Journal of Mathematics Education
Spring 2015, Vol. 8, No. 1, pp. 37-55

The Effects of Simplified Schema-based Instruction on Elementary Students' Mathematical Word Problem Solving Performance

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Schema-based Instruction (SBI) is one of the most supported methods for teaching word problem solving. In this study, the researchers simplified SBI and referred it to SSBI. The purpose of this study was to test the effectiveness of this new method with second grade students. Participants, using SSBI, did not need to identify categories. Results demonstrated that all participants' word problem solving skills were significantly improved. The results also evidenced that students not only mastered SSBI, but also maintained the skills.

Key words: Math Education, Word Problems, Math Intervention, Elementary Teaching, Single Subject Design, Multiple-Baseline across Participants Design

Review of Literature

According to National Council of Teachers of Mathematics (NCTM) and Common Core State Standards for Mathematics (CCSSM), word problem solving is an important skill that students learn during their school years, it is required throughout all the grades from Kindergarten to high school (NCTM, 1989; CCSSM, 2010, p.11). In Fact, the importance of word problem solving in mathematics has been emphasized since the beginning of the 1980s (De Corte, Greer, & Verschaffel, 1996). Students were believed to be able to handle word problems after they gained addition and subtraction computational skills since kindergarten (CCSSM, 2010, p.15). NCTM (1989) suggested that word problems should be related to children's everyday experience, so students could be promoted to learn more concepts, operations, and arithmetic symbols relevant to real-world situations. This may help students practice the skills of computation, operation, and application of math knowledge in real life situations.

However, according to National Assessment of Educational Progress (NAEP), word problems have become a very difficult area for students across ability and all age levels (1992). In 2005, the National Center for Educational Statistics (NCES) also reported that roughly two-thirds of the fourth grade students in the United States could not perform proficiently in word problem solving (Perie, Grigg, & Dion, 2005). Researchers have been attempting to develop effective word problem solving instruction. Unfortunately, not much progress was made during the 1990s and the beginning of the new century (Lester & Kehle, 2003). Word problem solving remains a difficult area among elementary and high school students (De Corte, Greer, & Verschaffel, 1996; Jitendra & Hoff, 1996; Neef , Nelles, Iwata, & Page, 2003). One of the reasons is that researchers did not develop new strategies that could be used to effectively teach students word problem solving skills (Lester & Kehle, 2003). This situation has been changed recently with new research contributing to this area and newly developed strategies (Jitendra, Griffin, Deatline-Buchman, DiPipi-Hoy, Sczesniak, Sokol, & Xin, 2005; Jitendra, George, Sood, & Price, 2010; Neef, Nelles, Iwata, & Page, 2003).

Schema Based Instruction

SBI is one of the most successful methods in word problem solving. Gick and Holyoak (1980) defined problem schema as a general description of two or more problems, which can be used to group problems into types that require similar solution methods (Chi, Feltovich, & Glaser, 1981; Gick & Holyoak, 1980; Quilici & Mayer, 1996). Therefore, the broader the schema students have, the more chances students will have to recognize a novel word problem and higher possibility to solve it (Fuchs, Fuchs, Finelli, Courey, & Hamlett, 2004). In SBI, the role of the mathematical structure of problems is very important to problem “comprehension and representation” (Jitendra, George, Sood, & Price, 2010). Gick (1986) pointed out that in order to develop a problem representation, the learners first need to find the structure of a problem and connect this new problem to the prior knowledge, then create a personal interpretation (network) of this new problem. Then, the use of existing strategies is applied to find the solution to this new problem. This process is also called schema activation (connect new problem to prior existing knowledge and build a new larger network) through which students should be able to find the schema for solving the new problem (Gick, 1986). So the most important aspect in using SBI solving word problems is the development of schemas (Fuchs, Fuchs, Prentice, Hamlett, Finelli, & Courey, 2004; Kintsch, 1994).

Previous SBI Studies

There are numerous studies have already tested the effectiveness of SBI in word problem solving. For example, Jitendra and Hoff (1996) tested the effectiveness of a schema-based direct instruction strategy on the word problem solving performance in three elementary students with learning disabilities. One-step addition and subtraction word problems were divided into three types in this study: change problems, group problems, and compare problems. The investigation included five procedures. First, participants were screened for prerequisite two digit addition and subtraction computation skills. During baseline tests, participants scored an average of 42% accuracy in all three types of problem solving. During the SBI intervention, participants were first trained to identify the schemata (problem schema) of word problems until participants can get 100% righ. During the intervention process, diagrams were used to help recognize story types. Maintenance data were collected two or three weeks (varied among participants) following the intervention. Results showed that the SBI successfully helped those students improve their abilities in solving word problems evident by the increased percentages of correct answers. Also, participants maintained the skills during the two or three week follow-ups.

