

Improving Math Fact Fluency

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### Introduction

Mathematics is a pivotal piece of the “classroom pie.” It is the job of educators to ensure that students become efficient and effective in applying basic math skills. Instruction in math is especially important at the primary level. In a first-grade classroom, emphasis is highly placed on addition and subtraction skills. The Common Core State Standards, which are widely adopted across the United States (although not locally in Nebraska), indicate that students in first grade must be able to “use properties of addition to add whole numbers to create and use increasingly sophisticated strategies based in these properties (e.g., “making tens”) to solve addition and subtraction problems within 20”. This paper will highlight and discuss what it means to be fluent in solving math facts, as well as strategies that have been researched and shown to help improve students’ abilities to compute basic addition and subtraction facts both accurately and fluently. The strategies that will be included in this paper are, Goal Setting, Cover, Copy, and Compare, Flashcards and Games.

### Math Fact Fluency

Fluency has been defined many times by numerous researchers. Gross, et. al, simply state, “Fluency is the quick and accurate responding to a selected stimulus” (2014, p.555). More specifically related to mathematics, Bay-Williams and Kling state, “Fluency with basic facts can be defined as the ‘efficient, appropriate, and flexible application of calculation skills and is an essential aspect of mathematical proficiency’” (2014, p. 240). In primary grades, fluency is the ability to solve basic single digit addition and subtraction facts quickly, effectively, and

accurately. (Baroody, et. al, 2013).

Often, instruction relies heavily on teaching students to accurately perform basic addition and subtraction problems and less time is spent increasing students' fluency. Researchers can agree that not only should students be able to accurately compute these types of basic math problems, but students should be able to compute them fluently as well. Researchers Poncy and Skinner indicate that "students who require too much time, effort, and/or cognitive resources to accurately respond to basic facts, may have difficulty learning more advanced mathematics skills and concepts" (2011, p.2). Allison Gregg, is a fourth year teacher at Belle Ryan Elementary in Omaha Public Schools. Mrs. Gregg has received a Master's Degree in mathematics from the University of Nebraska at Lincoln and was selected this year to participate in a program titled, Math Studio. Math Studio is only being offered at two Omaha Public Schools and allows teachers in the building to more deeply explore effective strategies in math instruction. Gregg believes that "many students do not enjoy math because it is difficult of them. It is difficult because they do not know their facts which is required when solving almost every single problem" (personal communication, January 12, 2017).

Ultimately, the goal of educators is to prepare students to be successful in more advanced academics as they continue their schooling. Gregg agrees that once students can master addition and subtraction fact fluency, multiplication and division facts will come more easily. Similarly, Gross, et. al, describe how math fact fluency prepares students to be successful in solving more complex math problems in the future. (2014). Gregg also notes that studies have shown that "not knowing basic facts 'takes up space' in the brain that could be used to learn higher level math skills" (personal communication, January 12, 2017). Additionally, Gregg notes that many

curriculums are “spiral” curriculums and ask students to build on skills they learned in previous years (personal communication, January 12, 2017). Increasing math fact fluency will aid in doing so.

### Strategies for Improving Fluency

Timed tests have typically been the strategy most commonly used to teach students to become fluent with basic addition and subtraction. However, timed tests can often cause anxiety and stress in students when used as the basic form of teaching fluency. Extensive research has been devoted to finding alternative ways to help students become more fluent in performing basic math skills while still being fun, engaging, and effective. As noted, the strategies that will be discussed in this paper include, Goal Setting, Cover, Copy, and Compare, and Games. Each strategy brings its own unique benefits and is an alternative to administering timed tests.

### Goal Setting

Goal setting is not a new concept. People set goals for many aspects of their life. However, setting goals in the classroom can be overlooked. In terms of math fact fluency, students should set goals regularly to help motivate them to put forth their best effort. Research has shown that goal setting does enhance student motivation (Gross, et al., 2014). Gross also states, “Goal setting has the potential to increase academic performance by teaching students to focus effort” (2014, p.556). When effort is focused, students spend their time more efficiently and effectively.

One important factor of setting goals is to teach students to set goals that are attainable. The goals set by each student must be meaningful and reachable. If a student consistently is unable to reach their goals, they may become discouraged and lose focus. Goals also shouldn't

be set too low. If a student has no trouble reaching a goal, they may also lose motivation and lack interest in the desired outcome. “Goals that are too high or too low will lead to decreased performance,” (Gross, et al., 2014, p. 556) therefore it is important to discuss goal setting with students and set individualized goals. It is also crucial that students set goals at the beginning of the intervention/instruction. Goals may be altered or changed as students continue to learn and increase skills and abilities.

