Spring 5-4-2015

The Influence of Personalized Mathematical Word Problems on Second Graders' Performance, Attitudes Toward Word Problems, and Difficulty Ratings

Brianna D'Agata

The Influence of Personalized Mathematical Word Problems on Second Graders' Performance, Attitudes Toward Word Problems, and Difficulty Ratings

Brianna M. D'Agata

University of Mary Washington

Abstract

This study seeks to investigate the effects of personalization in mathematical word problems compared to non-personalized, textbook word problems. Students have been found to perform higher on word problems when students' names and interests are included in the context (Hart, 1996). In addition, personalized word problems have been rated easier to solve and preferred over textbook word problems (Ku & Sullivan, 2002). In the present study, differences between personalized and non-personalized word problems were examined in subgroups of mathematical and reading levels. Interest Survey information was used to personalize or replace the context of textbook word problems, while leaving the same numeric values and required operations. Second graders received either a non-personalized or personalized word problem each morning. Word problems were counterbalanced so that a word problem and its counterpart were administered at least two weeks apart. Results indicated that the personalization of word problems improved students' performance, perceived difficulty ratings, and attitudes toward word problems. However, differences between non-personalized and personalized word problems were not statistically significant.

The Influence of Personalized Mathematical Word Problems on Second Graders' Performance, Attitudes Toward Word Problems, and Difficulty Ratings

Word problems or story problems in mathematics are especially difficult to solve for students in the primary grade levels (Ku & Sullivan, 2002). There are various explanations for why word problems are so challenging for young students. One reason that lower elementary students solve mathematical word problems incorrectly is that they have less experience working with word problems than upper elementary and secondary students (Bates & Wiests, 2004). Studies indicate that when new mathematical information is introduced, students try to connect this new material to knowledge they have already learned (Witeck & Ennis, 2007). Students in the lower primary grades do not have as much mathematical background knowledge as those in the older elementary grade levels. Therefore, it is more difficult for younger students to transfer the problems into mathematical operations that are necessary for finding solutions (Ku & Sullivan, 2007).

Another explanation for difficulty with mathematical word problems is that children tend to have low motivation. Solving formal word problems is not an activity students are typically engaged in doing outside of school. This is because word problems, especially textbook word problems, are not interesting to children and do not motivate them to want to find solutions (Ku, Harter, Liu, Thompson, & Cheng, 2007).

The context of mathematical word problems are typically irrelevant to the students solving them, which makes word problems more difficult to comprehend and un-motivating to work out (Bates & Wiests, 2004). Students need to be able to apply the context of word problems to situations in their environment (Witeck & Ennis, 2007). When students can relate to the

context of the word problem, they can find solutions more easily and avoid cognitive load. In other words, familiar information decreases the amount of new or irrelevant knowledge students have to comprehend to solve a word problem correctly (Ku & Sullivan, 2002).

An instructional technique for solving word problems known as personalization can be used to alleviate the difficulty with solving mathematical word problems. When conventional or textbook word problems are personalized, the original context from the problem is replaced by students' personal information (Bates & Wiests, 2004). The context of a personalized word problem may include familiar names of students or school staff members, students' interests, and humor (Hart, 1996). By integrating relevant background information into word problems, students are more motivated to find solutions and better able to integrate new knowledge into existing mathematical understandings (Bates & Wiest, 2004; Hart, 1996).

Word Problem Types and Language

The mathematical operation required for proper solution in a word problem does not necessarily relate to or affect the amount of difficulty children may have in solving the problem. Instead, word problem types are what determine challenges with mathematical word problems. Word problems that require the same operation for correct solutions are not always identical in difficulty (Chapin & Chapin, 2001; Stern, 1993).

Types of word problems for middle elementary students involving the mathematical operations of addition or subtraction include Join, Separate, Part-Part-Whole, and Compare problems. The chart below provides word problem examples for each type of word problem.

