Investigation of the Interest-Based Method and Mathematical Word Problem Solving Skills Among Middle School Students with Learning Disabilities in Inclusive Classrooms

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Abstract

This study examined the effects of two training methods (interest-based and traditional) used to improve math word problem performance of middle school students with and without learning disabilities, as measured by the Herr Scale of Mathematical Word Problem Solving Situations. Students were randomly assigned to one of the two treatment groups: the interest-based method or the traditional method. Significant treatment group main effects were found in math word problem performance of students with learning disabilities. Results indicated students with learning disabilities in the interest-based method had higher posttest scores compared to students with learning disabilities in the traditional method. In addition, the posttest scores of students with learning disabilities in the interest-based method were similar to the posttest scores of students without learning disabilities. However, there were no significant differences in the posttest scores of students without disabilities between the treatment groups. Curriculum implications were addressed.

Keywords: interest-based training, word problems, learning disabilities

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Considerable research suggests that students with disabilities solve word problems differently than students without disabilities (Smith, 1986; Edeh & Hickson, 2002; Fuchs, Fuchs & Prentice, 2004). Problem solving is the ability to generate a wide variety of potential strategies, the ability to evaluate probable consequences of each strategy, and the ability to plan a logical sequence for implementing useful strategies (Edeh & Hickson, 2002). Problem solving skills are important in mathematics when solving word problems. According to Rubio and Valle (2004), numerical exploration is useful in solving algebraic-arithmetic word problems and is important for a student's success in problem solving. Furthermore, Xin, Wiles and Lin (2008) suggest that successful problem solvers are able to identify the mathematical content in detail when presented with word problems, while those who struggle with solving word problems can only identify surface related information and not the mathematical content.

Mathematical Word Problems

Kong and Orosco (2016) conclude that students struggle with word problems for various reasons beyond procedural or calculation challenges. Further, Kong and Orosco outline the progress that has been made in helping students with math difficulties, a segment of the student population, which continues to face challenges. It is known that students with high incidence disabilities, such as a learning disability, struggle with solving word problems (Edeh & Hickson, 2002; Edeh, 2006; Sullivan & Bal, 2013). Several studies (Kavale & Forness, 1999; Mathur, Kavale, Quinn, Forness, & Ruther-ford, 1998 & Edeh, 2006) showcase how the traditional method has not consistently helped students with high-incidence disabilities. Therefore, alternative strategies are needed to help them in solving word problems and be successful in their math classes.

Garderen (2007) found that alternative strategies, such as the use of diagrams, have been successful in teaching students with learning disabilities at the middle school level in solving one

and two-step word problems. Furthermore, students were able to transfer this strategy as they attempted to solve math word problems. Fuchs, Compton, Fuchs, Hollenbeck, Craddock, and Hamlett (2008) found positive outcomes when students used schema-based practices to solve algebraic problems situations. Such an approach (providing alternative problem solving strategies) proved to be more effective than those modeled during basic algebraic instructional practices.

Learning Disabilities

Learning Disabilities (LD) are neurobiological disorders that affect the basic processes in understanding spoken or written language. Students with LD are characteristically poor problem solvers. According to Montage, Ender and Dietz (2011), students with LD typically lack knowledge of problem solving processes, especially those needed for representing problems. Students with LD, tend to abandon previously learned effective strategies and replace them with ineffective strategies. As a result, they do not generalize the effective strategies across domains. Students with LD tend to utilize poor cognitive strategies when attempting to solve mathematical problems and, therefore, need instruction in alternative strategies when solving math word problems. In order for this to be effective, teachers need to understand how to incorporate students' interests in their instruction to help "maximize learning and the retention of the information learned" (Edeh, 2006, p.166). In using an interest-based method, students are more apt to understand the strategy, internalize it, and use it across domains.

Theoretical Framework for the Present Study

Dewey's theoretical concepts (1938) of recognizing children's interests in the educational environment paved the way for the interest-based approach to teaching. Dewey (1938) asserted that students learn best when they are interested in the subject matter and that teachers should adjust instruction to support student interests. Using this framework, Edeh (2006) found

significant gain in students' posttest scores for self-generated independent problem solving skills of students who were taught using the interest-based method compared to students who were taught using the traditional method. The three-month follow-up of her study also showed that students in the interest-based method retained their gain. Here, an interest-based method offered an effective cognitive strategy purposed to hold the attention of students with LD and keep them engaged in the activities (Edeh, 2006).

We know that students with LD tend to utilize poor cognitive strategies when attempting to solve mathematical problems. In addition, we also know that students with LD tend to be poor problem solvers, as they tend to abandon previously learned effective strategies and replace them with ineffective strategies. As a result, they do not generalize the effective strategies across domains. Therefore, Edeh (2006) contended that the interest-based teaching method will help in maximizing the retention of the information learned.

