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Cooperative Learning in Math Education

Leah Kane
Northwestern College - Orange City

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Northwestern College

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Dr. Sara Waring Tiedeman

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Abstract

The purpose of this action research project was to determine whether cooperative learning benefits students in the content area of math. Data was collected for this project over a two-week period of time. Qualitative data in the form of observation was taken while students worked in their cooperative learning groups. Quantitative data was incorporated by looking at the progress of students towards their math-learning goal. The math-learning goal being assessed throughout the following research is on subitizing. More specifically, students will be able to subitize the number of dots seen on a ten frame after having looked at the ten frame for two, three second, periods of time.

Cooperative Learning in Math Education

Johnson & Johnson (1999) state the following:

> Two are better than one, because they have a good reward for toil. For if they fall, one will lift up his fellow; but woe to him who is alone when he falls and has not another to lift him up…And though a man might prevail against one who is alone, two will withstand him. A threefold cord is not quickly broken. (Ecclesiastics 4:9-12) (p. 68)

Cooperative learning is a teaching strategy where students are given the opportunity to work in groups instead of on their own to better their understanding of content being learned. Cooperative learning continues to become increasingly popular throughout schools across the United States. In fact, cooperative learning is becoming so popular that a majority of classrooms are now being designed with the strategy in mind. Classrooms are becoming more and more student-centered and group work oriented each year, which goes hand in hand with the cooperative learning strategy.

Several strategies may be used within the teaching strategy of cooperative learning. Different cooperative learning strategies can be seen on a daily basis in classrooms across America. Teachers have multiple options when incorporating cooperative learning into their classrooms. This allows teachers to choose what strategies work best for their class. Different strategies may work differently with different students and classes. Though there are many different strategies within cooperative learning, teachers must know what is and what is not considered cooperating learning.

Cooperative learning may look different depending on the age group, but it can be done with students of any age. In fact, cooperative learning strategies can easily be adapted depending

on the grade level. In this action research paper, you will see whether cooperative learning opportunities in a Kindergarten classroom benefit the students in the content area of math as they learn to subitize. Different cooperative learning strategies will be used over several weeks. Data will be collected through various observations and assessments throughout their learning. This paper will not only show examples of cooperative learning and determine whether it contributes to student achievement, it will also show how cooperative learning can be used with all ages, even students as young as Kindergarten.

Review of the Literature

What is Cooperative Learning?

According to the Cooperative Learning Institute, cooperative learning is an instructional use of small groups so that students work together to maximize their own and each other's learning (Johnson & Johnson, n.d.). Therefore, cooperative learning does not simply mean group work. There is more to cooperative learning than group work alone. This can be a misunderstanding when looking at cooperative learning and student achievement. Educators must understand what cooperative learning is and how to implement cooperative learning effectively in order truly see the impact that the strategy has on students.

There is a lot of research behind the success of cooperative learning, however one must take into consideration what is and what is not considered cooperative learning. To use cooperative learning effectively, one must know what is and is not a cooperative group (Johnson, Johnson, & Holubec, 1998b). Johnson and Johnson (1999) discuss what is and what is not cooperative learning, the types of cooperative learning, as well as the five basic elements that make cooperation work. Johnson and Johnson (1999) state not all groups are cooperative. There is nothing magical about working in a group. Some kinds of learning groups facilitate learning

and increase the quality of life in the classroom. Other types of learning groups hinder students learning and create disharmony a dissatisfaction. Therefore, when implementing cooperative learning it is important to have an understanding of what it is. There are three types of cooperative learning: formal, informal and cooperative base groups. Formal cooperative learning consists of students working together, for one class period or several weeks, to achieve shared learning goals and complete specific tasks and assignments (e.g., problem solving, writing a report, conducting a survey or experiment, learning vocabulary, or answering questions at the end of the chapter) (Johnson, Johnson, & Holubec, 1998b). Informal cooperative learning consists of having students work together to achieve a joint learning goal in temporary, ad-hoc groups that last from a few minutes to one class period (Johnson, Johnson, & Holubec, 1998a; Johnson, Johnson, & Smith, 1998). Cooperative base groups are long-term, heterogeneous cooperative learning groups of 3-4 members with stable membership (Johnson et al., 1998a; Johnson et al., 1998). In these groups, students are there to support one another towards their goals. In all three types of cooperative learning, students are working together towards a joint or shared learning goal. In the article, Johnson and Johnson (1999) state the following quote once said by John Atkinson, “achievement is a we thing, not a me thing, always the product of many hands and heads” (p. 72). In order to ensure success and achievement through cooperative learning educators must recognize the basic elements of cooperation. These elements are positive interdependence, individual accountability, face-to-face promotive interaction, social skills, and group processing.

Cooperative learning methods have been offered as an alternative to ability grouping, special programs for the gifted, Chapter I pull-outs, and special education. They have been suggested as a means of introducing higher-level skills into the curriculum, of ensuring students

an adequate level of basic skills, of mainstreaming academically handicapped students, and giving students the collaborative skills necessary in an increasingly interdependent society. Further, cooperative learning methods have been proposed as a major component of bilingual and ESL programs and as a way to improve relationships among students of different racial or ethnic backgrounds (Slavin, 1988). Although there are many benefits of cooperative learning, as listed above, Slavin (1988) goes on to discuss how in order for cooperative learning to be successful and benefit students, it must be done right. Slavin (1988) states that he is becoming increasingly concerned about a widespread belief that *all* forms of cooperative learning are instructionally effective. However, this is not true. There is more to cooperative learning strategies in order to assure effectiveness than one may think. According to Slavin (1988) cooperative learning must include a group goal and individual accountability. Simply just putting students into groups and having them work together will not always lead to achievement.

Advantages of Cooperative Learning

There are many advantages that come along with cooperative learning. One of these advantages is student engagement. When cooperative learning is implemented effectively, students are more engaged in their learning. The brain loves it when we collaborate (Gregory 2016). We have the innate need for social interaction. The release of dopamine is increased by cooperative tasks. Dopamine, a neurotransmitter that is responsible for attention, memory storage, and comprehension as well as executive functioning, is released increasingly in brain areas connected with memory and learning when we have positive experiences such as in supportive groups (Gregory, 2016).

Social Skills

Another major benefit of cooperative learning is the development of social skills. This is becoming increasingly important with each generation. Generation Z, also known as Gen Next or Gen I, includes people born between the early 1990s and the early 2000s (Posnick-Goodwin, 2010). Some consider members of Generation Z to be smarter, more self-directed, and more able to quickly process information than before quickly process information than previous generations; but there is one thing they may not be-team players. In addition, that just might be the best reason to pay attention to new research about cooperative learning (Igel & Urquhart, 2012). This will more than likely continue with future generations. Igel and Urquhart (2012) go on to so say that even though Generation Zers are notoriously social, they prefer texting to talking. Furthermore, although neuroscience suggests that cooperative learning is "good for the brain" (Willis, 2007, p. 1), not all young people know how to learn in cooperative groups, and not all teachers know how to apply best practices when creating cooperative learning activities. Cooperative learning is a way for teachers to help students develop the teamwork and social skills needed for society; however, teachers need to understand how to implement the strategy effectively. Igel (2012) goes on to discuss the benefits of social learning, such as cooperative learning, for young students and how cooperative learning works. Current research suggests that social learning experiences-often called group or cooperative learning in the classroom-can have positive effects on young people. Social and constructivist learning theories assert that humans acquire and extend knowledge through interaction with one another. Probing one another's beliefs and ideas, explaining one's own beliefs and ideas, and challenging weak theses allow learners to grapple with high-level material (Bandura, 1986; Vygotsky, 1978). Psychology speaks to the emotional benefits of social learning, particularly for those students who would otherwise struggle in isolation. For many people, learning with others attaches

positive emotions to what may otherwise be a negative and isolating experience (Hinde, 1976). Cooperative learning will continue to benefit the generations to come; therefore, teachers will need to be educated on the implementation of cooperative learning.

A mix of special education students and general education students usually yields the best results in terms of active learning (Mastropieri & Scruggs, 2001). Cooperative learning not only allows for student engagement and the development of social skills, it also supports the inclusive classroom. It is our goal as educators to have all students in the general education classroom as much as possible. We want all students to receive the same education and have the same interactions with their peers. However, it can be a struggle to assure we are meeting the needs of all of our learners in the general education setting. Cooperative learning can help ensure we are meeting these needs. Teresa Jones and Donna Sterling (2011) discuss their experience with cooperative learning in a science classroom. They discuss how cooperative learning can be implemented in a science classroom to promote inclusion. They also introduce and explain some cooperative learning strategies that can be used in the classroom and how they can be adapted based on student abilities and needs.