Type of Word Problem	Example
Join	Bob had 2 rocks. He picked up 3 more rocks. How many rocks did Bob have now? (2+3=__)
Separate	Bella had 7 lollipops. She ate 4 of them. How many lollipops does Bella have left? (7-4=__)
Part-Part-Whole	Mrs. Smith's class has 15 students and Mrs. Myer's class has

	16 students. How many students are there total? (15+16=__)
Compare	Emma has 6 sisters. Jake has 2 less sisters than Emma. How many sisters does Jake have? (6-2=__)

In addition, these types of word problems can each be altered so that the part of the equation missing or the question being asked in word problem differs. For Join and Separate problems, the question may ask the problem solver to determine the Result Unknown (ex. 5+2=__), Change Unknown (ex. 5+__=7), and Start Unknown (ex. ___+2=7). For Part-Part-Whole problems, the problem solver may need to find the Whole Unknown (ex. 5+4=__) or One Part Unknown (ex. 5+__=9). For Compare problems, there are Difference Unknown (ex. 5-3=__ or 3+__=5), Larger Quantity Unknown (ex. 4+6=__), and Smaller Quantity Unknown (ex. __+2=6 or 6-__=2) [Chapin & Chapin, 2001].

Finally, the language of word problems can confuse children and make problem solving difficult. It is useful for students to pay attention to the key words in word problems for selecting the correct operation such as *more* suggesting to use addition and *fewer* suggesting to use subtraction. However, relying on these terms will not lead to accurate solutions (Stern, 1993). Comparison word problems have been found to be the most challenging mathematical word problem types for children because the key words in the context do not always accurately direct one to select the correct mathematical operation (Chapin & Chapin, 2001; d'Ailly, 1997). The example below demonstrates this challenge with some Comparison word problems:

Jenn has 6 footballs. Ben has 12 footballs. Ben has how many more footballs than Jenn? Solution: 12-6=__ or 12+__=6

Performance

Personalization, or differentiating the context so that it provides relevant and meaningful information to students has been shown to lead to students' improved success on word problems (Hart, 1996). A researcher studying the effectiveness of personalized mathematics problems gave 6th grade boys and girls either textbook or personalized word problems, which were altered each week. The personalized word problems consisted of the same numbers and same mathematical operations as the textbook problems. However, unlike the textbook word problems, the context of the personalized word problems included humor and teachers' or students' names that were relevant to the students' school (Hart, 1996). Results indicated students' performance increased when given the personalized word problems compared to the textbook word problems. Personalizing the context of the word problems by considering students' interests made comprehension no longer an obstacle and allowed students to create mental representations necessary for correctly solving word problems (Hart, 1996).

There is an abundance of research supporting the idea that 3rd, 4th, 5th, and 6th grade students' performance on mathematical word problems is higher when the contexts of the word problems are personalized (Ku & Sullivan, 2002). One technique improving students' performance on mathematical word problems is known as self-referencing. Referring to the self in word problems is one effective method to tap into students' past experiences (d'Ailly, Simpson, & Mackinnon, 1997). The researchers of a study selected word problems from mathematics textbooks. Instead of changing the original characters' names to the names of third, fourth, and fifth grade subjects, they replaced these names with the word "you". Inserting "you" into word problems decreased the cognitive load on students' working memory, making problem solving easier to accurately solve. In addition, students asked for the self-referenced word problems to be repeated less often than the non-self-referenced word problem. Incorporating

self-referenced word problems into mathematical instruction encouraged students to understand the information faster and more easily, and therefore solve with higher accuracy (Bates & Wiests, 2004; d'Ailly, et al., 1997).

Personalization influences higher performance on mathematical word problems for individual students, as well as groups of students (Lopez, 1990). In one study, word problems were personalized using three different treatments: individual, group, and non-personalized. The nouns and pronouns in the word problems for the individualized treatment were personalized based on individual students' interests and biographical information. The group treatment recognized the majority of students' most favorable places, people and objects. Students in the individual and group treatments performed significantly higher on a post-test consisting of personalized word problems than did students in the non-personalized treatment (Lopez, 1990).