Interest-Based Method and Students with LD

Montage, Ender and Dietz (2011) state that cognitive strategy instruction has been effective in improving problem solving performance of students with LD. The intent of using the interest-based method is to provide additional cognitive strategy instruction to students with LD that would help them to process the math word problems, facilitate learning, and improve their overall math performance. Math word problems, as traditionally presented in lessons, appear unrealistic and in isolation to students with LD. When these students perceive activities as unrealistic, they tend to give up trying. However, when these concepts are woven through interest-based activities, students tend to be more invested because of the relevancy of the activities to their experience (Edeh, 2006).

The interest-based method, as defined in Edeh (2006), is the training method that allows for a student's input. Through this method, teachers incorporate and infuse diverse students'

interests in their teaching to make learning relevant to all students. Interest-based materials are the teaching materials that are created using students' actual identified interests.

The current study was designed to examine the effects of two training methods (interest-based and traditional) in improving math word problem performance of seventh grade middle school students with and without learning disabilities. With the interest-based method, math word problems are re-written using students' interests. For example, the word problem, "Stuart bought a sweater on sale for 30% off the original price and another 25% off the discounted price. If the original price of the sweater was $30, what was the final price of the sweater?" was re-written using a student's interest as, "Your friend bought a video game on sale for 30% off the original price and another 25% off the discounted price. If the original price of the video game was $30, what was the final price of the video game?" As seen from the above example, "Stuart" was changed to "Your friend" and "sweater" to "video game" to account for student interest and engagement. The process of solving this word problem and its solution are the same. However, the wording for the interest-based is more relevant to the students with this interest. Table 1: *Sample of Herr Scale of Mathematical Word Problem Soliving Situations* shows samples of both traditional and interest-based math word problems.

Method

Participants

One public middle school with two seventh grade math classes consisting of 41 students (combined) in both classes participated in this study. Data was collected in both seventh grade classrooms. One classroom used the interest-based method and the second classroom used the traditional method. Parents/guardians of the students were notified and they provided informed consent. Identification of gender and ethnicity were not of salient importance to this study, and this information was not included.

Both classes were considered to be inclusive classrooms where at least 20% of the students in each classroom had an IEP. The participants were between the ages 12 and 13 years with one student who was age 14 at the time of this study (this student had repeated a grade prior to middle school). Both female teachers in the participating classrooms gave consent and participated in the study.

There were 21 participants in the interest-based treatment group, of which 5 participants were diagnosed with LD, and 20 participants in the traditional treatment group, of which 4 participants were diagnosed with LD. There were 9 students, total in both treatment groups, with LD.

Seventh grade was chosen as the focus of this study for several reasons. In this particular district, seventh grade is the first year of middle school (elementary school is through sixth grade). Typically, when students transition between levels (elementary to middle school or middle to high school), schools and teachers have little information about students beyond their transcript (and IEP if they have one). Teachers have few preconceived ideas about students because they often do not know them and often have little information about their academic accomplishment and their interests. Such was the case with the seventh grade classes selected for this study. The teachers entered this study with little knowledge of their students' interests. Therefore, the teachers engaged in this study were starting the interest-based method from the very beginning of initially investigating and learning about their students' interests which could then potentially be incorporated into the word problems. Likewise, the students in this study (both regular education and special education) had not experienced math instruction at the elementary level that was focused to their interests. This made for an optimal sampling of subjects who were all experiencing the interest-based method for the first time.

Seventh grade was also chosen because math instruction begins to become more complex

at this point, beyond basic arithmetic, with the introduction of algebraic concepts. In the experience of the authors, it is at this point that student interest is most likely to wane, achievement suffers as does mastery of objectives, and consequently student feelings toward math can become less favorable and they become less engaged. This is especially true for students with learning disabilities. Therefore, a new approach to engaging students and focusing their attention in more complex word problems is needed. The authors hypothesized that the interest-based method would meet the needs of students with learning disabilities, enable their engagement, and improve their performance given these unique circumstances.

Design

A 2 x 2 ANOVA for pretest scores was used to reveal any significant differences among the treatment groups. Analysis of covariance (ANCOVA) was used to compare the effects of training on the participants' problem performance. The ANCOVA included the posttest scores as the dependent variables and the pretest scores as covariates.

Materials

The materials for this study included participants' school records, IEPs for those with LD, Herr Scale of Mathematical Word Problem Solving Situations, the participating teachers' training materials, and interest-based materials created for participants.

Procedure

Interest-based materials were created for participants in the interest-based classroom using their actual identified interest(s) during the first meeting and after the pretest was completed. Every student, in the interest-based classroom was given a piece of paper with the instructions, "Write two or three favorite activities (things) you like to do for fun, either in school or outside of school." Each participant wrote what she or he liked to do for fun and these interests were grouped into three categories, sports, video games, and music, which represented

the items provided by the students. Afterward, the math word problems that the teacher collected from the textbook were re-written using at least one each student's identified interests as shown in Table 1.