Another study were conducted by Hutchinson (1993), the participants also included students with learning disabilities. There were a total of 20 students with learning disabilities who were divided into two groups. In the experimental group, students were taught to solve word problems using a cognitive strategy that incorporated schema identification. Specifically, the experimental group was asked to solve three types of word problems: relational, proportion, and two-variable, two-equation. The results showed significant differences between those two groups in word problem solving performance: the experimental group scored 66% on an open assessment measure which included items from a standardized test, while the comparison group only scored 40%. Additionally, the experimental group scored higher in skill maintenance six weeks after the intervention compared to the control group.

Furthermore, Jitendra et al. (1998) compared the effectiveness of SBI and traditional instruction on students' acquisition, maintenance, and generalization of simple mathematical one-step word problem solving skills. In this study, participants were divided into two groups. In the experimental group, there were 34 students with mild disabilities or at risk for mathematics failure. The comparison group consisted of 24 third-grade students in general education. In the experimental group, participants were first taught to identify the features of the semantic relations (problem schema) in the problem and determine the problem type (change, group, and compare). Then, the instructors began to teach participants to find an appropriate operation through using the diagram strategy (action schema). In the comparison group, an instruction from the Addison-Wesley Mathematics basal mathematics program was adopted. This instruction included two phases. In the first phase the instructor presented and directed the Think Math activities. In the second phase, instructors used a five-step checklist procedure to solve word problems. Participants in both of the two conditions were tested after the intervention to see maintenance of the skills they learned from training. Results demonstrated a remarkable increase in students' performance in word problem solving in the experimental group. Although participants from both groups made progress and maintained their acquired skills in word problem solving, the growth rate of the participants in experimental group was significantly more rapid than the control group in posttest and maintenance test.

Summary

The studies addressed above share the following common characteristics. First, word problems were divided into two to four categories and the categorization varied from study to study. Students were taught to first recognize the type of a word problem and then used a corresponding strategy to solve that specific type of word problem. The results of all those studies are positive in terms of the effectiveness of SBI in increasing participants' skills in word problem solving which indicate that categorizing word problems might not be a necessary component to be included in SBI, especially to the students at the lower grade level in elementary schools. Second, participants included in those studies are students with special needs (learning disabilities or developmental disabilities). Actually, there are only few studies using SBI strategy in general education (Fuchs, Fuchs, Finelli, Courey, & Hamlett, 2004). Therefore, the effectiveness of SBI in improving word problem solving in this population is well-established, however, a need to investigate if SBI is effective for students without special needs in general education exists. Third, participants were screened for prerequisite skills before they were recruited into those studies. Some of the studies screened the students' reading skills, some screened computation skills, or screened both. This is a necessary procedure to ensure that students' difficulties with word problem solving are not caused by a lack of these prerequisite skills. Fourth, the diagram strategy was employed by all the studies. This indicates the importance of diagram strategy in SBI. Finally, students' performance during and after intervention in these studies indicated the effectiveness of SBI in increasing students' word problem solving skills and maintenance data suggested that students were able to generalize their learned skills to novel problems.

Purpose of the Study

As research projects have already shown that categorizing word problems was a hard cognitive procedure for many students (Neef et al., 2003; Xin, Wiles, & Lin, 2008). In order to broaden students' schema in word problem solving and help them improve the ability to recognize the connection to the novel problems (Fuchs et al., 2004), the current project provided students a “one covers all” strategy, Simplified Schema-based Instruction (SSBI), in solving one-step addition and subtraction word problems at the second grade level in general education. Using this new method of SSBI, students do not need to categorize those word problems, instate they need to read and retell the word problem first, then they will determine the operation and solve the word problems based on their understanding of the word statement. Thus, the purpose of this study was to test and verify the effectiveness of SSBI at the second grade in general education. In addition, the investigators also intended to discover if participants could maintain SSBI strategy after the intervention is terminated.

Research Questions

1. Will SSBI be effective in increasing for beginning learners’ mathematic word problem solving performance?
2. Will SSBI be effective in increasing mathematic word problem solving performance in students in general education?
3. Will SSBI skills be maintained after the intervention terminated?

Method

Participants and Settings

In this research study, the investigators utilized a single subject design (multiple-baseline across participants) to test the effectiveness of SSBI. Participants were four second grade students in general education settings. Participants were recruited from one local elementary school located in a southeastern state. All four participants were from the same classroom. Participant A was a male Caucasian student, seven years, three months old. Participant B was a male African American student, seven years, five months old. Participant C was a female African American, seven years, one month old. Participant D was a male Hispanic student, seven years, nine months old.

Participants were selected based on the following criteria: (a) student was nominated by his or her teacher for word problem solving difficulties (this was determined by teachers according to participants’ performance in math word problem solving); (b) the four participants mastered prerequisite oral reading and mathematics computation skills determined by the screening test (described below); and (c) the teacher and students’ parents consented to participation in the study.

Materials

A series of worksheets containing one-step addition and subtraction word problems using the equations A+B = C or A-B = C were created and adapted from Free Math Word Problem Worksheets (http://www.softschools.com/math/word_problems/worksheets/). There were five problems on each sheet (each sheet contained only five problems). Training and testing probes used in all the phases were selected from these worksheets. Furthermore, in order to keep the consistency of the word problems' difficulty level, there were always three subtraction word problems and two addition word problems selected on each worksheet. An example of a typical worksheet is shown in Appendix.