Attitudes and Motivation

Although many children struggle solving word problems, they usually find personalized word problems more interesting and easier to solve than conventional word problems. Including background information or context in word problems that is relevant to children's lives and experiences reduces their cognitive load, making problem solving less challenging (Ku & Sullivan, 2002). When word problems are easier to solve, children generally have more positive attitudes towards them. They, therefore, exercise greater effort and motivation towards solving personalized word problems (Hart, 1996; Ku & Sullivan, 2002). Children have better attitudes towards personalized word problems as opposed to non-personalized word problems, favoring them because of the humor and familiarity of objects and people involved (Hart, 1996).

Personalized word problems have been rated easier for students to solve and have increased students' motivation and attitudes toward mathematics (Ku, et al., 2007). Ku and

colleagues (2007), surveyed 136 fourth graders on their favorite foods, sports, stores and other categories before using that information to create personalized word problems. Half of the students received personalized math instruction, while the other half received non-personalized instruction. Not only did the students in the personalized instruction group have significantly more positive attitudes toward the math program, but they also thought these word problems were much easier to solve than the non-personalized word problems (Ku et al., 2007). The personalized word problems were more enjoyable to read, easier to comprehend, and motivating to solve (Ku et al., 2007).

Comprehension of Word Problems

Some of the difficulty with solving word problems can be attributed to miscomprehension of unfamiliar language. These challenges can be seen where children are instructed to retell a story problem or word problem. It is unlikely and unrealistic for a child to be able to retell a word problem verbatim. In the mind, memorization of an entire word problem surpasses the capacity of the working memory. The improbable ability to do so requires comprehension for accurate word problem retelling (Stern, 1993).

One study found that children who were able to recall word problems correctly were also more capable of using the appropriate strategies to solve these problems correctly (Cummins, Kintsch, Reusser, & Weimer, 1988). For example, understanding word problems' essential components for problem solving led to accurate solutions. Likewise, when children miscomprehended a word problem and weren't able to retell the word problem accurately, they usually solved that problem based on their misunderstanding of the information. The researchers called these solution errors because they were accurate solutions for the miscomprehended word problems, but inaccurate solutions for correctly comprehended word problems. In other words,

the solution was always accurate based on what was comprehended, but the word problems were not always comprehended successfully (Cummins, et al., 1988).

Two distinct comprehension strategies for word problems have been explored in past research (Hegarty, Mayer, & Monk, 1995). Researchers have described the direct translation approach as a comprehension strategy where children perform computations for word problems first and think about the content of word problem later (Stigler, Lee, Stevenson, & 1990). When students use the direct translation technique, they usually rely on key relational information in the problem statement to determine arithmetic operations such as "less" meaning subtraction or "more" meaning addition. Students who rely on this method typically demonstrate a procedural approach focusing on the numerical values or operation when solving as opposed to conceptualizing the problem's situation (Hegarty, et al., 1995).

Hegarty and colleagues (1995) describe the problem model method as a more meaningful approach for comprehension that successful problem solvers use. Students who comprehend using the problem model approach create a mental model of the problem's situation to support solutions to word problems. Students who use the problem model approach comprehend better than others due to the qualitative representations they use to describe the problem, rather than numbers and keywords the direct translation students would use. These successful problem solvers are more likely to be able to describe the situation in a problem, but are less likely to forget keywords than unsuccessful problem solvers, even when making recall errors (Hegarty, et al., 1995).

Mental and Visual Representations

Personalizing mathematical word problems facilitates students in creating mental representations or mental images. This is due to the individualized content of the word problems

being more interesting to students and easier to comprehend (Hart, 1996). In other words, personalized content makes word problems easier for students to imagine in their mind. Students are better able to visualize the pictures of the recognizable people, places, and objects in the personalized story problem before drawing this mental image on paper (Davis-Dorsey, Ross, & Morrison, 1991).

Drawing pictures for solving word problems enhances students' verbal and written explanations, as well as displays their logic for solving the problem (O'Connell & O'Connell, 2007). This is usually the first strategy elementary students learn and demonstrate when solving mathematical word problems. It is a useful aspect of solving word problems because it allows children to express solutions however they would like and at a very young age (O'Connell & O'Connell, 2007).