Table 1

Sample Herr Scale of Mathematical Word Problem Solving Situations

Traditional mathematical word problems	Interest-based mathematical word problems
1. Stuart bought a sweater on sale for 30% off the original price and another 25% off the discounted price. If the original price of the sweater was $30, what was the final price of the sweater?	1. Your friend bought a video game on sale for 30% off the original price and another 25% off the discounted price. If the original price of the video game was $30, what was the final price of the video game?
2. In a school, 50% of the students are younger than 10, 1/20 are 10 years old and 1/10 are older than 10 but younger than 12, the remaining 70 students are 12 years or older. How many students are 10 years old?	2. In your elementary school, 50% of the students are younger than 10, 1/20 are 10 years old and 1/10 are older than 10 but younger than 12, the remaining 70 students are 12 years or older. How many students are 10 years old?
3. A car is traveling 75 kilometers per hour. How many meters does the car travel in one minute?	3. One of your parents is driving you and your friends to your track and field game. Your car is traveling at 75 kilometers per hour. How many meters does the car travel in one minute?

Training of the Examiners

One of the two teachers who participated in the study was trained, by the researcher, on how to re-write math word problems using students' interests. The examiner was instructed not to change her teaching style, but only to use students' interests for examples when teaching. The examiner participated in a mock teaching, using students' interests, as part of her training. The second teacher did not receive any training. Both teachers were instructed not to share their teaching materials during the four-week period when the interest-based materials were used for teaching.

Data Collection

Participants in both classes (interest-based and traditional methods) each received a total of four weeks of instruction on math word problems in their respective classrooms. The interest-based materials (re-wording of the math word problems using students' identified interests) were used in the teaching of the participants in the interest-based class, but not for the participants in the traditional class.

Before instruction began, the participants in both classes were pretested. Then, they completed four weeks instruction of a math word problems unit and took the posttest right after the instruction. Both the pretest and posttest questions were based on the content of the math word problems that students were required to learn. Though questions in both pre and post tests were identical, the order of questions were changed and questions for students in the interest-based class were re-worded using students' actual interests for the one class.

Results

Means and standard deviations (SDs) of participants' pretest and posttest scores by treatment groups are presented in Table 2*: Means and Standard Deviations (SDs) of Participants' Pretest and Posttest Scores by Treatment and Categories*. A 2 x 2 ANOVA for pretest scores failed to reveal any significant differences among the treatment groups.

Posttest scores for math word problem performances were analyzed using a 2 (treatment groups) x 2 (categories) ANCOVA. Treatment groups (interest-based vs. traditional) and categories (students with LD vs. students without LD) were the between-subject factors. Analysis of covariance was used to compare the effects of training on participants' math word problem performance. The analysis of covariance included the posttest scores as the dependent variables and the pretest scores as covariates.

Math Word Problem Solving Performance

The 2 (treatment groups) x 2 (categories) analysis of covariance (ANCOVA) on posttest scores yielded a significant treatment group main effects for math word problem performance $F(2, 67) = 59.135$, $p<.010$. Overall, the participants with LD in the interest-based group generated accurate responses on math word problem $F(2,65) = 29.374$, $p<.021$) on posttest compared to participants with LD in the traditional method group. However, there were no significant differences between participants without LD on posttest scores in either treatment groups. See Table 2 below.

Table 2

Means and Standard Deviations (SDs) of Participants' Pretest and Posttest Scores by Treatment and Categories

	Pretest				Posttest			
	With LD		Without LD		With LD		Without LD	
Treatment	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*
Interest-Based	9.25	1.39	24.85	3.01	46.45	4.24	48.63	2.21
Traditional	9.61	1.15	23.92	2.54	29.87	4.94	47.22	3.71

Note: There were 21 participants in the interest-based treatment group, of which 5 participants were diagnosed with LD and 20 participants in the traditional treatment group, of which 4 participants were diagnosed with LD. There were 9 students, total in both treatment groups with LD. Maximum score = 50.

Discussion

The main findings of the study are discussed in terms of training effects and curriculum implications.

Training Effects

Performance differences were evident in participants' math word problem performance as a result of teachers participating in the interest-based method training. The results of this study

indicated that students with LD who participated in the interest-based instruction performed significantly higher on the posttest than the students with LD in the traditional-based instruction. The performance of the participants in the interest-based group is in alignment with Garderen (2007) who found that alternative strategies have been successful in teaching students with learning disabilities at the middle school level in solving one and two-step word problems. Furthermore, the findings in this study support Dewey's theoretical concepts that when students' interests are utilized in instruction, students' performance improves (Dewey, 1938). In addition, the findings in this study also support the suggestion by Scribner and Cole (1981) of how appropriate usage of tools may structure how "someone handles cognitive opportunities" (p. 64). Progress has been made in utilizing different strategies to help students who learn differently; therefore, using the interest-based method provides another form of strategy for students with LD in processing the math word problems, facilitating learning, and improving their performance.