When students are working together and experiencing achievement and success, they become more confident in their learning and their attitudes toward their learning starts to change which brings me to my next benefit of cooperative learning; efficacy. Self-efficacy is a crucial component of achievement. Self-efficacy is defined as the belief we have in our own abilities, specifically our ability to meet the challenges ahead of us and complete a task successfully (Akhtar, 2008). If you change your attitude regarding your ability, you are more likely to succeed and achieve. Therefore, self-efficacy is very important in order to succeed. Self-efficacy is something that many students struggle with, especially in the content area of math. Capar (2015)

found that based on results from his research the cooperative learning method was better than the traditional method in terms of an increasingly positive attitude towards mathematics. His research consisted of the analysis of 26 studies from 1988 to 2010.

Disadvantages of Cooperative Learning

Even though there are many advantages associated with cooperative learning, some may argue that there are disadvantages as well. Many teachers approach group work with optimism and hope, yet soon the wheels fall off and they retreat to other methods. Unfortunately, it is one of the least understood or well-implemented strategies (Antil, Jenkins, Wayne, & Vadasy, 2009). There are several reasons why teachers end of giving up on the strategy. One of these disadvantages may be students engaging in off task work. Whenever students are working in groups, there is a chance that some students will be engaging in off task behavior. In the traditional classroom where teaching was done as a lecture from the front of the classroom, there were still children engaging in off task behavior. There is always a possibility of off task behavior. However, off task work is less common when students are working in cooperative learning groups. This is because students are held accountable for their own learning in cooperative learning groups. This is something that could differ from simply having students working in groups. If students know they will be held accountable, they are less likely to engage in off task behaviors.

Unequal contributions within groups may be another downside that some may see to cooperative learning. However, when cooperative learning is implemented effectively students all have equal contributions to work or discussions. The different cooperative learning strategies assure all students are contributing to work. They are designed to hold students accountable for their contributions. Therefore, when cooperative learning is implemented effectively, there

should not be an issue with unequal contributions. Gregory (2016) goes on to discuss more reasons why teachers may be skeptical about implement cooperative learning strategies into their classroom, all of which following along the lines of students engaging in off task work or not all students putting in effort. Gregory (2016) states that, “In reality all these things can happen. But thoughtful planning and strategic orchestration can address many of these issues.” In the end it comes down to how cooperative learning is set up and managed that determines its success.

Implementing Cooperative Learning

For teachers to use cooperative-learning strategies effectively, they must become sensitized to the many complexities of the technique. As we have come to understand, such learning cannot occur through only hearing or reading about cooperative learning. The subtleties that can make or break a cooperative-learning activity are best realized through self-experience (Artzt, 1999). Students in a mathematics teacher education course participated in a cooperative learning activity a few weeks into the course. The teacher waited three weeks into the course when she felt acquainted enough with the students to group them appropriately. Through the students’ own experiences with participating in a cooperative learning experience, they were able to reflect on what went well and what did not go as well during their experience. This helped them implement the strategy of cooperative learning more successfully in their own classroom. By experiencing cooperative learning, reading about cooperative learning, and then reflecting on their experiences in an informed and thoughtful way, the students were able to recognize that cooperative learning, like most teaching techniques, is a complex strategy with no simple formulas for success (Artzt, 1999). Since cooperative learning is very complex strategy, students were able determine important components that the found made the strategy more successful during their own experience.

Kagan (1994) noted four concepts that characterize the roles of student in cooperative learning activities: interdependence, individual accountability, equal participation, and simultaneous interaction (Emmer & Gerwels, 2002). In this article Emmer and Gerwels (2002) complete a study on the implementation of cooperative learning strategies. There has been extensive research on cooperative learning, and the research suggests that in order for cooperative learning to be successful, certain components, similar to the ones listed above, must be present. Although the research points to components needed for success, the question is, do teachers adhere to these components? "If developers believe that the interdependence, accountability, and group goals are important, then how might learning or other outcome be affected by their absence?" (Emmer & Gerwels, 2002, p. 77). In their research, Emmer and Gerwels (2002) visit classrooms to determine which components are present, and which components are not, where cooperative learning is taking place. "Although teachers may understand the necessary aspects of a cooperative learning program (assuming they have been trained in its use), teachers may not be able to translate those abstract concepts into actions" (Emmer & Gerwels, 2002, p. 77). Therefore, the problem may not be whether or not teachers are aware, but more so how to interpret and implement the crucial components of cooperative learning into their own classrooms. Cooperative learning is a complex strategy that requires the implementation of several components in order for success. When these components are interpreted correctly and implemented, cooperative learning has the potential to enhance student learning. Teachers need to fully understand each component that needs to be present, as well as what each component looks like in action.

Research has found that cooperative learning can facilitate greater student participation (Webb 1999), promote positive attitudes about learning mathematics (Leikin & Zaslavsky 1997),

and thereby increase student achievement in mathematics (Artzt & Yaloz-Femia 1999: Webb 1991). Because of this, teachers are becoming more open to trying strategies such as cooperative learning in their own classrooms. However, Rubel (2006) discusses how teachers often struggle with how to implement the strategy into their own classrooms. This is due to our own learning experiences. Most educators have not had the opportunity to partake in cooperative learning. The education we received was different from the education we are providing to students. Rubel (2006) discusses how a mathematics class for teachers allows the teachers to take part in a cooperative learning experience. The experience helped them understand how cooperative learning looks in the classroom. Their experience also allowed them to reflect on their experiences with cooperative learning and determine how they will integrate the strategy into their own classrooms.

Cooperative learning must be modeled and taught just like anything else in the classroom. In order for cooperative learning to be successful teachers, need to state the expectations for cooperative learning and establish routines. The teacher will need to communicate such routines and expectations to students and review them regularly. Gregory (2016) also brings us the idea of starting small. He discusses how you may consider having students work with partners first before moving on to work with larger groups. He emphasizes the need for modeling when teaching students how to work cooperatively together. He also discussed the aspects that are crucial for cooperative learning to be successful. He defined these as the elements of successful group work. These elements are positive interdependence, individual accountability, social skills, and face to face interaction (Gregory, 2016.) All of these need to be present for cooperative learning to be successful. Therefore, these may need to be modeled to students several times prior to engaging in cooperative learning experience, and reviewed often.

Cooperative Learning Strategies

An example of a cooperative learning strategy is the jigsaw strategy. This strategy can be easily adapted to any age or grade level. Gregory (2016) states that the jigsaw is a way of organizing group learning to process information, deepen understanding, and facilitate dialog. How the jigsaw strategy works is each student in the group is assigned a part of the material. Their job is to become to expert on their material. Then they share what they learned about their material with the rest of the group. The overall goal of the jigsaw is that every student in the group understands not only their portion of the material, but the portion that the other group members shared about as well. Gregory (2016) goes on to discuss different types of jigsaws. The one explained above was a simple jigsaw.

Another common strategy that can be used for cooperative learning is Numbered Heads Together. Numbered Heads Together is an alternative teacher questioning strategy that actively engages all students simultaneously in collaborative, content-related discussions (Hunter, Maheady, Jasper, Williamson, Murley, & Stratton, 2015). This strategy is a Kagan Structure. This strategy allows students to work together to solve a problem or come up with an answer. Once students have had time to solve the problem or discuss the question, the teacher will randomly all on a student by pulling a stick, rolling a dice, etc. That student will then be responsible for answering the question. At this point, the student would have had plenty of time to work with other students to understand the problem or question, so if the student was on task and engaged, they should have the answer. This strategy helps hold students accountable and assures they are staying on task and contributing to the group. An emerging database of literature suggests that NHT is more effective than the voluntary hand-raising practices that have dominated America for decades (Hunter et al., 2015). This strategy can easily be incorporated

into the gradual release of responsibility when teaching a lesson. It is becoming more popular to see the you do together phase added to the gradual release. The you do it together phase can be found after the we do and before the you do. This strategy works perfectly during the you do together phase of the gradual release of responsibility. Before having students go off and work on their own, you can incorporate a few problems into your lesson using the numbered heads together strategy to get students working together. This gives students a chance to learn from each other and teach each other before they go off on their own.