Dependent Variables and Data Collection

Accuracy percentages were used to measure students' word problem solving performance. An accuracy percentage was calculated by using total earned points dividing by total potential points and then multiplying by 100%. Correct responses were defined as: the larger number was at the beginning of the equation, the smaller number was behind the operation symbol, correct operation (addition or subtraction), correction solution, and correct use of label. Each of the response was worth two points and therefore, each word problem was worth 10 points in total. Students' worksheets were collected at the end of each session by the primary investigator. The investigator and/or trained graduate student graded the worksheets independently.

Experimental Procedures

Screening of Participants. Participants were screened on oral reading fluency and math computation using standard Curriculum-based measurement (CBM) procedures. In this project, mathematics intervention, only the students who can meet the reading and computation CBM criterion can be treated. So the screening on reading and math computation are required in this project. CBM includes standardized measures for reading, mathematics, writing, and spelling. CBM was developed by Deno and colleagues in the early 1970s (Shinn, 1989). CBM was original designed for the teachers in special education area. Nowadays, CBM is widely used in both general and special education settings.

Determining Baseline. During baseline, no instruction or feedback was provided to students. Students were given one worksheet containing five mixed one-step single- and double-digit addition and subtraction word problems to solve. If a participant has stable performance or a decreasing performance during the baseline phase, the intervention (independent variable) can be introduced to this participant (Cooper, Heron, & Heward, 2007). In this study, all the four participants received the baseline at the same week in a classroom in their schools. Each participant was give one worksheet containing five word problems each time. There were two to three times of baseline sessions were conducted in each week and every time the participants received different worksheets. Standard procedures were used for worksheet administration and scoring.

Intervention or Treatment. The SSBI was used to teach students to solve word problems individually two to three times a week. In SSBI, students do not need to learn problem types as in the previous studies (Jitendra & Hoff, 1996; García, Jiménez, & Hess, 2006; Xin & Zhang, 2009; Jitendra, George, Sood, & Price, 2010). A schema was taught to students for solving all problem types. Specifically, there were four steps in this simplified SBI. During Step 1, students were instructed to read the word problem out loud a couple of times to identify the following components of the problem, the larger number, the smaller number, the unknown number, and the label of interest. In addition, students were asked to rephrase the word problems to the experimenter in their own words. In Step 2, students were taught to fill the diagram in the order that the larger number in the first box, the smaller number in the second box, the unknown number in the box behind the equation, and the label in the parenthesis at the end of diagram:

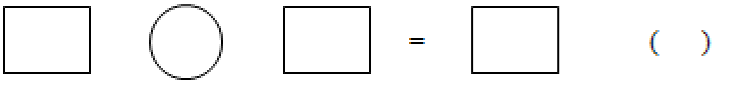

Figure 1. *SSBI equation diagram.*

During the third step, students were taught to decide the operation of choice. Students were taught that if the total or the sum of two numbers is unknown, addition is the choice of operation; however, if the total is known and the problem is to find one of the smaller numbers; or if the difference between two numbers is asked for, subtraction is required to solve the problem. Then, students were instructed to read the problem again to make a choice of operation. At last, students were required to solve the equation and check the answer. After the student was certain that the solution is correct, he or she would retell the solved problem to the primary investigator using the result to replace the unknown (e.g., Lucy has 12 cookies, she gave 3 to her little sister, and now she has 9 cookies left). Verbal praise was provided for correct responses and corrective feedback for incorrect responses during the entire phase. One worksheet containing five word problems were taught in each session. Following instruction, students were asked to solve the same five problems independently. The problems were administered and scored in the same manner as in the baseline. Accuracy percentages were calculated and recorded for data collection purpose.

When the stable or increasing performance have been observed for the first the participant, the intervention is applied to another participant who has a steady responding or decreasing performance in baseline phase, and so on (Cooper, Heron, & Heward, 2007).

Maintenance. Maintenance of learned skills was evaluated one month after the termination of the intervention. During the maintenance phase, participants were asked to complete one worksheet containing five word problems. The probes used in the maintenance stage were similar to the probes used during the previous phases. Worksheets were administered in the same manner as in baseline. Only one maintenance session was conducted per week and the maintenance phase continued for four weeks. In total, there were four worksheets completed by each participant. The probes used in the maintenance phase were graded in the same fashion as in previous phases.

Data Analysis

The data were analyzed by visual inspection of students' accuracy percentages on word problem worksheets across all experimental phases (baseline, intervention, and maintenance). Data analysis included the evaluation of level, trend, and variability. During the visual inspection, each data point was compared with the previous point to see if there is descending, ascending or equal trends existed. Additionally, the data points' level and variability were also considered. The level of data points means the data intervals and the data variability means the data ranges. In addition, considering the effect size emphasizes the size of the difference rather than confounding this with sample size and the small sample size and the limited data points collected in each phase in this study, the F test and Cohen's d were both calculated to analyze the differences between the data from the baseline and the maintenance phases. In order to find out the Effect sizes the magnitude of the SSBI intervention in this study from baseline phase to the maintenance phase, the F test and Cohen's d were used in this study. These two tests can help the investigators understand the size of the experimental effect.