A second factor to help increase student performance through goal setting is providing feedback. Goal setting is only effective when one knows if they have met the goal they set. Working towards a goal without ever knowing the outcome can decrease motivation and cause frustration. Feedback to students should be specific, individualized, and timely. Students should receive feedback on whether their goal was achieved or not as well as ways that can help them achieve their next goal. Feedback should be meaningful for each student and should not be the same for everyone. The feedback provided should be individual to each student’s performance as well as areas for growth. Finally, feedback on these goals should be given in a timely manner. If feedback is not provided right away students will lose focus on their goals as they will not know if they have reached these goals (Goodwin & Miller, 2012).

#### Cover, Copy, and Compare

Cover, Copy, and Compare (CCC) is a strategy that has been shown to “enhance accuracy and speed of accurate responding” (Poncy & Skinner, 2011, p.3) to basic math facts. The strategy can be applied class-wide or on an individual basis using stations, etc. In CCC, students are presented a problem with the correct answer. After observing the correct problem, the student covers the problem and writes the answer to the same problem. Finally, the student

uncovers the answer and compares their response to the correct answer. If the student determines they have answered the problem correctly, they move to the next math fact and repeat the process. If the student determines they answered the problem incorrectly, they correct their answer. This correction requires the student to rewrite the problem and answer correctly and can be done several times. After correcting, the student would continue this process with the rest of the provided math facts (Poncy & Skinner, 2011).

The CCC method can be used for practicing both addition and subtraction facts. It can be provided with or without time constraints. Since the overall goal is to help students increase math fact fluency, a timed element can be added once students are comfortable with the process and procedures. The CCC method differs from a typical timed test because it requires students to answer a problem correctly before they can attempt the next math fact. It also differs in that students are provided feedback on their progress instantaneously as they move through the problems.

CCC has several benefits in helping students attain both fluency and accuracy. CCC requires that the last response be accurate, which “may enhance acquisition of accurate responding” (Poncy & Skinner, 2011, p.3). This requirement ensures that the students are not rushing through problems simply to meet a time requirement. Rather, students must acknowledge and record the correct response to each math fact. Practice with the CCC method can be timed, therefore it can require little time to administer. This can help increase both speed of responding as well as maintaining the correct response (Poncy & Skinner, 2011). Another benefit to using CCC is that individualized feedback is provided as students progress through problems. This style of feedback allows each student to know how they are doing, without the requirement of a

teacher correcting them. This keeps students accountable and responsible for their answers.

### Flashcards

Historically, flashcards have been used for students to practice math facts through a drill style. Fourth grade teacher, Gregg, indicated that she has observed flash cards work as a fluency tool for students in memorizing important, basic, facts (2016). Using flash cards are beneficial because they are easy for students to use, inexpensive, and straightforward. Flash cards give students explicit exposure to addition and subtraction facts and allows for efficient practice.

However, this standard practice can be modified and individualized to help students increase their fluency and accuracy of math facts. Students can each be given their own set of flashcards with the facts they are expected to learn. The student will then sort the cards into two piles, one pile for the facts they can instantly solve correctly and one pile for the facts they cannot instantly solve. “For facts that are not automatic, they then record a clue onto each card that they could use to help them derive that fact.” (Kling, 2011, p. 82). Students’ clues can utilize any of the strategies students have learned, such as doubles facts. Adding this written clue to the flash card gives the student a visual tool to help them quickly solve facts. This modification also helps students to more fluently identify and apply different strategies when solving facts, rather than simply memorizing the facts.

### Games

A main goal for teaching is “to provide students with activities that will help them improve their computational fluency but also are engaging, make efficient use of time, and are self-motivating” (Lewis, 2005, p.8). One great way to make teaching math facts engaging, efficient, and motivating, is by using games. Games can be especially engaging in primary

classrooms. “Children are intrinsically motivated to play games and play them well” (Kamili & Lewis, 2003, p. 235), making them a great classroom tool.

Researchers agree that using games to help teach mathematics must be done purposefully (Godfrey & Stone, 2013, Bay-Williams & Kling, 2014). “If math games are played purposefully, with discourse and a goal of fact mastery in mind, they can help children build number sense, fact fluency, and confidence in their mathematical abilities” (Godfrey & Stone, 2013, p.97). It is important that teachers explicitly model what the expectations are for games. This allows students to best utilize their time playing the games and alleviates time spent figuring out rules, procedures, etc. Games are most effective when used in small groups of students. Games can be easily implemented into math stations once students can play them independently.