According to Fisher and Frey (2013) most current efforts to implement the gradual release of responsibility framework limit these interactions to adult and child exchanges: I do it; we do it together; you do it. However, this three-phase model omits a truly vital component: students learning through collaboration with their peers—the *you do it together* phase. Although the effectiveness of peer learning has been demonstrated with English language learners (Zhang & Dougherty Stahl, 2011), students with disabilities (Grenier, Dyson, & Yeaton, 2005), and learners identified as gifted (Patrick, Bangel, & Jeon, 2005), it has typically been examined as a singular practice, isolated from the overall instructional design of the lesson. The use of the cooperative learning strategy, numbered heads together, can ensure an effective way of implementing to you do it together component of the gradual release.

Kagan Structures

Another resource for cooperative learning strategies is Kagan. Kagan offers professional development and workshops on their cooperative learning strategies. These strategies are referred to as Kagan Structures. These structures can easily be used with students as young as Kindergarten. Some of these strategies are Think Pair Share, Numbered Heads Together, and Fan-N- Pick. These are just a few of the several strategies that Kagan has to offer. Kagan

Structures produce revolutionary positive results. Teachers, schools, and districts now use Kagan Structures to increase academic achievement, improve ethnic relations, enhance self-esteem, create a more harmonious classroom climate, reduce discipline problems, and develop students' social skills and character virtues (Kagan Online, n.d.). The Kagan Structures have proven themselves effective teaching and learning tools for cooperative learning, multiple intelligences, character education, language learning, and emotional intelligence (Kagan Online, n.d.). Kagan includes several articles that show the success their structures have had in the classroom.

Think Pair Share is one of the most common cooperative learning strategies. Think Pair Share is used every day in classrooms throughout the country. For this strategy, the teacher poses a question or problem to students. Students are then given time to think on their own. After they have thought on their own, they have the chance to discuss and share with a partner. The teacher then calls on a few volunteers to share. The volunteer then shares what their partner shared with them. This strategy can easily be incorporated into any lesson and does not take a lot of extra planning or additional time. However, in order for the strategy to be the most effective, the strategy needs to be explicitly taught and modeled to students. This strategy is a quick way to keep students involved and engaged in the lesson.

Fan-N-Pick is another Kagan strategy that can easily be incorporated into the classroom. For this strategy, students are divided into groups of four. The strategy can also be played in pairs if needed. Cards with questions are then fanned out in the middle of the group of students. The students then take turns picking a card and answering the problem. For pairs, the student who did not answer the problem either praises or tutors the answer. Then the roles switch. If students are playing in a group of four, person one fans the cards and tells person two to “pick a card any card.” Person two then picks a card and reads the card, person three answers the card,

and person four either restates, praises, or tutors the answer. Students would then rotate, so everyone has a chance for every role. This strategy assures all students are engaged and held accountable for their learning.

Methods

Participants

This action research was completed in a Kindergarten classroom of 25 students. The Kindergarten class consisted of students with a wide range of abilities in the content area of math, as well as social skills. The classroom also contains students who are English language learners. This action research did not require the students or parents to be informed of the research taking place. Different cooperative learning strategies such as Numbered Heads Together, Fan-N-Pick, and Think Pair Share, were used during daily lessons, as well as math rotations. These strategies will continue to be used during math instruction and other content areas as well.

Data Collection

The research took place over a two-week period of time. It started with an assessment of each student in the class. The assessment consisted of quick looks with ten frames. Each student was shown the same quick look cards in the same order. They were given three seconds, and then an additional three seconds if they were not able to guess the number during the first three seconds. Student responses to each quick look card were recorded. This process is known as subitizing. After the assessment with each student was complete, cooperative learning strategies were integrated into the students' math block. Over the next two weeks' students took part in different cooperative learning strategies such as Fan-N-Pick, Numbered Heads Together, and Think Pair Share. These strategies were integrated into daily math lessons and rotations. Before

beginning the strategies, each strategy was introduced and practiced. Students practiced each strategy in a small group setting with the teacher to ensure the strategy was understood by the students. If the strategy required students to be working on their own with another student, for example Fan-N-Pick, an associate was able to walk around and supervise student learning. The strategies were also reviewed each day before being used to ensure students fully remembered the strategy. Although this can be time consuming, it is better to take time reviewing at the beginning then have students waste even more time partaking in a strategy the wrong way. In order for cooperative learning to be successful, it must be implemented correctly. This means the strategy must be done the right way in order for students to benefit from using the strategy.

Aside from each strategy being explicitly taught before implementing, the class also created math group norms. The norms were created with the students so they would take ownership in the norms and therefore be more likely to engage in the norms created. Erwin (2004) states the following:

> If the teacher engages the students in developing clear behavioral guidelines that the students see as adding quality to their school lives, the relationship between the students and the teacher is enhanced. What's more, students will be much less likely to disrupt the learning environment, which in turn increases the likelihood that students will achieve quality work. (p. 102)

As a class, students brainstormed what they thought would be helpful when working with others. The norms consisted of the following: use Whole Body Listening while working with others, everyone shares their ideas and math thinking, be kind, be respectful. These norms were then posted and discussed each day before beginning math. Because a majority of Kindergarten students are not able to read, going over the norms at the beginning of math each day is

especially important in reminding them of the expectations while working with a cooperative learning group. Visuals could also be added to the norms to make them more accessible for students while they are working. Having an associate be able to supervise was also helpful in assuring students were adhering to norms while working together. Although norms were created as a class, cooperative learning research was used in guiding the creation of the norms to ensure cooperative learning was implemented successfully. As stated earlier, Gregory (2016) found that elements such as positive interdependence, individual accountability, social skills, and face to face interaction must me presents in order for cooperative learning to be successful. This was something that was kept in mind while creating the norms with student. For example, in order for cooperative learning to be successful, everyone must participate. Therefore, the norm that everyone shares their ideas and math thinking was included when creating the norms.

After students spent two weeks working in cooperative learning groups in which they practiced three different cooperative learning strategies during their math instruction, they completed another assessment. This assessment consisted of the teacher pulling each student individually and presenting them with the same quick look cards that were used in the previous assessment. The assessment, again, consisted of the teacher holding the quick look card up for three seconds and then turning it around. If the student was unable to answer in the first three seconds, the student got another three seconds. However, this time if the student was unable to answer the card, the teacher asked the student to explain what they saw. This helped determine whether or not they understood how to explain what they were seeing, but did not have the skills to add what they saw together.

While students worked in their cooperative learning groups, they worked on explaining what they saw when looking at the quick look card and how they saw it to each other. This is

why the decision was made to ask them to explain what they saw. Even if they were unable to answer how many dots were on the card, were they able to explain what they saw when they looked at the ten frame? This would determine if they understood the process of subitizing, but were not yet able to put together what they saw to determine how many total dots were on the card. The cards that students used while working together can be found in Appendix A.

Findings

Data Analysis

Table 1

Student Responses on Pre Assessment

	Card 50	Card 53	Card 58	Card 56	Card 51	Card 70	Card 67	Card 66	Card 60	Card 61
Student 1	C	I	I	I	I	I	I	I	I	I
Student 2	C	C	C	C	C	C	NR	I	C	C
Student 3	C	C	C	C	C	C	C	I	I	C
Student 4	C	C	C	C	C	C	C	NR	I	C
Student 5	C	C	C	C	C	C	I	C	NR	C
Student 6	C	C	C	C	C	C	NR	I	C	NR

Student 7	C	C	C	C	C	C	C	C	C	C
Student 8	C	C	I	C	C	C	C	C	I	I
Student 9	C	C	C	C	C	C	I	I	C	I
Student 10	C	C	C	I	C	I	I	C	I	I
Student 11	C	C	I	C	C	I	I	I	NR	I
Student 12	C	C	C	C	C	C	NR	I	I	I
Student 13	C	C	C	C	C	C	C	C	C	C
Student 14	C	C	C	C	C	C	C	C	C	I
Student 15	C	C	I	I	C	I	I	C	I	C
Student 16	C	C	C	C	C	C	C	I	I	I
Student 17	C	C	C	C	C	C	C	C	C	I

Student 18	C	C	C	C	C	C	NR	NR	C	C
Student 19	C	C	C	C	C	C	I	C	C	C
Student 20	C	C	C	C	C	C	C	C	C	C
Student 21	C	C	C	C	C	C	C	C	C	C
Student 22	C	C	C	C	C	C	I	I	I	I
Student 23	C	C	NR	C	C	NR	NR	NR	I	I
Student 24	C	C	C	C	C	C	C	I	I	I
Student 25	C	C	C	C	C	C	C	C	C	C