Pictorial representations are an effective way students can decide to display their thinking by drawing pictures. When primary students solve word problems, they typically draw pictorial representations. When students have a deep understanding of pictorial representations and are given opportunities to connect mathematics to their lives, such as with personalized word problems, implications exist. Their pictorial representations may also display associations to the word problems, or in other words, demonstrate their conceptual understanding of the personalized word problem (Davis-Dorsey, et al., 1991; Witeck & Ennis, 2007). Mastering the ability to draw pictorial representations is a hope all educators have for their primary students (Witeck & Ennis, 2007).

Present Study

Research has shown that students are more motivated and perform better on personalized mathematical word problems than non-personalized word problems. Furthermore, students are

more capable of comprehending personalized word problems due to the meaningfulness of the text in those word problems (Davis-Dorsey, et al., 1991). However, few studies until the present one have examined the effects of personalization in the lower elementary grades. The present study aims to investigate whether personalized word problems aid in second graders' mathematical performance in solving word problems, perceived difficulty, and attitudes toward word problems.

A variety of subgroups will be examined for the purpose of this study. Past research examining higher-ability mathematics students verses lower-ability mathematics students, found that higher mathematics level students had more positive attitudes toward the personalized word problems (Ku & Sullivan, 2002). However, both levels of mathematics students benefited from personalized word problems (Ku, et al., 2007). In addition to mathematics levels (high, average, and low), reading levels (high and low) will also be examined.

This study seeks to add new knowledge to the field of mathematics education through examination of personalized word problems for 2nd grade students. The current study addresses the following research questions with regard to second grade students:

1) How does a student's ability to correctly solve personalized word problems compare to their ability to solve non-personalized, textbook word problems?
2) How do personalized verses non-personalized mathematical word problems influence students' attitudes and perceived level of difficulty ratings toward solving mathematical word problems?
3) Considering the above questions, what differences exist between high, average, and low mathematics students, as well as high verses low reading students?

Method

Participants

This study was conducted in a title I public elementary school in Northern Virginia. The participants included 23 students ages 7 or 8 years old from one of the four 2nd grade classrooms in the elementary school. All of the students had to give assent and consent to make up the actual research population. There were ten students from the second grade class who were eligible for free or reduced lunches and thirteen who were not. Fifteen of the students in the classroom were Caucasian/White (five males and ten females). Five of the students in the class were African American/Black (four males and one female), two were Hispanic (males), and one male was of mixed race.

The research questions from this study about personalized verses non-personalized word problems were examined across reading levels (high and low) and mathematics levels (high, average, and low). Students' results from PALS, a state-wide literacy examination in Virginia, were used to group students into a low or high reading level (PALS: Phonological Awareness Literacy Screening, 2007). Specifically, the exam assesses word knowledge and oral reading abilities. Students in the low reading group read at a kindergarten to high 1st grade reading level. Students in the high reading level read at a 2nd grade to 5th grade reading level. The low reading group consisted of eleven students (four males and seven females). There were twelve students in the high reading level group (eight males and four females).

Mathematics levels were determined by part of a mathematical hiding assessment on identifying missing parts of numbers with models (Math Perspectives, 2011). There were five students considered having low mathematical abilities (one male and four females). The average mathematics group included nine students (six males and three females). The high mathematics level included nine students (five males and four females).

Materials and Procedure

Prior to the study, parental or guardian consent letters were sent home for parents to sign if they granted their child permission to participate in this study (Appendix A). Student assent letters were read to students in class, asking them to participate in this study (Appendix B). Participation in this study was voluntary; therefore, students could decline participation if they or their parents chose to. Once consent and assent was given, the students took a 20-item survey to determine their personal interests (Appendix C). The survey included items such as favorite hobbies, sports, foods, etc. The results from the survey were used to personalize the textbook word problems found in one of the school's second grade mathematics textbook, *Envision Math* (Charles, et al., 2012). Textbook word problems were selected and used as non-personalized word problems in this study. Personalized versions of these textbook word problems included the same numerical values and required the same mathematical computations for problem solving as the non-personalized word problems. However, the context of these word problems was personalized to include students' interests and names, humor, self-referencing, and relevance to students' school. Non-personalized, textbook word problems and personalized word problems can be viewed in Appendix D.