Results

Screening Tests

The screening test was conducted prior to the baseline. Students' oral reading fluency was measured as an indicator of their reading competency (Fuchs, Fuchs, & Hosp, 2001). CBM reading and computation probes were administered using standardized CBM procedures. The median of the three scores were used to determine if the student met the criteria of possessing reading and computation skills at their grade level. The CBM standards in reading and computation fluency were listed below: In total, eight students were screened, but only four students demonstrated they mastered prerequisite reading and computation skills. The four participants' scores are listed in Table 1.

Table 1
CBM Standards of Reading Fluency

Grades	Level	CWPM	ICWPM	Comprehension (%)
	Frustrational	<40	>4	80
1-2	Instructional	40-60	4 or less	80
	Mastery	60+	2	80

Note, Adapted from Deno & Mirkin (1977).

Table 2
CBM Standards of Computation Fluency

Grade Level	Level	CDM	IDPM
	Frustrational	0-9	8+
1-3	Instructional	10-19	3-7
	Mastery	20+	2 or less

Note, Adapted from Deno & Mirkin (1977).

Table 3
Screening Results

Name	Reading (median) (Correct Word Per Minute)	Computation (median) (Digits Correct Per Minute)
Participant A	50	22
Participant B	55	18
Participant C	56	18
Participant D	57	10

After the screening test, the baseline was introduced to those four participants, followed by the intervention and maintenance phases. The results of all three phases of the four participants' performance reported individually like case studies. The results include students' word problem solving accuracy data in baseline, intervention and maintenance phases. The results of F test and Cohen's d were reported individually later.

Baseline, Intervention and Maintenance Phases

Participant A. Figure 1 illustrates Participant A's performance during the three phases. Participant A's scores ranged from 16% to 84% during baseline with an average score of 53.3%. A decreasing trend was observed during the baseline phase. Participant A was the first student to enter the intervention (Cooper, Heron, & Heward, 2007).

During the intervention phase, Participant A received seven sessions. Participant A's scores ranged from 84% to 100% with a mean score of 96.6%. There was slight variability during in the intervention phase, but scores remained at a very high level and showed increase at the end.

The maintenance phase was conducted one month later after the intervention. Participant A's scores ranged from 72% to 100% with an average score of 89%.

Because $F < F_{crit}$ (8.34 < 9.55) and *p value > a (.06> 0.05)*, the null hypothesis saying that there was no difference between the data from the baseline phase and the maintenance phase was not rejected. Thus, there was no significant improvement for Participant A from the baseline phase to the maintenance phase (Figure 2).

The Cohen's *d* = -1.38 was also calculated to analyze the effect size between the baseline and the maintenance.

The trained graduate student regarded 35.7% (five worksheets) of all the worksheets in three phases. The average score of IOA (Inter-Observer Agreement) is 94%.

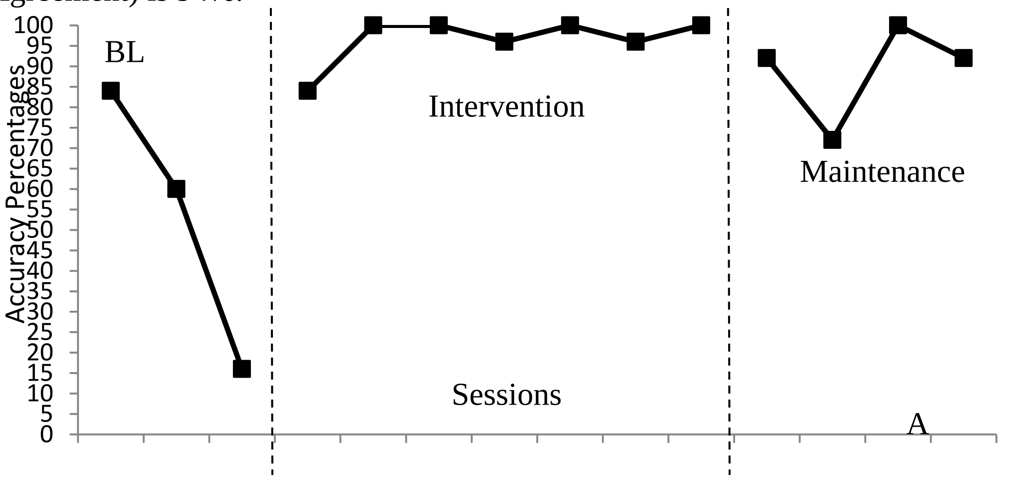

Figure 2. *Results in all phases for participant A.*

F-Test Two-Sample for Variances α 0.05

	BaselineA	*MaintenanceA*	
Mean	53.33333	89	
Variance	1189.333	142.6667	
Observations	3	4	
df	2	3	
F	8.34		
P(F<=f) one-tail	0.060	0.119	Two-tail
F Critical one-tail	9.55	16.04	Two-tail
One-tail	Accept Null Hypothesis because p > 0.05 (Variances are the same)		
Two-tail	Accept Null Hypothesis because p > 0.05 (Variances are the same)		

Figure 3. Results of F-test for participant A.

