The Effect of Cooperative Learning Groups and Competitive Strategies on Math Facts Fluency of Boys and Girls

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Abstract

It is important for students to become automatic in their responses to simple equations so that their efforts can be focused on more difficult Mathematical problems. The way children learn can affect how well they learn. Studies indicate that boys and girls have different styles for learning, and their progress can be improved through the use of preferred learning styles. The purpose of this Action Research was to test the theories of gender-preferred learning styles. If preferred learning styles are effective, then the benefit of using them should be reflected as significant increases in raw scores on math facts fluency tests. Students in a first grade class participated in addition practice games that had been presented in formats to complement gender-indicated learning styles: cooperative-group and competitive activities. Timed pretests were administered before boys and girls practiced addition in cooperative group format, followed by identical, timed posttests. The results of the pre- and posttests were compared and the raw-score gains were calculated. The process was repeated with competitive practice activities, while using math-facts that were of a sequentially higher level of difficulty. The gains made from each segment of the project were compared. Effectiveness of each method was analyzed for the whole class, and then separated into girls-only and boys-only results. This study indicated that although whole-class scores improved during both phases of the Action Research, gender-indicated learning style activities were more advantageous to the girls than to the boys who participated.

Introduction

Statement of Problem and Purpose of the Research

Students in primary grades are taught the mathematics of combining, and separating or finding the differences between sets, and are expected to master addition and subtraction of whole numbers. The National Council of Teachers of Mathematics (2000) recommends: “In prekindergarten through grade 2 all students should develop fluency with basic number combinations for addition and subtraction” (Appendix p. 3). Strategies which are commonly taught - such as using manipulatives, “counting on” (beginning with the higher addend of an equation and counting by ones to include another addend to find a total), or adding with doubles plus one – have been aids to student comprehension of the process but have not led to student fluency. It has been noted that many older elementary students continue to use counting strategies to arrive at sums or differences, and have been unable to respond to basic addition or subtraction equations automatically (Gersten & Chard, 2001, p. 4).

The way children learn can affect how well they learn. There are studies which indicate that boys and girls have different styles for learning, and student success can be linked to learning styles (Hein & Budny, 1999; Dunn & Dunn, 1978). Gender learning differences have led to research and reports such as *How Schools Shortchange Girls* (American Association of University Women, 1992) and *Girls Get Extra School Help While Boys Get Ritalin* (Jerz, 2003). The purpose of this study was to investigate if using learning strategies (cooperative groups and competitive activities) would increase automatic responses by boys and girls when recalling math facts.

Research Question

Will there be a difference in mathematics fact recall growth between boys and girls if they study math facts a) in cooperative groups and b) using competitive strategies?

Literature Review

Boys' and girls' brains develop differently (James, 2007; Macmillan, 2004; Gurian, Henley, & Trueman, 2001). While girls develop verbal/linguistic skills early, boys' brains concentrate on spatial and kinesthetic intelligences. Boys need more movement than girls while they learn which often results in discipline difficulties in the classroom (Gurian & Stevens, 2006). Gurian suggests that these differences in the development of the brain also account for the higher percentage of boys than girls in special education.

The approaches to teaching need to differ for boys and girls (Sax, 2006; Gurian, et al., 2000; Howell, J., Cantor, A., Lutz, J. A., Schoff, S., & Reynolds, T., 1993). Boys and girls develop at different rates in the areas of vision, hearing, and smell (Sax, 2006; Macmillan, 2004). As early as four days old, girls have been found to have eye-contact with adults for twice the amount of time as boys (Gurian & Stevens 2006). Girls have a keener sense of hearing than boys, especially at high frequencies (James, 2007; Sax, 2006); to improve learning, teachers may need to speak louder to boys. Boys respond well to short, direct commands, while girls usually respond better to softened voices and instructions delivered more nearly as requests (Sax, 2006; Gurian et al., 2001). Even the atmosphere of the classroom can affect student success. Temperature preferences differ between boys and girls; boys have been found to be more alert – and better prepared to learn – in cooler temperatures (Sax, 2006).