C = Correct Response I = Incorrect Response NR = No Response

Table 2

Student Responses on Post Assessment

	Card 50	Card 53	Card 58	Card 56	Card 51	Card 70	Card 67	Card 66	Card 60	Card 61

Student 1	C	C	C	I	C	I	I	I	I	I
Student 2	C	C	C	C	C	C	C	C	C	C
Student 3	C	C	C	C	C	C	C	C	C	C
Student 4	C	C	C	C	C	C	C	C	C	C
Student 5	C	C	C	C	C	C	C	C	C	C
Student 6	C	C	C	C	C	C	C	I	C	C
Student 7	C	C	C	C	C	C	C	C	C	C
Student 8	C	C	C	C	C	C	C	I	C	C
Student 9	C	C	C	C	C	C	C	C	C	C
Student 10	C	C	C	C	C	C	C	C	NR	I
Student 11	C	C	C	C	C	C	I	I	C	C

Student 12	C	C	C	C	C	C	C	C	C	C
Student 13	C	C	C	C	C	C	C	C	C	C
Student 14	C	C	C	C	C	C	C	C	C	C
Student 15	C	C	C	C	C	C	C	C	C	C
Student 16	C	C	C	C	C	C	C	C	C	C
Student 17	C	C	C	C	C	C	C	C	C	C
Student 18	C	C	C	C	C	C	C	C	C	C
Student 19	C	C	C	C	C	C	C	C	C	C
Student 20	C	C	C	C	C	C	C	C	C	C
Student 21	C	C	C	C	C	C	C	C	C	C
Student 22	C	C	C	C	C	C	C	C	C	C

Student 23	C	C	C	C	C	C	C	I	C	I
Student 24	C	C	C	C	C	C	C	C	C	C
Student 25	C	C	C	C	C	C	C	C	C	C

C = Correct Response I = Incorrect Response NR = No Response

Tables 1 and 2 show whether or not students responded to the card correctly, incorrectly, or did not respond at all. The cards shown to students, listed in the table above, can be found in Appendix A. The cards in Appendix A are listed in the order they were shown to students. The number of each card can be found on the tables above, as well as in the left hand corner of each card in the index.

Table 3

Student Scores on Pre and Post Assessments

	Pre Assessment	Post Assessment
Student 1	10%	40%
Student 2	80%	100%
Student 3	80%	100%
Student 4	80%	100%
Student 5	80%	100%
Student 6	70%	90%
Student 7	100%	100%

Student 8	70%	90%
Student 9	70%	100%
Student 10	50%	80%
Student 11	40%	80%
Student 12	60%	100%
Student 13	100%	100%
Student 14	90%	100%
Student 15	50%	100%
Student 16	70%	100%
Student 17	90%	100%
Student 18	80%	100%
Student 19	90%	100%
Student 20	100%	100%
Student 21	100%	100%
Student 22	60%	100%
Student 23	40%	80%
Student 24	70%	100%
Student 25	100%	100%

Table 4

Overall Classroom Percentage of Correct Responses on Pre and Post Assessments

Percentage Answered Correctly on Pre Assessment	Percentage Answered Correctly Post Assessment
73%	90%

It is evident in the tables shown above that every student in the class made an improvement after partaking in cooperative learning during math instruction. The data also shows that there were not any students who did not benefit from cooperative learning, meaning there was not any regression in student achievement. Therefore, based on the data shown above, cooperative learning benefited student achievement in the content area of math.

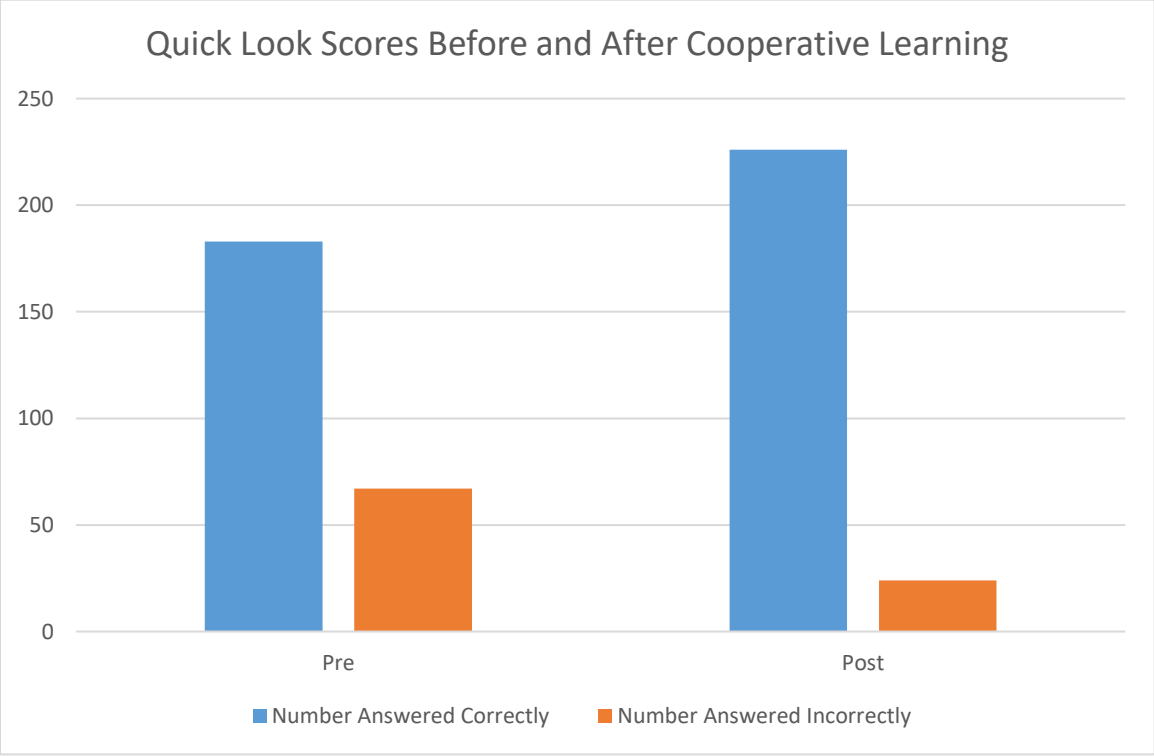

Figure 1. Quick Look Scores Before and After Cooperative Learning.

Figure 1, shown above, displays student responses to the quick look, subitizing, cards. The graph displays both correct and incorrect responses to the cards on both the pre and post assessments. The pre assessment was given before cooperative learning, and the post assessment was given after students worked in cooperative learning groups for two weeks. The data shows that number of correct responses increased and the number of incorrect responses decreased after students were involved in cooperative learning.