Participant B. Figure 3 illustrates Participant B's performance during the three phases. Participant B's scores ranged from 0% to 32% during baseline with an average score of 22.9%.

During the intervention phase, Participant B received nine sessions. Participant B's performance was very stable and remained at a high level of 100% during the entire intervention phase.

During the maintenance phase, Participant B's scores ranged from 84% to 92% with an average score of 90%.

Because F > Fcrit (15.24> 8.94) and *p value < a (.002< 0.05)*, the null hypothesis saying that there was no difference between the data from the baseline phase and the maintenance phase was not rejected. Thus, there was significant improvement for Participant B from the baseline phase to the maintenance phase (Figure 4).

The Cohen's *d* = -5.9 was also calculated to analyze the effect size between the baseline and the maintenance.

The trained graduate student regarded 30% (six worksheets) of all the worksheets in three phases. The average score of IOA is 90%.

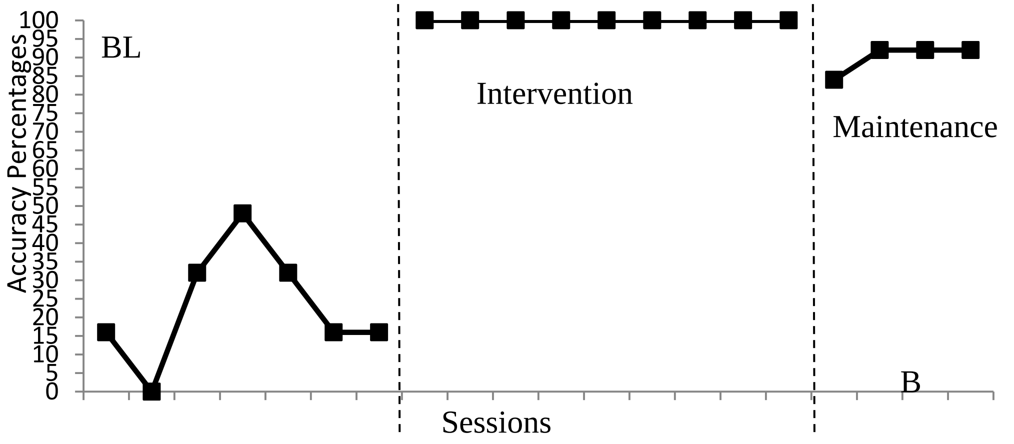

Figure 4. Results in all phases for participant B.

F-Test Two-Sample for Variances α 0.05

	BaselineB	*MaintenanceB*	
Mean	22.85714	90	
Variance	243.8095	16	
Observations	7	4	
df	6	3	
F	15.24		
P(F<=f) one-tail	0.024	0.048	Two-tail
F Critical one-tail	8.94	14.73	Two-tail
One-tail	Reject Null Hypothesis because p < 0.05 (Variances are Different)		
Two-tail	Reject Null Hypothesis because p < 0.05 (Variances are Different)		

Figure 5. Results of F-test for participant.

Participant C. Figure 5 illustrates Participant C's performance during the three phases. Participant C's scores ranged from 16% to 48% in baseline with an average score of 30.2%.

During the intervention phase, Participant C received seven sessions. Participant C's scores ranged from 96% to 100% with a mean score of 99.4%. There was slight variability (within 4%) existed, but it remained at a very high level during the entire intervention phase.

Maintenance phase was conducted one month later after the intervention. Participant C's scores ranged from 92% to 100%. The average score for Participant C during the maintenance phase was 96%.

Because F < Fcrit (8.67 < 8.85) and *p value > a (.051> 0.05)*, the null hypothesis saying that there was no difference between the data from the baseline phase and the maintenance phase was not rejected. Therefore there was no significant improvement for Participant C from the baseline phase to the maintenance phase (Figure 6).

The Cohen's *d* = -9.16 was also calculated to analyze the effect size between the baseline and the maintenance.

The trained graduate student regarded 30% (six worksheets) of all the worksheets in three phases. The average score of IOA is 95%.