Using learning styles in the classroom has been shown to produce significant improvement in learning and recall (Searson & Dunn, 2001). Advocates of single-sex classrooms point out that when separated by sex, teachers can plan lessons and activities that target the learning styles of boys or girls (Kirshenbaum, 2007). In single-sex classes, girls have been more active in math and science, which are typically thought to be the domain of boys in mixed-sex classes; without boys present in class, girls participate and discuss more. Classes comprised of only boys can take advantage of their competitive natures and allow for more noise and movement, which are elements of their learning styles (Delisio, 2006).

The theory of improved academic skills through single-sex classes is not supported by all researchers. While acknowledging differences in brain development, Mead (2006) reports that girls' recent academic position in comparison to boys is due to the improvement in education for girls, not a decline for boys. She states that boys have also shown improvement, but at a more modest rate. Kommer (2005) contends that although there are appropriate occasions for single-gender grouping, if boys and girls are to learn to work as equals in the world, they should begin in the classroom.

Brain Development

For about the first six weeks of gestation, brain development is the same for both sexes, but diverges in boys and girls soon after that (Gurian, et al., 2000). Male and female hormones influence the size and shape of the brain, how it operates, and the sequence of its continued development (Macmillan, 2004). Estrogen makes females less aggressive, and less competitive (Gurian, et al., 2000), while testosterone has the opposite effect on boys (Macmillan, 2004; Gurian, et al., 2000).

The physical structure of the brain differs in boys and girls. The right hemisphere of boy brains is larger than the left (Macmillan, 2004). From the increased right hemisphere, boy brains begin to specialize and develop visual-spatial and visual-motor abilities (Gunzelmann & Connell, 2006). Girls' brain hemispheres develop relatively evenly, and are connected by a corpus callosum which is up to twenty percent larger than one in a boy brain (Gurian et al., 2001). This thick bundle of nerves provides more communication between the brain hemispheres for girls, coordinating the language skills that are a function of the left hemisphere, with the interpretative abilities from the right hemisphere (Gurian, et al., 2001).

The frontal lobe of the brain, which helps with speech, thought, and emotion, is more active in females than in males (Gurian, et al., 2001), and helps girls improve speaking communication skills (Gurian, et al., 2001). Conversely, boys develop a larger amygdala, which contributes to boys' higher levels of activity, aggression, curiosity, and competitiveness (Macmillan, 2004). In general, before birth, girls' brains develop to make them more verbal and social, and boys' brains develop to make them more aggressive and competitive (Gurian, et al., 2001, p.39).

Learning Styles and Gender Tendencies

Learning style has been defined as:

"… the way each person begins to concentrate on, process, internalize, and remember new and difficult academic information" (Dunn, Honigsfeld, & Martel, 2001, p.2), and

"… the characteristic of the cognitive, affective, and physiologic behaviors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment" (Hein & Budny, 1999, p.7).

Researchers state that student learning is improved and learning time is shortened and more productive when teachers accommodate student learning styles (Madrazo & Motz, 2005; Larkin & Budny, 2005; Dunn & Dunn, 1978). Some learning style attributes, such as visual, tactual, or kinesthetic, are common preferences of males. Although females generally have auditory learning preferences, both boys and girls prefer active learning to reading or listening

(Dunn, et al., 2001). Another learning style element is the sociological preference for learning alone, in pairs, or small groups (Jensen, Madsen, & Rohde, 2006; Dunn, et al., 2001; Gurian, et al., 2001; Wallace, 1993). Generally, boys prefer to work alone or in competitive situations; girls prefer to work with others in social or collaborative groups (Kommer, 2005; Halpern, 2004; Howell, et al., 1993). Cooperative or 'team' learning is a method in which boys can also be successful if it is designed with enough specific tasks to provide roles for each group member (Kommer, 2005; Gurian, et al., 2001).

In a study of students with strong preferences to learning alone or learning in groups, Wallace (1993) found that those preferring to learn alone "evidenced statistically higher mean lesson-test scores than those who were identified as preferring to learn with peers." Wallace suggested the possibility that this result is due to a traditional structure in the classroom, and that the organizational pattern in the classroom had not matched a preference to working with peers. Some education theorists encourage an atmosphere where students can learn in their preferred styles, but also practice and strengthen alternative learning situations (Larkin & Budny, 2005; Kommer, 2005).