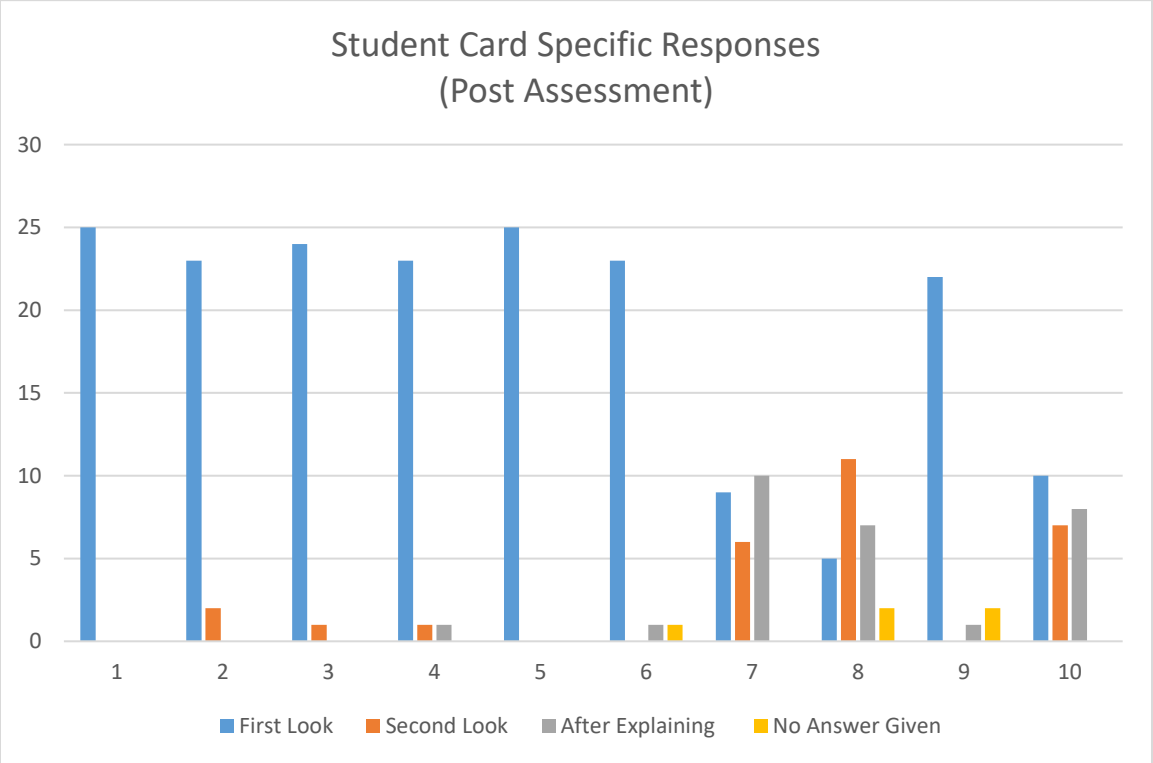

Figure 2. Student Card Specific Responses (Post Assessment).

Figure 2, seen above, shows student responses to each quick look subitizing, card. It shows the number of students that responded on the first, or second look, as well as students who responded after explaining, or students who were not able to answer at all. This shows how quickly students were able to answer, and even if they were not able to answer quickly, did they understand the process. It shows that if students were not able to answer quickly, they were able

to answer a majority of the time after explaining what they saw on the card. Cards seven, eight, and ten were more challenging for students. They were larger numbers. Some students developmentally were not at the point to quickly add what they saw, but they were able to figure out how many by explain what they saw.

Discussion

Summary of Major Findings

Upon completing this action research, it was found that students were in fact able to correctly subitize more cards after working in cooperative learning groups for two weeks. Every student was able to subitize more cards correctly after working in cooperative learning groups. It was also found that most students were able to answer the cards quicker than they were before the cooperative learning. During the pre-assessment most students answered during the second look or after the card was down. During the post assessment, a majority of students answered within the first look.

What was even more apparent was the explanations students were able to give on how they subitized the cards. Students were able to use math language to explain the strategies they used to subitize. Even if students were not able to subitize the dots correctly in the 6 seconds, they were able to explain what they saw and how they saw it. Therefore, students understanding of the process of subitizing increased within just two weeks of working in cooperative learning groups.

An increase in confidence and self-esteem was also noticed after students worked in cooperative learning groups. Students did not question their answers and were not as hesitant when responding to the cards. They were also very confident when explaining how they subitized the dots on the card. In their cooperative learning groups, they had a lot of time to

discuss their math thinking and how they saw the dots with their partner, which helped them develop confidence when explaining their answer.

Limitations of the Study

It was found that a major limitation in this study was where students are at developmentally with number sense. Students may have increased their understanding of the process of subitizing after partaking in cooperative learning experiences; however some students lacked the ability to add together what they saw after explaining how they saw it. They were able to explain how to do it, but were not yet able to solve what they needed to solve. If this research was done at the end of Kindergarten, more students may have been successful when solving the subitizing cards.

Another limitation of the study was time. With more time, students would have been able to make even more gains. Although we saw gains in just two weeks, two weeks is a very short amount of time in the classroom. Cooperative learning requires a lot of modeling and pre teaching, especially at such a young age. In order for cooperative learning to be successful, strategies have to be done correctly. Therefore, the teaching and modeling of the strategies is crucial. Teaching and modeling the strategies, as well as giving students plenty of time to work in their groups after learning the strategy, was hard to do in just two weeks. It can often take two weeks or more for Kindergarten students to learn and prefect a new routine. Cooperative learning, when done effectively, takes time to teach and practice the strategies. It can take time for students to fully learn the strategies. Therefore, the two-week time frame was a limitation of this study.

Further Study

Cooperative learning strategies will continue to be used with this Kindergarten class as the school year continues. As students learn more skills in the content area of math, cooperative learning strategies will be used to practice various skills. This action research in ongoing. With each skill that students learn, student achievement will be assessed. Students will be assessed before strategies are used, as well as after strategies are used. This will continue to determine if the strategies be used are effective in improving student achievement. The same strategies used in this research will continue to be used, and new strategies will be introduced as well. With data continuing to be collected on cooperative learning strategies, it will then be able to be compared with data from other Kindergarten classes working on the same skills, but are using cooperative learning strategies.

Conclusion

Based on the results from the action research that took place, cooperative learning does in fact improve student achievement in the content area of math. As shown in the graphs above, every student in the class made an improvement in the skill of subitizing after partaking in cooperative learning. Therefore, cooperative learning had a positive effect on student achievement in the content area of math in a Kindergarten classroom. As a whole, using cooperative learning strategies improved student achievement.

It was found that if students were not able to respond to the quick look due to where they are at developmentally in math, they were still able to explain their math thinking. This is due to the discussions they were able to have with their cooperative learning groups. A majority of students were then able to respond to the quick look card after explaining their thinking. Knowing how to explain their thinking and being able to share their thinking with others helped

students take their learning to another level. Students learned from each other and were able to think in ways they would not usually think. This process helps students persevere and in turn solve problems by explaining their thinking. When you are able to explain your thinking, you have taken your learning even further. The underlying assumption here is that if a student understands something, she can explain it—and that deficient explanation signals deficient understanding (Garelick, 2015). When students are able to explain their thinking, it shows their understanding of the content.

Cooperative learning improved student achievement in the content area of math, helped students be able to explain their mathematical thinking, improve student confidence, as well as build positive social skills between students. Therefore, cooperative learning did not only benefit students academically. When cooperative learning in done effectively, it can positively impact students in multiple ways.

