 and arrays are such powerful visuals for my 3rd graders.

In one classroom, a gameplay video of two students provided valuable insight into how they took ownership of the final scores. The transcript below is the conversation between two students playing on a 7x7 board as they rearranged the stones to calculate their final scores and recorded the results on their scoresheets.

White stone student (WSS): I have 26 again.
(WSS notices she has the same score as in the previous game)

Game Instructor: You have 26. What's the final score for black?

Black stone student (BSS): It is 19.

(BSS begins to write 19 on her scorecard.)

WSS notices that BSS had written an incorrect score for the previous game and points out the mistake.

WSS: This is 19. Remember, I told you it's 19."

(BSS erases the previous number and writes the correct one.)

BSS: I counted wrong.

Although the Go instructor prioritized educational benefits over competition, this conversation revealed that students cared about their scores in each game. The two students demonstrated a strong sense of ownership in the game process, motivating them to cross-check each other's scores with precision using number shapes. When asked to cross-verify each other's scores, students present their results in precise number shapes, which makes it easier for their opponents to confirm. This practice taught them the importance of number precision and accuracy in their calculations.

In this context, applying math skills became both natural and authentic. To downplay competition, students could select their best games to record on their scorecards and add to their running total. The scorecard tool helped prevent discouragement from a zero score (no remaining stones). This approach was essential for encouraging beginners. In these classrooms, students frequently assisted each other by suggesting moves, and we observed sustained

interest from students with special needs.

Various mathematical skills were observed as students played the Go games, including those about number operations and visual/spatial thinking. It is important to note that all teachers recognized the connections between the Go game and concrete representation of numbers, multiplication, and mental math. Table 2 compares teachers' observations of connections over time, indicating the percentage of teachers who noted connections between Go and mathematical concepts and skills covered in the CCSSM.

Connections between the Go game and mathematics you have observed your students learn and play Go?	**Teacher Responses (Beginning-of-the-Project Survey)**	**Teacher Responses (End-of-the-Project Survey)**
· Concrete representations of numbers	100%	100%
· Multiplication	100%	100%
· Mental math	100%	100%
· Visual/spatial thinking	N/A	100%
· Composition and decomposition of numbers	83%	100%
· Number sense	83%	86%
Addition·	67%	86%
· Subtraction	67%	86%
Checking answers (scores)	67%	86%

Count on	N/A	71%
Repeated addition	67%	N/A
Repeated practice of basic facts	67%	71%
Skip counting	67%	71%
Regrouping	50%	57%

Table 2. Teachers' Observations of Students' Application of Math Skills During Go Games

The data indicate that regrouping was the least observed skill during student gameplay, with only 57% of teachers noting its occurrence by the end of the project, which is lower than other math skills and concepts. This may be because regrouping requires more explicit instruction using Go game stones rather than being naturally integrated into gameplay discussions. According to the Correlation Model, regrouping receives a score of 2, indicating a weak connection to the standards. It typically involves multi-digit number operations, such as performing standard algorithms for addition and subtraction. It entails changing the place value of digits, particularly when carrying over a digit during computation.

In addition, the teachers recognized several general benefits of Go gameplay, including increased student attention, heightened engagement, and enhanced decision-making skills. All six teachers noted that Go promoted "thinking about decision-making," a crucial component of metacognition. This aligns with Goal 3 of the Social/Emotional Learning Standards for K-12 students in the state, which emphasizes demonstrating decision-making skills

and responsible behaviors in personal, school, and community contexts.

Over 70% of the teachers indicate that Go provided the following benefits to their students: increased engagement and attention, consideration of consequences, greater motivation in the learning process, and the low-cost, low-maintenance nature of the game for classroom teachers. More than 40% of teachers also highlighted Go's positive impact on social-emotional learning and the development of students' ownership and agency. Additionally, 30% of teachers mentioned improved communication as a valuable benefit.

In a recent email correspondence, one of the teachers shared the following comment about two of her students with special needs, including Brandon, a student with ADHD, and their behaviors during the Go game:

> Thank you so much for sharing the clips with me! The student I was talking about is Ethan, and he is the other player in the video!! How exciting is that!! Ethan is also one that needs a lot of attention, and he is the one who will benefit from the social-emotional piece of the game, as well as math, for sure. He is easy to get frustrated. But Brandon, you can tell that he is always excited to play the game and can stay very focused during the game. E. is another one too. He definitely has a passion for learning. I love how he counted! I have used Weiqi in my extended times for students who finish work early and during recess.