Memory and Math Automaticity

Learning math facts is a foundation to comprehension of more complex mathematics (Bezuk, 2001). Learning the basic facts to the point of automaticity can free the mind and more efficiently allocate time on task to more complex problem solving (Bezuk, 2001; Gersten & Chard, 2001; Geary, 1999). It is important that students develop a conceptual understanding of addition and subtraction and how they are related to daily life (Burke & Dunn, 2002; Gersten &

Chard, 2001). Rote memorization of basic facts is fragile knowledge, and does not solidify in the student the discernment of appropriate selection of operations in problem solving (Bezuk, 2001).

People remember what they understand, and how much they remember is based on what they already know (Kuhn, 2000). Understanding math facts is a developmental process with three stages: concrete, pictorial, and symbolic. Students begin learning about addition and subtraction using manipulatives or concrete objects. They are able to act out combining or separating objects to arrive at an ultimate set of objects. Next, students are able to use pictorial representations instead of objects to reinforce their understanding of adding and subtracting, and finally use only symbolic representations – numerals and operation signs – to arrive at an answer (Burke & Dunn, 2002; Bezuk, 2001).

Memory research indicates that children remember best by discussing what they have learned in groups, practicing and using what they have learned, and by teaching others (Madrazo & Motz, 2005). Skills for making accurate computations and using appropriate operations must be built and reinforced through regular practice (Bezuk, 2001; Gersten & Chard, 2001).

Summary

It is important that students learn and respond to basic math facts automatically to allow their energies to be applied to more complex math processes. Based on the previous research literature, boys and girls should be able to learn math facts by building concepts and memory developmentally, moving from manipulating concrete objects to using symbolic representations. Learning style sociological preferences would seem to be determined by gender brain development. Girls' brains develop stronger social and verbal tendencies which are compatible with cooperative grouping for learning activities. Boys' brains develop areas that would incline them to prefer competitive activities to learning in cooperative groups, although they can benefit from small groups if there is adequate organization. Regular practice of math facts is necessary to build memory. By participating in learning activities that correspond to the preferred sociological learning styles of boys and girls, student test scores should reflect increases in math fact automaticity. This action research is intended to test the theories of gender-preferred learning structures – cooperative grouping and competitive activities – to determine methods that increase math fact automaticity among boys and girls.

Method

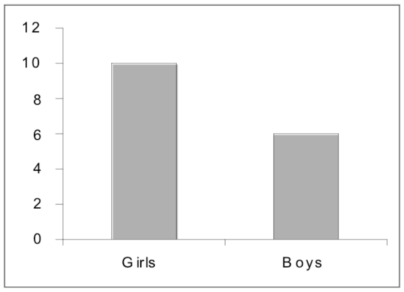
This Action Research project was conducted to investigate if using learning strategies (cooperative groups and competitive activities) would increase automatic responses by boys and girls when recalling math facts.

Subjects

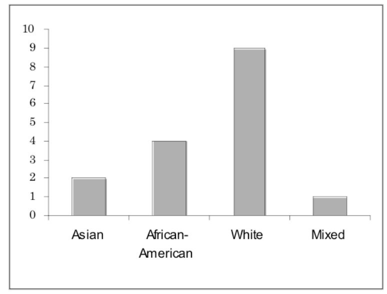
The sixteen subjects in this Action Research attended first grade at a school in a suburban area near a large metropolitan region of the southeastern United States. Student ages ranged from five to seven years old; the youngest student had a fall birthday and had transferred in to the school system during kindergarten. There were six boys and ten girls among the students. The ethnicities of the students in the study were two Asian, four African-American, nine White, and one Mixed Race. The composition of the class by sex and ethnicity is shown in Figure 1.

Figure 1

Composition of Classroom by Sex and Ethnicity



Number of Girls and Boys in Class



Students by Ethnicity

Procedure

Regular math instruction had begun prior to, and continued during, the time of this Action Research. Before the research period, students had lessons on addition strategies, which included ‘counting all’, ‘counting on’, and ‘doubles plus one’. Students had practiced equations with sums from 0 to 10 in class and on homework assignments. The initial phase of the research project began soon after those lessons so that students would develop comprehension of the concept before working to achieve fluency. The subsequent skill to sums from 0 to 10 is sums from 5 to 12, which was used in the second phase of the project.