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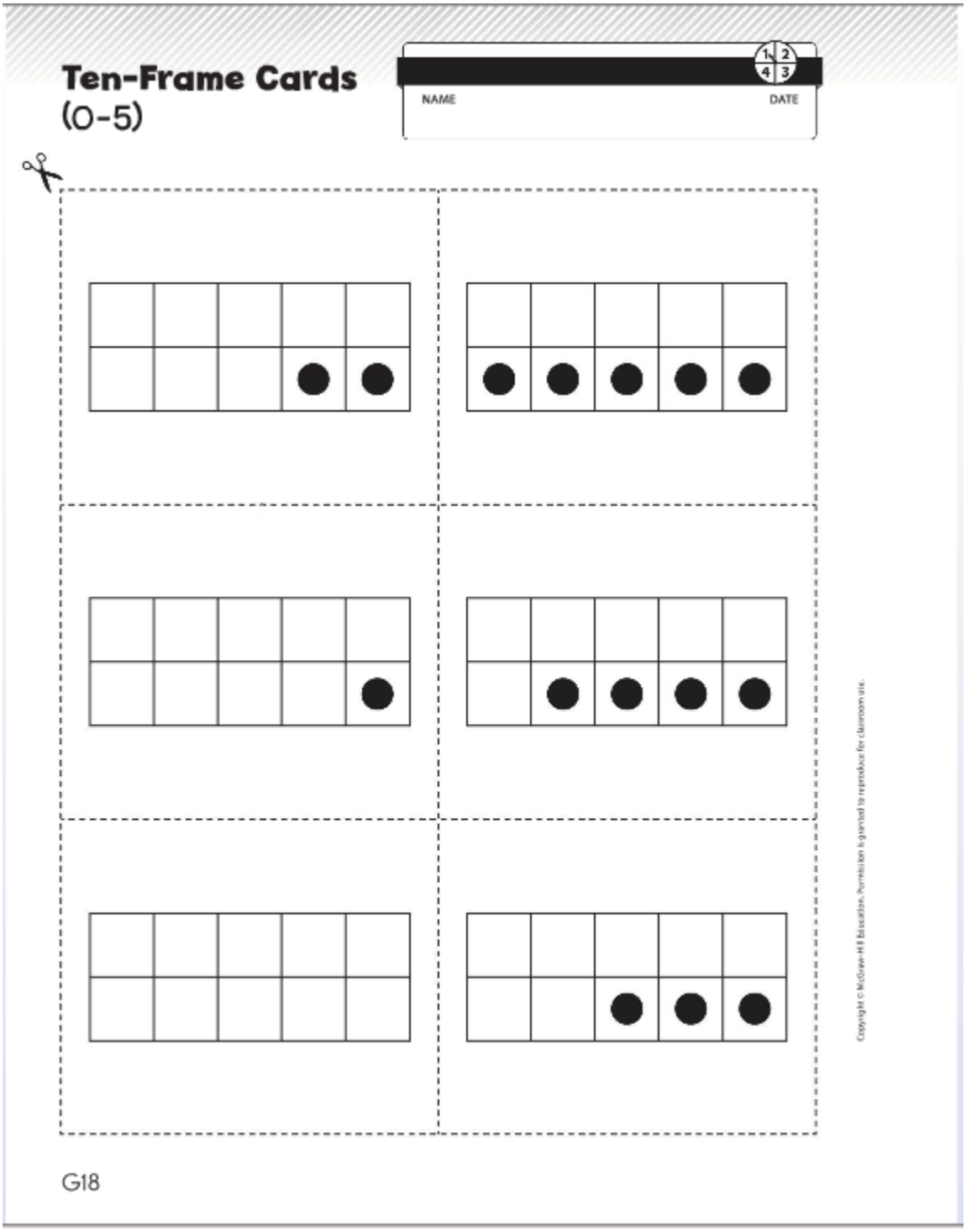
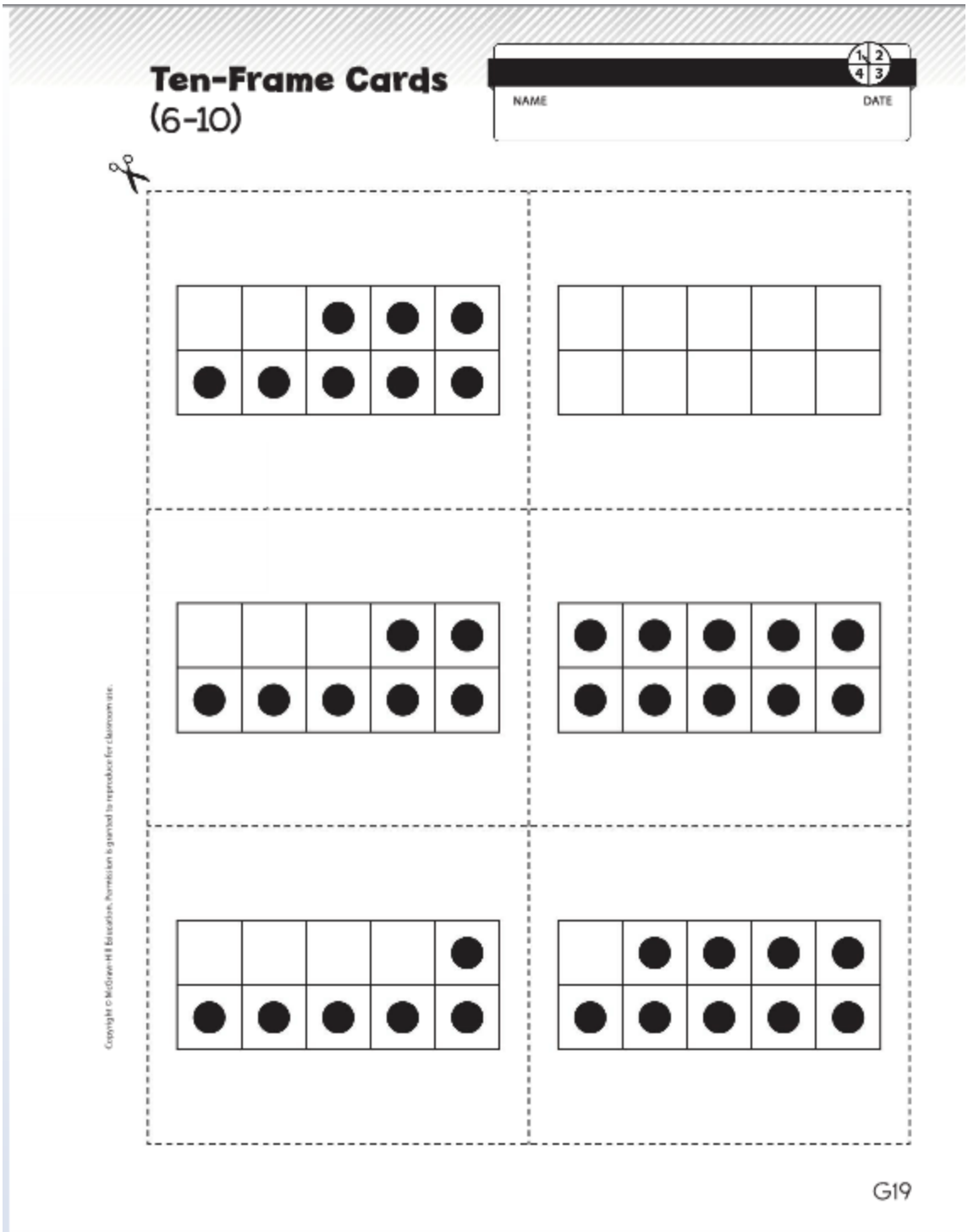
Appendix A




Ten-Frame Cards
(6-10)
NAME
DATE
G19

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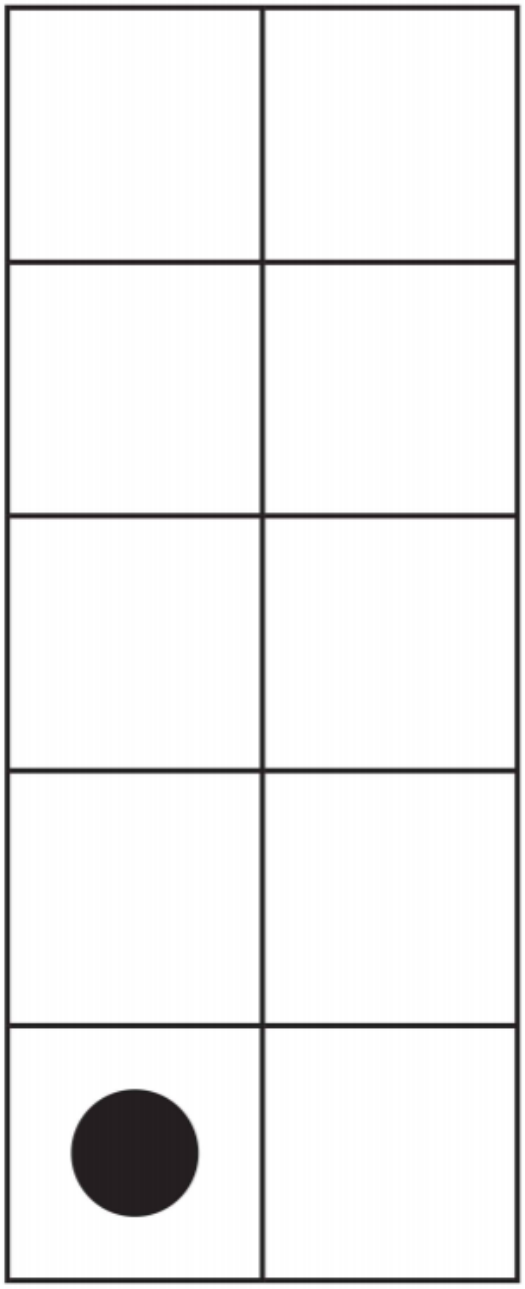