Students With and Without LD

Though there were no significant performance differences in pretest scores among students with LD in both treatment groups (Table 2), there were significant performance differences in posttest scores. In addition, there were no significant performance differences among students with LD and students without LD after the training, even though there were significant differences during the pretest performance (Table 2). The performance gap between students with and without LD during the pretest was minimized for those in the interest-based method, however, the performance gap still existed between students with and without LD in the traditional method after the posttest. Therefore, it is appropriate to suggest that some of the performance deficits of students with LD during the pretest and posttest for students in the traditional group may be as a result of their perception of the unrealistic (problems for which they have difficulties connecting) aspect of the traditional method. However, when students are

taught with relevant materials, the significant differences between students with and without LD seemed to diminish (Edeh, 2006).

Curriculum Implications

The results of the current study show the benefit of including the students' actual interests in the teaching process. The literature review for this study shows that the professionals agree that there is a great need for developing alternative teaching strategies for students with LD in order to help them learn to their maximum potential. As Dewey (1938) pointed out, "the traditional curriculum undoubtedly entailed rigid regimentation and a discipline that ignored the capacities and interests of child nature" (p.10). An interest-based method allows for students' input. This process allows for incorporation and infusion of diverse interests into the teaching materials and makes the information relevant.

An important curriculum implication is the potential of the interest-based method to minimize the performance gap between students with LD and students without LD. One of the purposes of education is to equip students with needed strategies to be successful in life. The performance gap between students with LD and those without is due, in part, to poor utilization of cognitive strategies in solving mathematical problems. However, educators can maximize their learning by incorporating students' actual interests in the teaching materials.

The distinguished teacher will provide opportunities for students to engage in writing their own word problems based on their unique interests. This type of practice aligns well with the Danielson (2013) *Framework for Teaching*, which is utilized in many states as a basis for teacher evaluation. The framework describes that, "The teacher's explanation of content is thorough and clear, developing conceptual understanding through clear scaffolding and connecting with students' interests" (p. 57) and, "the teacher seizes an opportunity to enhance learning, building on a spontaneous event or students' interests" (p. 79).

Students can also be encouraged to not just be receivers of information, but leaders of their own learning. Students could create their own word problems or problems for peers based on interest. Students could complete their own problems or exchange problems with peers. This, too, is supported by Danielson (2013) who describes distinguished practice where, "There is evidence of some student initiation of inquiry and student contributions to the exploration of important content; students may serve as resources for one another" (p. 69) and "Students formulate many questions, initiate topics, challenge one another's thinking, and make unsolicited contributions. Students themselves ensure that all voices are heard in the discussion" (p. 63). Interest-based method is not difficult to learn and teachers can be trained during one of the in-service trainings before the beginning of the school year.

Similarly, there are also implications for textbooks. Operating outside of the usual box of teaching requires a paradigm change. Therefore, in addition to providing word problems for students to complete, texts could provide opportunities for students to write their own word problems, or even write word problems for peers, based on interest. The text could set the parameters of the problem, what must be included, and then encourage the students to write word problems based on topics that interest them. This approach of the student creating and writing word problems is well supported in standards which call for students to be leaders of their own learning.

Limitations of this Study

The limitations of this study include a small sample size and frame. There were 41 students and 2 teachers representing 2 classrooms. It is possible that a larger sample size would have different findings. Additionally, the age of the students was limited to 12 and 13 years old. It is possible that students at a different age could respond differently to the interest-based method; they could potentially respond even more favorably or less favorably. Future studies

that have a larger sample size and wider range of ages hold promise in yielding results that are generalizable to a greater population.

Future studies could also focus on classrooms with an even greater special education population. The sample size in this study was at least 20% of the students had an IEP. Perhaps the results could be different in classrooms with a greater percentage of students with IEPS or significantly less IEPs. Additionally, this subject pool was quite homogenous in terms of race and socio-economic background. Future studies with more varied populations could focus to explore student response to the interest-based method disaggregated to student demographic patterns.

Conclusion

Students in this study with learning disabilities responded favorably to word problems with texts that aligned to their interest. Notably, their posttest performance showed measurable gains over their pretest performance and their posttest performance was comparable to students without learning disabilities. While further studies could investigate a larger population, this small study shows hope for the interest-based method of teaching math word problems to engage and improve the performance of students with learning disabilities.

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