On the first day of this Action Research Project, a pretest of addition math facts with sums from 0 to 10 was administered prior to using any of the activities to establish students’ skill levels. The pretest was taken from Frank Schaffer Publications: Math Grades 1-2 (1993), page 8. The test page contained 45 addition facts, of which 30 were written vertically and 15 were written horizontally. The students were given 1 minute (timed with a battery operated kitchen timer) to complete as many equations as they were able. Student raw scores were recorded from the pretest. Following the pretest, student names were selected randomly to form cooperative groups, and activities were introduced. Activities used for this project included Five Plus, Junior

Star Traveler, Make Ten, and Pass the Paper; copies are attached to this document, and shown as Appendices A - D.

On the second day of the first week until the fourth day of the third week of the Action Research, cooperative groups were assembled and given materials to practiced adding skills for sums from 0 to 10 for a fifteen minute period. On the fifth day of the third week, a posttest identical to the pretest was administered to the Action Research participants, and raw scores were recorded. Test-retest effects should be minimized since students had only 1 minute to work.

On the first day of the fourth week of the project, a pretest of math facts from 5 to 12 was administered to students. The pretest was taken from Frank Schaffer Publications: Math Grades 1-2 (1993), page 22. The test page contained 45 addition facts, of which 30 were written vertically and 15 were written horizontally. The students were given 1 minute (timed with a battery operated kitchen timer) to complete as many equations as they were able, and raw scores were recorded. The same activities which had been used during the cooperative group phase of the Action Research – Five Plus, Junior Star Traveler, Make Ten, and Pass the Paper – were explained in competitive formats. The game boards were altered as necessary to reflect sums from 5 to 12. Beginning the second day of the fourth week until the fourth day of the sixth week, students practiced addition skills with sums from 5 to 12, using the above activities in the competitive format and working in pairs. At the close of the Competitive phase of the project, students took a posttest which was identical to the pretest, and those raw scores were recorded. Test-retest effects should be minimized since students had only 1 minute to work. See Figure 2 for the time line used to conduct this Action Research project.

Figure 2

Time Line to Conduct Action Research Project

	M	T	W	Th	F
Week 1	Pretest: Sums 1 - 10	*Cooperative Groups Practice*			
Week 2	*Cooperative Groups Practice*				
Week 3	*Cooperative Groups Practice*				Posttest: Sums 1 - 10
Week 4	Pretest: Sums 5 - 12	Competitive Pairs Practice			
Week 5	Competitive Pairs Practice				
Week 6	Competitive Pairs Practice				Posttest: Sums 5 - 12

Results

Data Analysis

The purpose of this Action Research was to test the theories of gender-preferred learning styles. If preferred learning styles are effective, then the benefit of using them should be reflected as significant increases in raw scores on math facts fluency tests. Appendix E contains the record of raw scores for the pre- and posttests for timed math-fact tests, sorted by results for cooperative groups and competitive activities. The growth between the pre- and posttests for Cooperative Group Practice and the growth in Competitive Learning Activities were calculated for each student, and are reflected in separate columns. Since girls develop with strong social inclinations, the effects of a social learning style, or cooperative groups, would be expected to result in strong gains by girls. Competitive activities match the developmental style indicated for boys, and would be expected to result in strong increases for boys' math computation. Student scores have been grouped by sex; girls have been indicated with the number 1, and boys have been indicated by the number 2.

Figure 3 shows the Mean Scores and Standard Deviation for each Pre- and Posttest for the Whole Class, and the gains of each pair in cooperative groups and competitive activities. As shown in the table, the Mean Gain (3.44) for Cooperative Groups is higher than the Mean Gain for Competitive Activities (2.06). However, as shown in Figure 4, comparison of gains made after using cooperative groups to gains made after competitive learning activities showed a P-value of 0.14, and did not indicate a significant difference in gains between the strategies for the Whole Class.