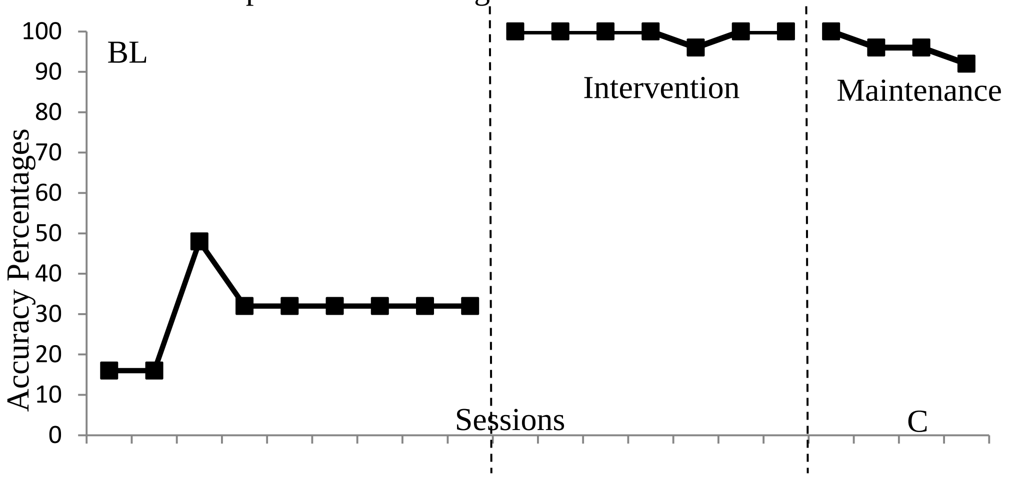

Figure 6. Results in all phases for participant C.

F-Test Two-Sample for Variances α 0.05

	BaselineC	MaintenanceC	
Mean	30.22222	96	
Variance	92.44444	10.66667	
Observations	9	4	
df	8	3	
F	8.67		
P(F<=f) one-tail	0.051	0.103	Two-tail
F Critical one-tail	8.85	14.54	Two-tail
One-tail	Accept Null Hypothesis because p > 0.05 (Variances are the same)		
Two-tail	Accept Null Hypothesis because p > 0.05 (Variances are the same)		

Figure 7. Results of F-test for participant C.

Participant D. Figure 7 illustrates Participant D's performance during all three phases. Participant D's scores ranged from 46% to 60% during the baseline with an average score of 53.7%.

During the intervention phase, after Participant D received four sessions, the researchers found that there is stable trend at a high level of accuracy in word problem solving. Thus the intervention was terminated after the participant completed seven sessions. Participant D's scores ranged from 96% to 100% with a mean score of 98%. There was slight variability (within 4%) existed, but it remained at a very high level with an increasing trend during the entire intervention phase.

During the maintenance phase, Participant D's scores ranged from 84% to 100%. The average score for Participant D during the maintenance phase was 92%.

Because F < Fcrit (1.24< 8.76) and *p value > a (.483> 0.05)*, the null hypothesis was not rejected. Therefore, there was no significant improvement for Participant D from the baseline phase to the maintenance phase (Figure 8).

The Cohen's *d* = -3.92 was also calculated to analyze the effect size between the baseline and the maintenance.

The trained graduate student regarded 30% (five worksheets) of all the worksheets in three phases. The average score of IOA is 90%.

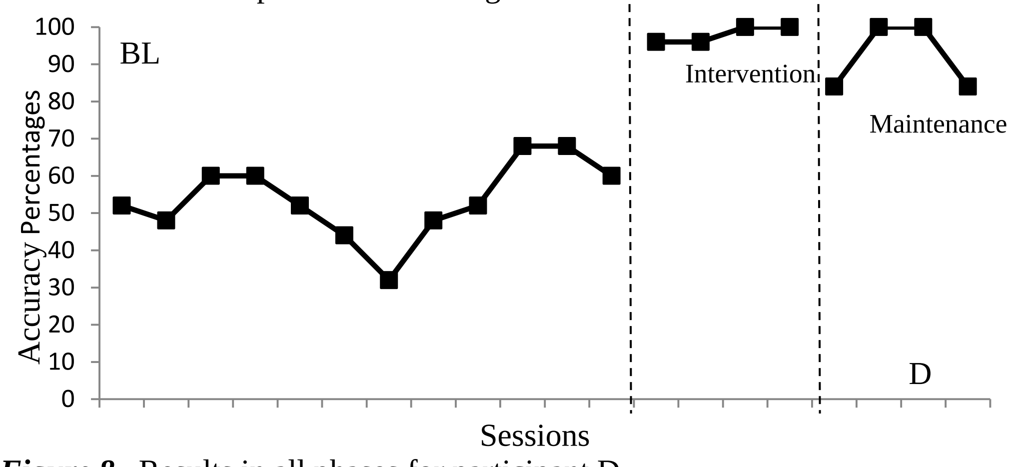

Figure 8. Results in all phases for participant D.

F-Test Two-Sample for Variances α 0.05

	BaselineD	MaintenanceD	
Mean	53.66667	92	
Variance	106.0606	85.33333	
Observations	12	4	
df	11	3	
F	1.24		
P(F<=f) one-tail	0.483	0.966	Two-tail
F Critical one-tail	8.76	14.37	Two-tail
One-tail	Accept Null Hypothesis because p > 0.05 (Variances are the same)		
Two-tail	Accept Null Hypothesis because p > 0.05 (Variances are the same)		

Figure 9. Results of F-test for participant D.