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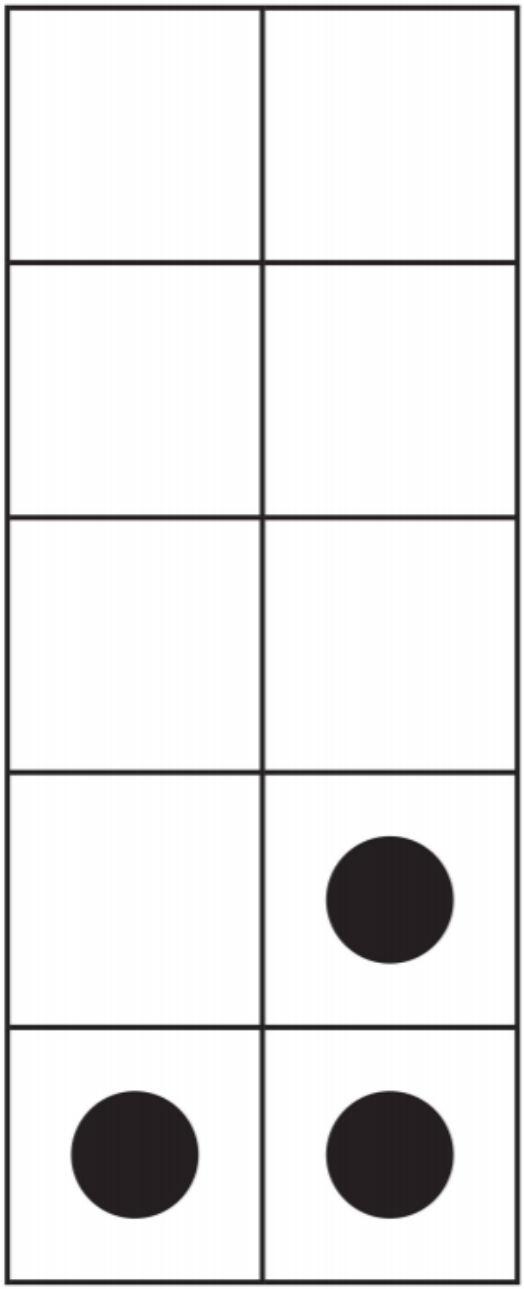

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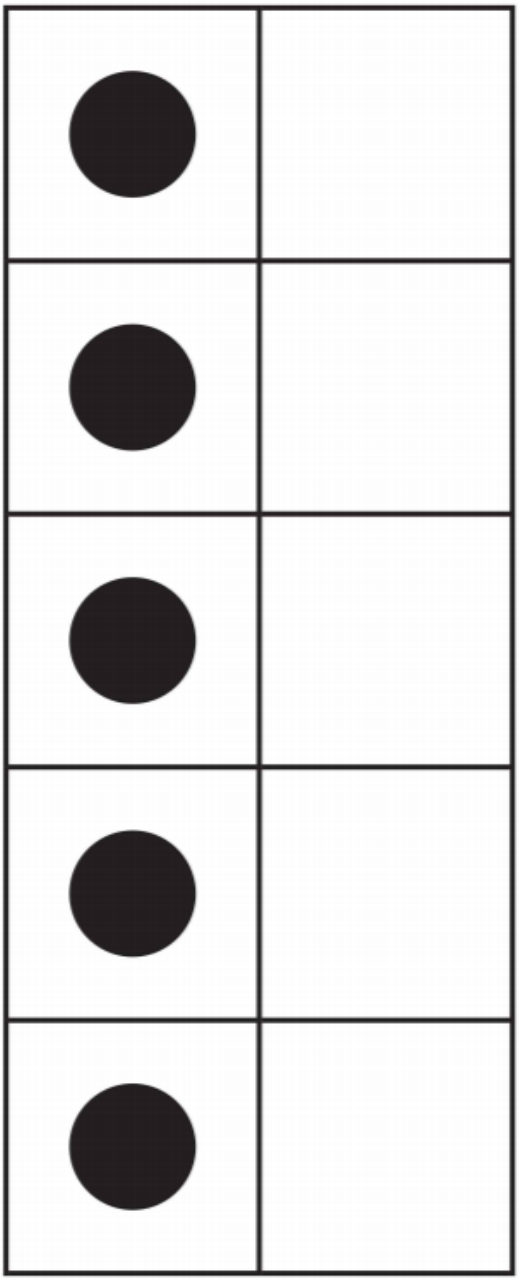

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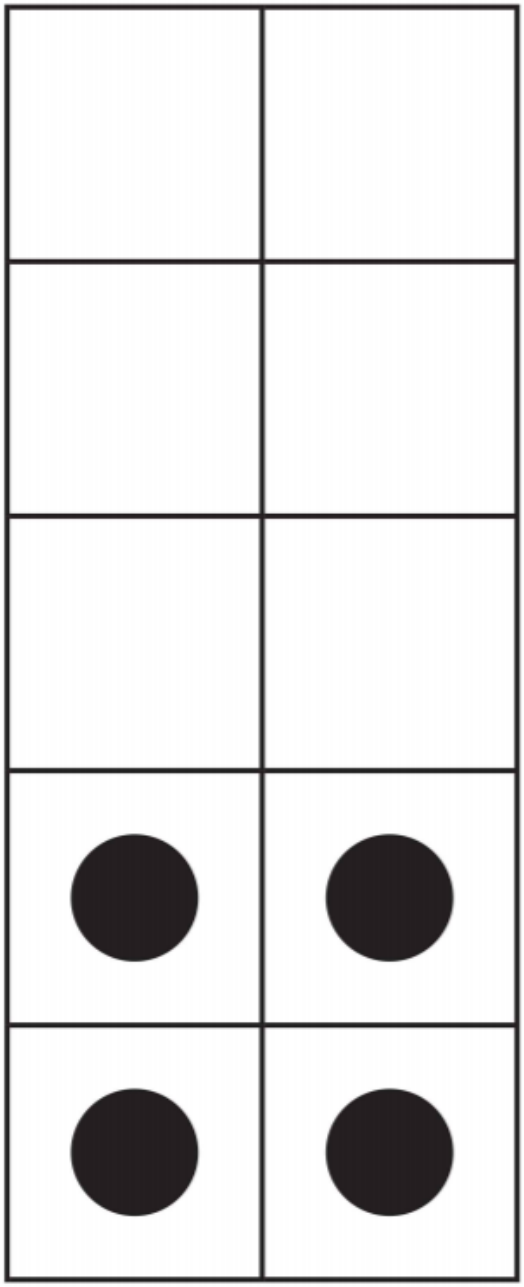

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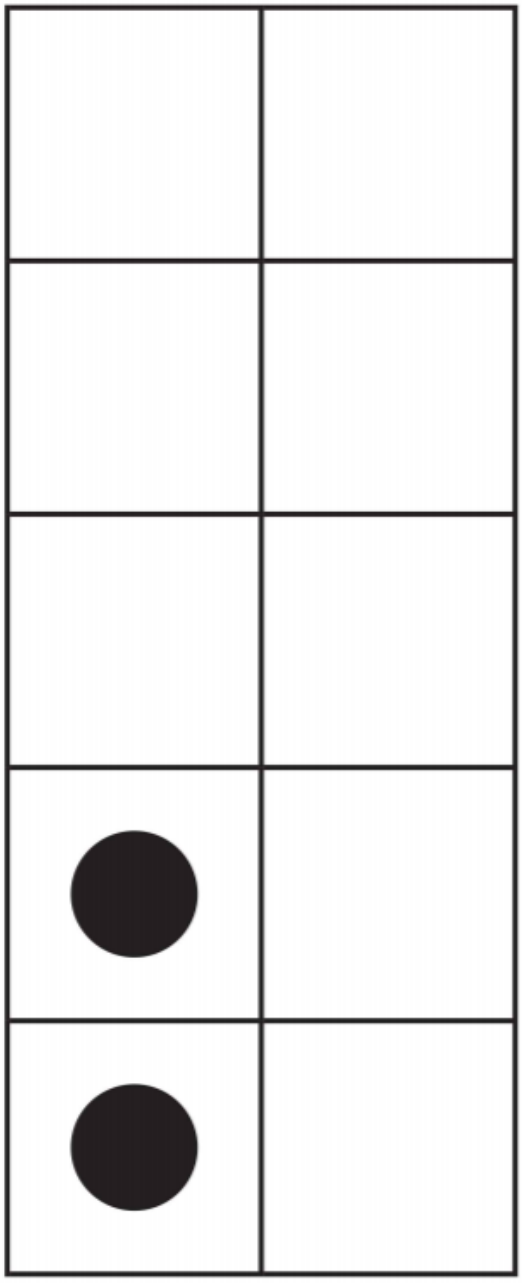