Figure 3

Descriptive Statistics Whole Class

	Cooperative Group Pretest	Cooperative Group Posttest	Pre/Post Gain	Competitive Activity Pretest	Competitive Activity Post	Pre/Post Gain
Mean	13.69	17.13	**3.44**	9.94	12.00	**2.06**
Standard Deviation	4.77	4.16	**1.79**	4.46	5.03	**3.26**

Figure 4

Whole Class Gains t-Test: Paired Two Sample for Means

	Cooperative Gains	Competitive Gains
Mean	**3.44**	**2.06**
t Stat	1.57	
P(T<=t) one-tail	0.07	
t Critical one-tail	1.75	
P(T<=t) two-tail	**0.14**	

The gains made by girls only in pre- and posttests for addition practice using cooperative groups and competitive activities were compared. Figure 5 shows the Mean Scores and Standard Deviation for these tests. The Mean Gain for girls only after practicing basic math facts in cooperative groups was 3.30, while the Mean Gain for girls only after practicing basic math facts in Competitive Activities was 1.00. The Mean Gain for Cooperative Group practice is higher than the Mean Gain after practice using Competitive Activities. These results indicate that using the social learning style Cooperative Grouping can be beneficial to helping girls learn.

Figure 5

Descriptive Statistics Girls Only

Cooperative Group Pretest		Cooperative Group Posttest		Pre-Post Gain		Competitive Activities Pretest		Competitive Activities Posttest		Pre-Post Gain	
Mean	12.100	Mean	15.400	Mean	3.300	Mean	7.800	Mean	8.800	Mean	1.00
Standard Deviation	4.581	Standard Deviation	3.806	Standard Deviation	1.767	Standard Deviation	3.259	Standard Deviation	2.781	Standard Deviation	1.25

Figure 6 shows the results of a t-test comparing the gains of cooperative groups and competitive activities by girls only. The P-value of 0.000887 indicates a statistical significance between the gains, which would indicate that working in Cooperative Groups is a more effective learning style for girls than using Competitive Activities.

Figure 6

t-Test: Paired Two Sample for Means

Cooperative to Competitive Gains, Girls Only

	Cooperative Gains	Competitive Gains
Mean	**3.3**	**1**
t Stat	4.866885	
P(T<=t) one-tail	0.000444	
t Critical one-tail	1.833113	
P(T<=t) two-tail	**0.000887**	

The gains made by boys only in pre- and posttests for addition practice using cooperative groups and competitive activities were compared. Figure 7 shows the Mean Scores and Standard Deviation for these tests. The Mean Gain for boys only after practicing basic math facts in Cooperative Groups was 3.667, while the Mean Gain for boys only after practicing in Competitive Activities was 3.833. The Mean Gain after using Competitive Activities practice is slightly higher than the Mean Gain after practicing in Cooperative Groups.

Figure 7

Descriptive Statistics Boys Only

	Cooperative Group Pretest	Cooperative Group Posttest	Pre-Post Gain	Competitive Activities Pretest	Competitive Activities Posttest	Pre-Post Gains
Mean	**16.33**	**20.00**	**3.67**	**13.50**	**17.33**	**3.83**
Standard Error	1.69	1.29	0.80	1.65	1.12	1.96
Median	17.00	20.50	3.50	15.00	18.50	2.50
Mode	#N/A	#N/A	3.00	15.00	19.00	1.00
Standard Deviation	**4.13**	**3.16**	**1.97**	**4.04**	**2.733**	**4.79**

Figure 8 shows the results of a t-test comparing the gains of cooperative groups and competitive activities by boys only. The Mean Gains for boys were slightly higher after practicing with Competitive Activities than when working in Cooperative Groups. However, the P-value of 0.941668 does not indicate a statistical significance between the gains. These results do not support the use of one of the tested learning styles over the other to achieve a higher increase in learning basic math facts for boys.

Figure 8

t-Test: Paired Two Sample for Means

Cooperative to Competitive Gains, Boys Only

	Cooperative Gains	Competitive Gains
Mean	**3.666667**	**3.833333**
t Stat	-0.07692	
P(T<=t) one-tail	0.470834	
t Critical one-tail	2.015048	
P(T<=t) two-tail	**0.941668**	

Conclusions

Both boys and girls seemed to enjoy the math games in either Cooperative Group or Competitive Activity format. The students expressed eager anticipation of playing the games each day during the Action Research period. The results show that the girls increased math fact fluency in cooperative learning groups more than they did after participating in competitive activities. The P-value of 0.000887 showed a significant difference in math fact fluency between the learning style activities. These results indicate that girls benefit more by learning in Cooperative Groups than using Competitive Activities.