Summaries. As illustrated in Figure 9, it is clear that all the participants' performance in word problem solving immediately increased during the intervention. It is highly likely that the intervention was the only contribution to the effects rather than other factors (Richards, Taylor, Ramasamy, & Richards, 1999). Even three out of four participants did not show significant improvement from baseline phases to maintenance phases, the values of Cohen's *d* demonstrated that there were very strong relationships between these two groups of data. This is another evidence of a strong treatment effect. Researchers also found that participants remained SSBI skills at a high level during maintenance phases (92% on average). Therefore, SSBI cannot only help students with their word problem solving, but also can be mastered by students.

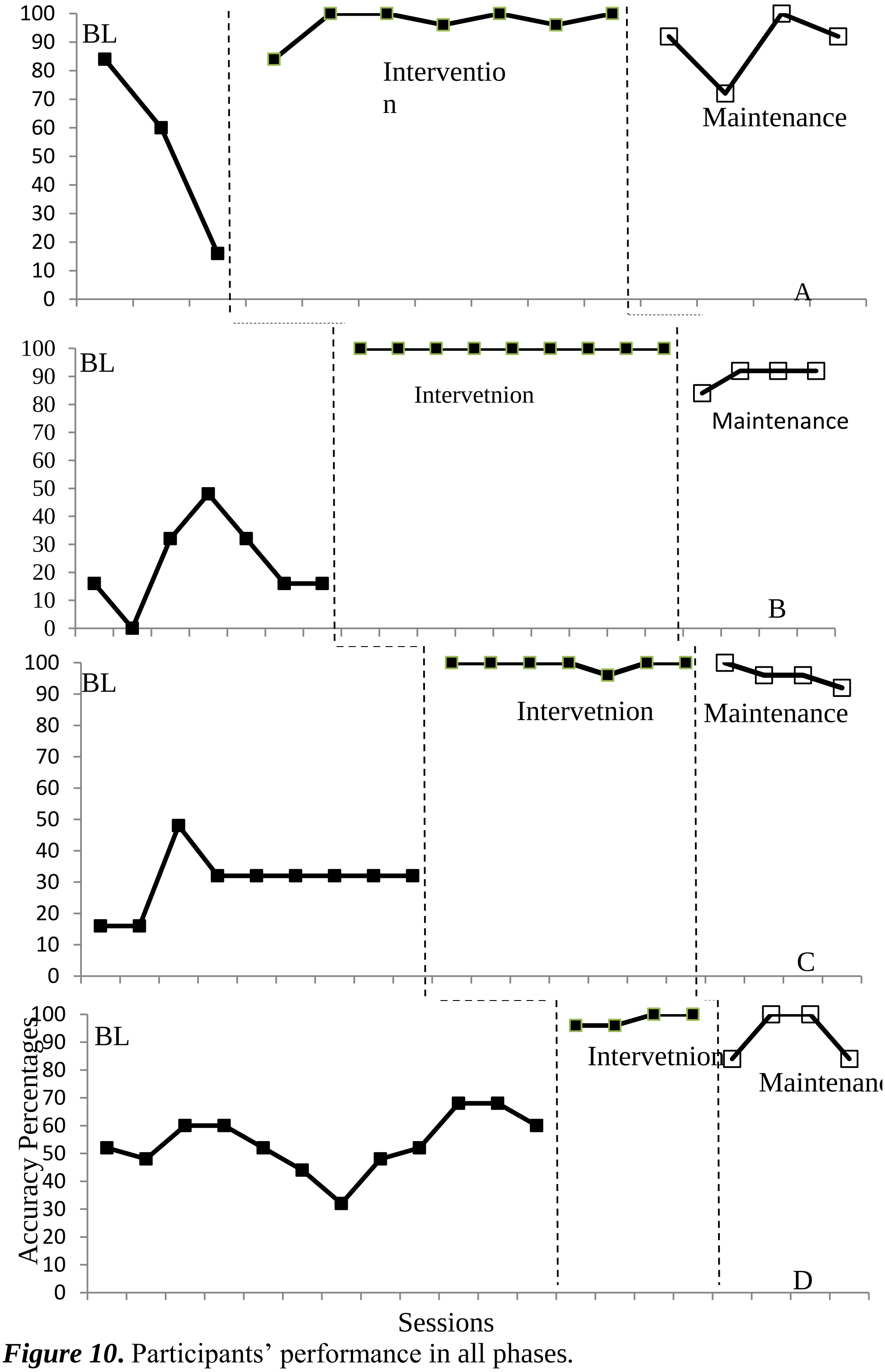

Figure 10. Participants' performance in all phases.

Inter-Observer Agreement and Treatment Integrity

Inter-Observer Agreement (IOA) Training Data. The graduate student and the primary investigator Graded Three same worksheets independently to collect IOA data. The percentages of the agreement were 95%, 100%, and 90% with an average of 95%. Therefore, only one training session was conducted. The IOA data were reported individually above.