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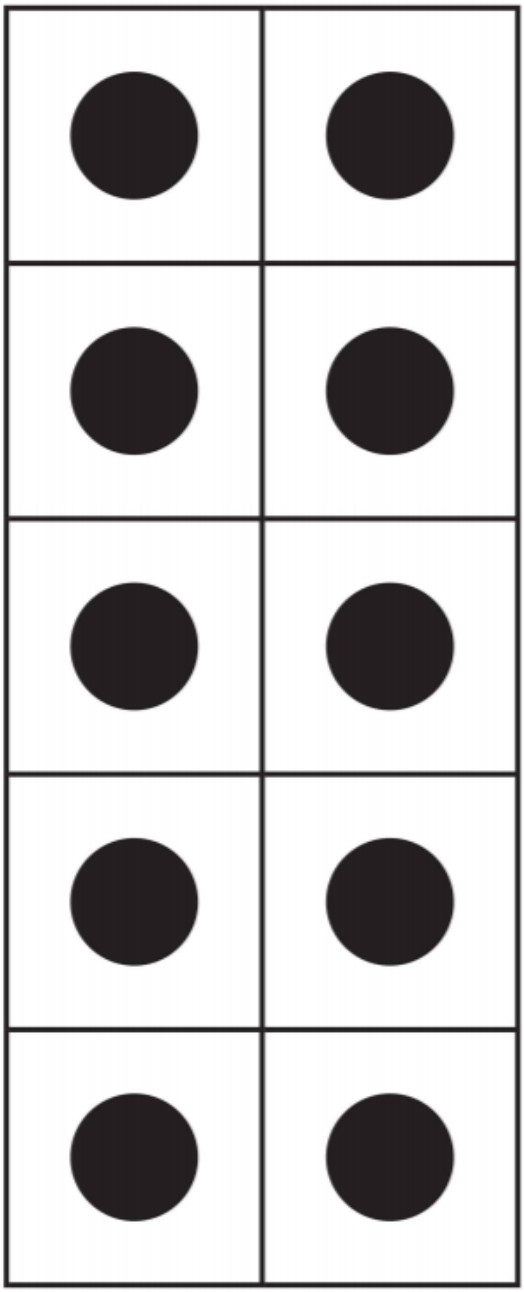

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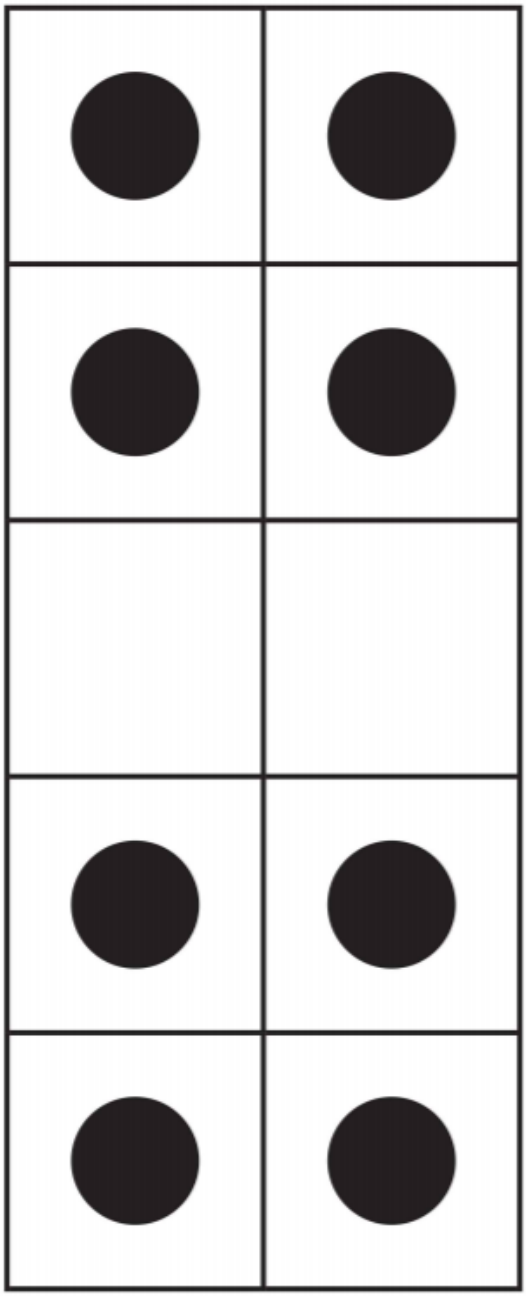

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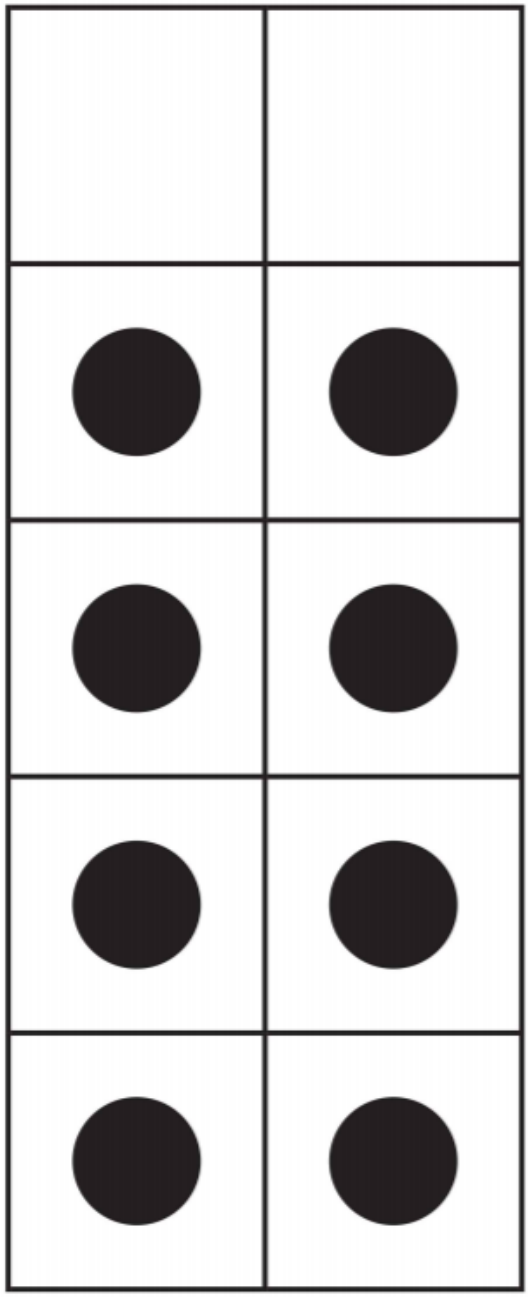

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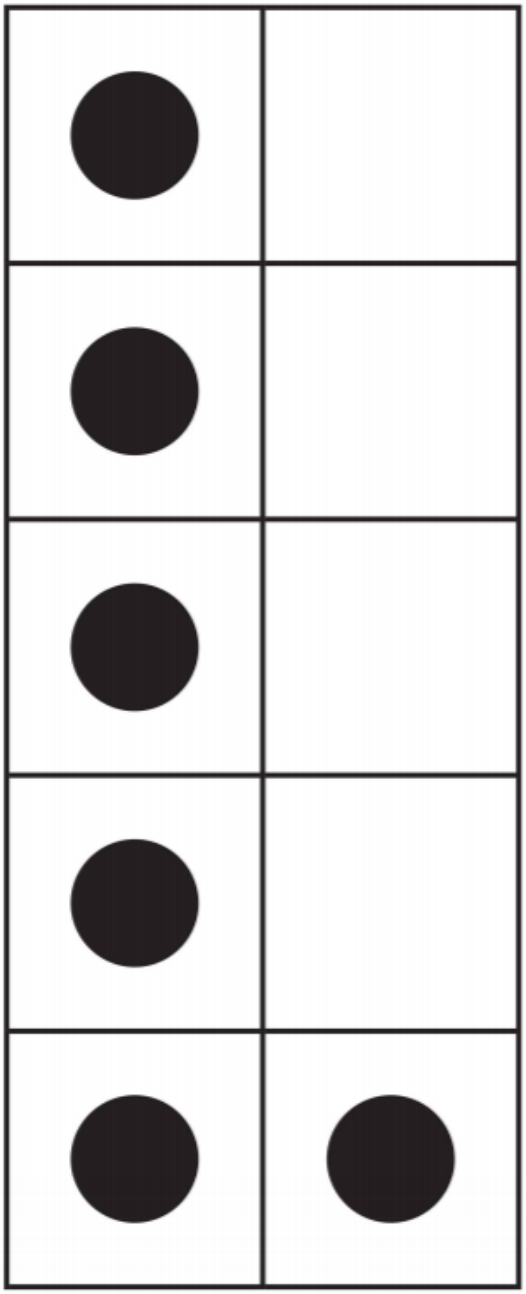

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