The boys' increases were slightly higher in Competitive Activities, but were nearly equal to the gains made while participating in Cooperative Groups. The P-value of 0.94 indicates no significant difference between gains made using either Cooperative Groups or Competitive Activities. The results for the boys are consistent with discussions by Kommer (2005) and Gurian et al. (2001), and may support the theory that if competitive activities are the preferred learning style for boys, they still are able to show satisfactory progress when learning in a format that is not gender-preferred as long as the cooperative group activities provide specific tasks for each group member.

If learning is improved and learning time is shortened and more productive when teachers accommodate student learning styles (Madrazo & Motz, 2005; Larkin & Budny, 2005; Dunn & Dunn, 1978), and if boys prefer to work alone or in competitive situations, and girls prefer to work with others in social or collaborative groups (Kommer, 2005; Halpern, 2004; Howell et al., 1993), then classroom activities should be planned and presented to accommodate these learning preferences. However, given the results of this Action Research, it is recommended that when time constrains teachers from providing learning activities in both Cooperative Group and Competitive Activity formats, the choice should be made to use Cooperative Groups, while making sure that each group member has a specific task to perform within the group.

Limitations

This Action Research project was preformed on a small group of students, having only sixteen children who took part in all phases of the research. The number of students involved was less than that which is necessary to constitute a reliable sample. The number of boys to girls was not equal (six boys and ten girls), and those unequal numbers may have affected the statistics. The pretest (sums from zero to ten) was identical to the posttest used during the Cooperative Groups phase, and the pretest (sums from five to twelve) was identical to the posttest used during the Competitive Activities phase of the Action Research. Although there may have been a test-retest effect in the gains made by students, the effect should have been minimized by the imposition of the test time limit. The duration of the project was only six weeks, allowing for three weeks to use the Cooperative Groups, and three weeks to use Competitive Activities. A longer study, involving a larger number of students, may yield different results.

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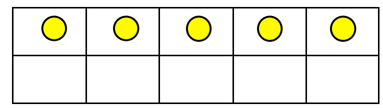
Appendix A

Title – **Five Plus**
From: Nimble with Numbers, Grades 1 & 2 (Childs, Choate, & Jenkins, 1999)
Subject - Math
Objective: Fill a pathway to the star

<u>Materials:</u>
Ten Frame with Five Counters
Five Plus game board
Ten Frame
Dot cube (1 – 5, Choose)
30 counters (25 of one kind, 5 of a different kind)



<u>Directions:</u>
1. In this game, a pair works **cooperatively** to fill a pathway.
2. Place the five counters that are different from the others in the top row of the Ten Frame. (The counters remain there during the entire game.)
3. The pair rolls the Dot Cube. If "Choose" appears, pair selects any number one through five. When a number is rolled, the pair adds that amount of counters to the Ten Frame, states the equation, and places a counter on the path with that sum.
   Example: If 4 is rolled, the Ten Frame is filled to show 9 (5 of one color, 4 of another), "Five plus four equals nine" is stated, and a counter is placed in the first cell of the 9-pathway.
4. The pair continues until one path to the star is filled.

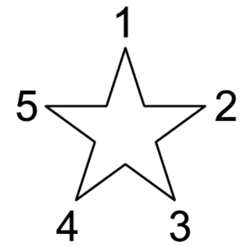
Title – **Five Plus**
From: Nimble with Numbers, Grades 1 & 2 (modified for **competitive** activity)
Subject - Math
Objective: Fill a pathway to the star

<u>Materials:</u>
Five Plus game board per player
Ten Frame
Dot cube (1 – 5, Choose)
30 counters (25 of one kind, 5 of a different kind)

<u>Directions:</u>
1. In this game, a pairs compete to be the first to fill a pathway.
2. Place the five counters that are different from the others in the top row of the Ten Frame. (The counters remain there during the entire game.)
3. A player rolls the Dot Cube. If "Choose" appears, pair selects any number one through five. When a number is rolled, the player adds that amount of counters to the Ten Frame, states the equation, and places a counter on the path with that sum.
   Example: If 4 is rolled, the Ten Frame is filled to show 9 (5 of one color, 4 of another), "Five plus four equals nine" is stated, and a counter is placed in the first cell of the 9-pathway.
4. The first player to fill a path to the star wins the game.