The results of this study are encouraging. In general, the results evidenced that the SSBI is effectiveness in the second grade with the students who are at risk in word problem solving. The results also indicated that the SSBI can also be maintained among those participants. These findings provide support to the use of SSBI in the second grade in general education. The following chapter discussed the students' performance individually and more detailed.

Discussion

The purposes of this research project were to test the effectiveness of the SSBI method in word problem solving at the second grade level, to verify the effectiveness of SSBI for students in general education, and third, to investigate if participants can maintain the SSBI strategy over time after the intervention. Consistent with previous studies (De Corte et al., 1996; Fuchs et al., 2004; Jitendra & Hoff, 1996; Jitendra et al., 2005, 2010), the results of this study demonstrated the effectiveness of SSBI strategy in which students did not need to categorize one-step addition and subtraction word problems. Performance on each session of mathematical word problems for all students improved successfully after the SSBI was implemented. In addition the participants maintained the SSBI skills successfully after the intervention was completed. The positive results of SSBI in this study extended the Schema-based Instruction strategy from special education into general education. Therefore, SSBI is effective for students at risk of failure and/or general education students who lack basic word problem solving skills (Kouba, Brown, Carpenter, Lindquist, Silver, & Swafford, 1988).

The three research questions were all answered in this study. First, because the SSBI is a simplified SBI, it was important to test its effectiveness, especially for the beginning learners. The results of this study illustrated the effectiveness of SSBI in word problem solving at Grade Two level. Second, the majority of previous SBI studies were conducted with students in special education (De Corte et al., 1996; Jitendra & Hoff, 1996; Jitendra et al., 2005, 2010). The investigators of this study intended to test and verify the effectiveness of SSBI in general education. The results of this study demonstrated that SSBI was effective in improving students' word problem solving in general education settings. Third, the word problems for maintenance were novel word problems with similar difficulty level. The results indicated that participants not only maintained the SSBI strategy in word problem solving, but also generalized their learned skills to those novel word problems.

The success of the SSBI in this project will be attributed to several factors. First, in order for students have the prerequisite skills of reading and computation, the screening test was implemented first. The investigator could exclude the other factors which could not be solved in this project, such as their poor reading skills and/or computation skills.

Second, the SSBI was effective in this study. Mathematical problems solving can be difficult for students, especially, for lower grade elementary students who are also beginners in this area (Lester, 1980). The results of this study supported that SSBI was effective to those lower graders. In addition, the results of this study also demonstrated the effectiveness to the participants who are at risk of failure in mathematical word problem solving and/or lack basic word problem-solving skills (Kouba et al., 1988) at the second grade level. Four participants' skills in word problem solving were all improved from the baseline phase to the maintenance phase (Figures 9), especially, all the participants remained a very high percentage (close to 100% averagely) level during the intervention phase.

Third, the participants in this study not only gained the SSBI skills in solving word problem, but also maintained the skills with high percentage accuracy from 72% to 100% with an average score of 92%. Even though the probes used during the maintenance phase were at similar difficulty level with the probes used in previous phases, the maintenance probes were all novel problems. Therefore, students also demonstrated the skills of generalizing the SSBI to those novel problems. That is SSBI helped students broaden their schema in word problem solving (Jitendra & Hoff, 1996).

Fourth, this study replicated the findings of some of the previous studies that the subtraction word problems are harder than addition word problems (Cawley, Parmar, Yan, & Miller, 1998; Jitendra et al., 2005; Neef et al., 2003). The difficulties of solving subtraction word problems remained among almost all of the elementary students. In this study, students' performances in solving one-step addition and subtraction word problems were improved using SSBI. The improvement can be observed from the differences of percentages. Therefore, in this study, the values of Cohen's d were all large enough to demonstrate a very strong difference between the baseline phase to the maintenance phase for all the participants. These improvements from all the participants were higher than many previous studies (De Corte et al., 1996; Fuchs et al., 2004; Jitendra & Hoff, 1996; Jitendra et al., 2005, 2010; Neef et al., 2003).

With respect to future research in word problem solving, the results of the present study suggest the following directions. There are some good models that are effective in other areas, peer tutoring, for example. Those models might also be effective in word problem solving using SSBI. Further, considering the limited external validity of this study, it is necessary to test if this strategy is still effective in the third grade. In special education, other methods may be employed to test the effectiveness of SSBI on a large sample of students.

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Appendix
EXAMPLE OF WORD PROBLEM WORKSHEET

Name____________________Date__________________

Note________________

1. Tom has 10 books. Tom gave his sister 3 books. How many books does Tom have now?
2. Lee has 10 bags. His sister gave him 8 bags. How many bags does he have now?
3. Tom had 11 blocks. He gave Paul 7 blocks. How many blocks does Tom have now?
4. Scot has 14 cups. His sister gave him 3 more cups. How many cups does Scot have now?
5. Sidd has 12 bags. His brother takes away 8 of his bags. How many bags does Sidd have now?

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