The goal of using games is for students to practice the mathematical strategies they have been taught. The use of games can make these strategies become more concrete and easier for students to understand and apply. Some of the addition and subtraction strategies learned in primary grades include, making a ten, doubles, counting on, and thinking addition to help subtract. Many games allow students to practice these strategies in a way that is motivating and fun and are an alternative to paper, pencil practice. Additionally, when students play games, they have “opportunities to acquire new strategies from their fellow players” (Bay-Williams & Kling, 2014, p. 244).

There are several games that have been researched to help increase math fact fluency. One game is, Tens Go Fish. This game is played similarly to the classic game of Go Fish. Students are dealt cards and asked to look for sums of ten, rather than matching numbers. Students ask their opponent if they have a card that allows them to make a ten with a card they



have in their hand (Bay-Williams & Kling, 2014; Kling, 2011). If the student is able to “make a ten,” they place the pair of cards down and continue play. Another game similar Tens Go Fish is called Find Ten/Turn Over Ten. This game is a matching game, played with the goal of finding two cards that create a sum of ten. Students lay all cards face down and select two cards to turn over. If the two cards create a sum of ten, the student gets to keep them. If they do not, the student turns the cards back over. (Kamili & Lewis, 2003;Kling, 2011). Both games allow students to practice the mathematical strategy of “making ten.” For additional practice, students can be asked to record the addition problems and sums created from the cards selected.

Another math game is called Double It. Double It can be played in groups or individually. This game provides students the opportunity to use the doubles strategy. In this game, students draw a card from a deck containing cards with numbers zero through nine. The student then doubles the number drawn and fills in the answer on a corresponding chart. Each answer has several available slots for students to fill in as they draw cards and create sums. Students continue play until an entire column is filled. (Bay-Williams & Kling, 2014).

The counting on strategy can be practiced with the game, High Roller. Students play High Roller by taking turns rolling two dice. The student determines which dice displays the higher number and sets that die aside. The second dice is rolled again. The student then adds this dice to the first by using the counting on strategy. The student starts with the number on the first dice rolled and counts on the amount of the second dice. Each student should record the addition problem and sum. (Bay-Williams & Kling, 2014).

Finally, it is important that students start to see the relationship between addition and subtraction. One game that encourages students to see this relationship is Salute!. Salute! is

played with three students. In the game, Salute!, one student is the leader. The other two students select a card from a deck, numbered zero through nine. Without viewing their card, students place their card on their forehead so the others in the group can see it. The leader views both cards and says the sum of both when added together. The two students must figure out what their card is, based on what the other player's card is and what the leader states as the sum.

(Bay-Williams & Kling, 2014).

A second game to help strengthen student's addition and subtraction skills is called Sneaky Snake. Sneaky Snake can be played in small groups or individually. In this game, students are given a board with spaces numbered one to twelve. Students take turns rolling two dice. Students then create either an addition or subtraction problem, based on the two numbers on the dice. The student then covers one number on the board that matches either the sum or the difference they found from solving the math fact (Kamili & Lewis, 2003). The game continues until one student covers all numbers on their board first.

As with any instruction, these games can be modified to meet the specific learning needs of each student. To further increase students' math fact fluency, students can be asked to record all answers, discuss strategies used, find alternative strategies to solve, etc. when playing these games.

### Conclusion

Math fact fluency is essential in students' success throughout their schooling. Goal Setting, Cover, Copy, and Compare, Flashcards and Games are effective strategies to help students achieve fluency in basic addition and subtraction facts. With these strategies, students become engaged, motivated, and accountable for their learning.

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	Target	Approaching Target	Below Target
<b>Research</b> (NBPTS 2 & 5)	Literature review provides a research base for the strategies implemented, to include what was learned, how it is good for students, and how it connects to the study.	Literature review provides a research base for the strategies implemented.	Literature review provides a research base.

Demi,

You have done a nice job on this. I really like the depth you added to explain the strategies you have chosen to consider and why. In the future try to summarize and paraphrase others' thoughts. We hear more of you and your voice when you do this. It also makes for a more professional paper because it shows that you synthesize what others have said. You have a few corrections to make and I would recommend putting some of the quotations in your own words and citing the reference by paraphrasing. You also quote Gregg a ton and yet we have no context as to what make this person an expert beyond just having a Masters in Math. Add more of your own voice. Please see above for specifics.