Appendix B

Junior Star Traveler (Currah & Felling, n.d.)



LEVELS Grade 1 and up

SKILLS

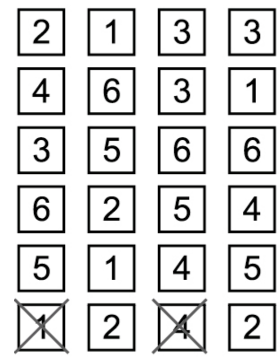
- adding to 10
- problem solving

PLAYERS

Students can play this game on their own (solitaire style), in pairs, or in **cooperative** groups.

EQUIPMENT

- playing cards Ace (=1) through 6 (24 cards in all)
- 1 die
- pencil/crayon



GETTING STARTED

▪ The object of this game is for pairs or groups of students to work together to take away all of the cards before coloring in all five points on a star.
▪ Players build a 6 x 4 grid of playing cards; all cards appear face up. The cards might look like the illustration that appears to the right.
▪ A player rolls the die. The player may take away any card or combination of cards that equals the die *and* that appears at the bottom of any column of cards. Players work together as members of a team or cooperative group to figure out what the best play will be. A maximum of only three (3) cards can be removed in one turn.
▪ **Example** The player rolls a 5, so he takes the cards 1 and 4 from bottom. This move leaves 5, 2, 4, and 2 exposed (as the bottom cards in each column) for the next roll. Another choice might have been to remove the 1, 2 and 2.

▪ In the event that a card or combination of cards cannot be found to equal the number on the die, players color in one point on their star.
▪ Play continues until all cards are removed or all five points on the star are colored.
▪ As players gain more experience with this game, they will develop more strategies to maximize their chances to win. Begin with number recognition, then move when students are ready to adding combinations, subtracting combinations, and mixed operations.

Junior Star Traveler (Modified for **competitive** activity)

PLAYERS Students can play this game in pairs.

GETTING STARTED

▪ Students compete in this game to be the first in a pair of students to take away all of the cards before coloring in all five points on a star.
▪ Players build a 6 x 4 grid of playing cards; all cards appear face up.
▪ A player rolls the die. The player may take away any card or combination of cards that equals the die *and* that appears at the bottom of any column of cards. The player works to figure out what the best play will be. A maximum of three (3) cards can be removed in one turn.
▪ **Example** The player rolls a 5, so he takes the cards 1 (Ace) and 4 from bottom. This move leaves 5, 2, 4, and 2 exposed (as the bottom cards in each column) for the next roll. Another choice might have been to remove the 1, 2 and 2.
▪ In the event that a card or combination of cards cannot be found to equal the number on the die, players color in one point on their star. Play continues until all of the points of one player's star are colored in. The player with points remaining uncolored is the 'winner.'

Appendix C

Title – **Make Ten**
From: Nimble with Numbers, Grades 1 & 2 (Childs, et al., 1999)
Subject - Math
Objective: Combine addends to cover all numbers.

Materials:
Make Ten game board
2 Dot Cubes
Counters

Directions:
1. In this game, a pair works **cooperatively** to cover all numbers.
2. Each player of the pair rolls the Dot Cubes.
3. The pair uses any number on the gameboard to add to one or two Dot Cubes to make ten. The pair states aloud the equation and covers the number with a counter.
4. The pair continues to use the same two amounts shown on the Dot Cubes and covers other numbers.
   Example: If 3 and 4 are shown on the Dot Cubes, children could cover 7 (7+3=10), 6 (6+4=10), and 3 (3+3+4=10).
5. When no other numbers can be covered, the pair rolls the two Dot Cubes and tries to cover additional numbers.
6. The pair continues to play until all numbers on the gameboard are covered.
7. The pair clears the gameboard and rolls two Dot Cubes to repeat the procedure.