3.2 Students' Perceptions of Go Game

An overwhelming majority of the students reported that they used math

skills while playing Go games. A total of 47 students from three of the four classrooms completed and returned the survey. In their responses, students identified addition and multiplication as the primary math skills they applied in Go games, followed by subtraction, combined operations (adding, subtracting, and multiplying), and repeated addition. Some students also reported using the commutative and distributive properties. This result was encouraging, as the students were concurrently learning multiplication in their third-grade math curriculum during the study.

An open-ended question students answered asked them to share how they would introduce Go to a friend and what they would say about the game. Below are some representative responses:

· It is a cool and fun game but sometimes can be challenging; you use a lot of math skills.
· It is a good game about math but you don't know you are doing math.
· Weiqi is a game of strategy.
· A game of math and strategy using stones that you move around in lines
· It's a nice cool game and has math skills in it.
· Weiqi is a fun way to play against someone and build your math facts as well as your strategy in a game!
· Weiqi is a fun game with friends. It is a game of numbers.
· Weiqi can help you learn how to be a good leader and you can use your math skills!
· That it is a good game to play and it will help you with your math skills.
· It's a game about surviving and math.

IV. Discussion

This exploratory study of Go game implementation in third-grade classrooms provides empirical evidence for Go's potential to engage students in mathematical learning and practice. Positive teacher and student perceptions can be attributed to two key factors. First, the Go game instructor delivered clear, well-paced, well-designed lessons to students in the project's initial phase, which allowed the teachers to observe their students' gameplay and familiarize themselves with the game. This preparation enabled teachers to later join students in gameplay and provide support. Second, key adaptations—such as smaller boards and simplified, intuitive rules for gameplay and scoring—were made to meet the unique demands of classroom settings, helping to match the game to ongoing math instruction.

Qualitative data collected during gameplay reveals a natural progression in students' mathematical thinking. As students reorganized stones into arrays, they moved from basic counting strategies to more complex multiplicative reasoning. This shift suggests that game-based learning can support deeper conceptual understanding. The collaborative nature of the game also promoted peer-mediated learning, enriching students' mathematical discussions. As students verified scores and shared strategies, they reinforced their math skills while developing a growth-oriented, collaborative mindset. Both teachers and students recognized Go's value, seeing it as an engaging tool for math practice in a fun and supportive environment. Overall, incorporating Go into the curriculum presents an innovative way to make mathematics more accessible and engaging for students.

V. Implications

The study provides empirical evidence supporting the integration of Go as a viable game-based learning tool in elementary mathematics classrooms. Findings demonstrate that Go can help students build and practice essential numerical skills through thoughtful and innovative adaptations to the scoring rule and visual aids like Turtle 10 and arrays.

The study strongly supports incorporating Go regularly in classrooms to help teachers create a low-anxiety, engaging space where students—especially those needing reinforcement in numerical skills—can build confidence and competence in mathematics. Findings demonstrate that Go positively impacts student learning and provides teachers with a versatile resource for teachers interested in game-based strategies. Teachers can leverage Go as more than just a game; it is a flexible tool that enhances student engagement with mathematics and fosters meaningful collaboration.

Go proved beneficial for students with diverse mathematical abilities and attention levels. It fosters peer support, as students naturally share strategies and reinforce math skills, creating an inclusive, collaborative learning environment. Notably, students with special needs, who typically require personal aides and often exhibit behavioral challenges, showed a sharp contrast during Go instruction. In these moments, they appeared deeply engaged and absorbed, with classroom aides no longer needing to monitor them closely.

This study underscores Go's educational potential beyond its competitive play. It highlights a valuable long-term goal for the Go community: collaborating with educators and partnering with schools to introduce Go in

classrooms as early as possible. This approach could significantly impact children's mathematics learning at a young age and amplify Go's pedagogical benefits.

To effectively teach Go in classroom settings, Go instructors need training in classroom pedagogy, focusing on making the game meaningful and accessible to all learners, particularly in non-East Asian countries where Go is less familiar than chess. With this training, Go players interested in enhancing children's math education can become valuable assets to their local school districts, offering Go game expertise and support to classroom teachers. This type of training ensures that teachers receive the necessary strategies to integrate Go into their classrooms effectively and sustainably.

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