Title – **Make Ten**
From: Nimble with Numbers, Grades 1 & 2 (modified for **competitive** activity)
Subject - Math
Objective: Combine addends to cover all numbers.

Materials:
Make Ten game board
2 Dot Cubes
Counters

Directions:
1. In this game, a pair competes to be the first to cover all numbers.
2. A player rolls the Dot Cubes.
3. The player uses any number on the game board to add to one or two Dot Cubes to make ten. The player states aloud the equation and covers the number with a counter.
4. The player continues to use the same two amounts shown on the Dot Cubes and covers other numbers.
   Example: If 3 and 4 are shown on the Dot Cubes, children could cover 7 (7+3=10), 6 (6+4=10), and 3 (3+3+4=10).
5. When no other numbers can be covered, play passes to the next student. The player rolls the two Dot Cubes and tries to cover numbers in the same manner described above.
6. The pair continues to play until all numbers on one of the game boards are covered. The player who covers all the numbers first is the winner.

Appendix D

Title - **Pass the Paper** - Addition Cooperative Activity (Sayre, n.d.)
By - Terry Sayre (Modified from Skip Counting Game)
Subject - Math
Grade Level - K-4
Objective: Students will practice addition while cooperating in a group activity.

Materials:
Timer
1 Pencil Per Student
Number Cube
1 Sheet of Paper per Table Group
Manipulatives for counting

Preparation:
Student's desks should be organized into **cooperative** groups of four or of equal sizes for this activity. The timer should be set for 5 minutes.

Lesson Outline:
1. Have each student get a pencil out. Next, pass out one piece of paper per table group.
2. Explain: "Each table group has one piece of paper. When I say "go" the first person will roll the number cube. The number will be the sum of all the equations you write. The next player will write an equation that equals the number rolled, and then passes the paper to the third player. The third player and all subsequent players will write equations with the same sum, but different from the equations which have already been written. Players continue writing equations and passing the paper until the timer sounds." When playing "Pass the Paper" explain that the paper should be passed clock-wise.
3. Next, check for understanding. Have the students repeat the instructions.
4. Student groups and teacher discuss equations and check papers for accuracy (use counters as necessary).

Objective: Students will practice addition while playing a **competitive** activity.
Materials:
Timer
1 Pencil per student
1 Number Cube
1 Sheet of paper per student
Manipulatives for counting
Preparation:
Student's desks should be organized for students to work in pairs for this activity. The timer should be set for 5 minutes.

Lesson Outline:
1. Have each student get out a pencil and sheet of paper.
2. Explain: "We are going to have a race. Each student should have a piece of paper and a pencil. When I say "go" a player will roll the number cube. The number will be the sum of all the equations you write. Each player will write as many equations as possible that have the sum of the number rolled. When the timer sounds, players put down their pencils."
3. After the timer, students compare their equations and cross out all that are also on their opponent's paper. The winner is the student who has remaining accurate equations.
4. Next, check for understanding. Have the students repeat the instructions.

Appendix E

Pre- and Posttest Raw Scores, and Correlated Gains

Student Identification	Sex	Pretest Coop Grp	Posttest Coop Grp	Gain Coop Grp Pre& Post	Pretest Competitive	Posttest Competitive	Gain Competitive Pre & Post
1	1	14	20	**6**	10	12	**2**
2	1	18	20	**2**	12	11	**-1**
3	1	14	17	**3**	7	8	**1**
5	1	10	13	**3**	6	8	**2**
8	1	6	11	**5**	4	7	**3**
9	1	14	18	**4**	9	9	**0**
14	1	18	18	**0**	13	14	**1**
15	1	12	15	**3**	6	6	**0**
16	1	4	9	**5**	3	5	**2**
17	1	11	13	**2**	8	8	**0**
6	2	21	24	**3**	17	18	**1**
7	2	12	15	**3**	6	19	**13**
10	2	20	21	**1**	15	15	**0**
11	2	11	18	**7**	12	13	**1**
12	2	18	22	**4**	16	20	**4**
13	2	16	20	**4**	15	19	**4**

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