The study was conducted in the students' classroom after the students had morning meeting. Students were assigned an ID code that they record on all of their work and materials for this study. During the five weeks of this study, students completed one word problem for morning work, four days a week. Students received either a personalized word problem or a non-personalized, textbook word problem. The order in which students were given personalized and non-personalized word problems was randomized each week. The word problems were counterbalanced so that a word problem and its counterpart were administered at least two weeks

apart. This eliminated the possibility for students to detect two different versions of the same word problem and then be able to solve them based on that finding.

A graphic organizer was created so that each word problem would be formatted the same on a worksheet, followed by the same set of instructions (Appendix E). For each word problem, the students had to write and solve the mathematical equation, show their work through drawings, and explain their answer. Then they rated each word problems' level of difficulty, along with their attitude toward the word problem using a smiley scale. A frown face rating would mean the word problem was very difficult or they did not like the word problem. A smiley face rating would mean the student really enjoyed the word problem or thought it was easy to solve. Students' ratings, along with their solutions were examined using a rubric I created (Appendix F). The rubric was designed to make detailed notes and comparisons of students' solutions for each textbook word problem and its personalized version. The students' solutions were examined for accuracy in order to assess students' achievement on personalized verses non-personalized word problems. If equations and solutions were difficult to interpret or examine, students were asked to verbally explain their solutions to me.

Results

The independent measures were personalized word problems and non-personalized, textbook word problems. The three dependent measures were the second graders' performance solving mathematical word problems, attitudes toward word problems, and perceived difficulty of the word problems. After data collection, numeric codes were assigned to label the variables in an excel workbook. Students' performance data was coded "1" if the word problem was solved correctly or "2" if the word problem was solved incorrectly. Since there were 10 non-personalized word problems and 10 personalized word problems, the maximum possible correct

solutions for each word problem version were 10. The smiley scale that students used to rate their attitude toward each word problem and their level of difficulty solving the word problem were coded "1", "2", or "3". A lower value indicated greater difficulty with or greater dislike toward a word problem and a higher value indicated less difficulty with or more positive attitudes toward a word problem.

A paired-samples t-test was conducted to compare second graders' performance in solving personalized word problems and non-personalized word problems at the .05 significance level. There was not a significant difference in scores for solving personalized word problems (M = 7.61, SD = 2.02) and non-personalized word problems (M = 7.48, SD = 1.73); $t(22) = 0.44$, p = 0.332. Although the means differ, these results suggest that personalization did not significantly affect students performance overall. See Figure G1 for the means of students' performance scores on each word problem version.

A series of paired t-tests were conducted to examine differences in performance between personalized and non-personalized word problems for mathematics groups (high, average, low) and reading groups (high, low). The low reading group had significantly lower scores than the high reading group on the non-personalized word problems. Therefore, students in each reading group (high and low) were assigned appropriately for the purposes of this study. Students in the low reading group did not score significantly higher on personalized word problems (M = 7.09, SD = 2.34) compared to non-personalized word problems (M = 6.73, SD = 1.90); $t(10) = 0.71$, p = 0.246. Students in the high reading group did not perform significantly higher on the personalized word problems (M = 7.9, SD = 1.62) compared to the non-personalized word problems (M = 8.17, SD = 1.27); $t(11) = -0.25$, p = 0.404. Although neither reading group performed significantly better on the personalized word problems, the low reading group did

perform higher on the personalized word problems than on the non-personalized word problems. Contrary, the high reading group performed slightly higher on the non-personalized word problems than the personalized word problems.

There were no significant differences in performance between personalized and non-personalized word problems for any of the mathematics groups (high, average, low). Although students in the low mathematics group performed higher on the personalized word problems (*M* = 6.8, *SD* = 2.95) compared to the non-personalized word problems (*M* = 6.2, *SD* = 2.39), differences were not significant; $t(4) = 0.88$, $p = 0.213$. There were no significant differences in scores between non-personalized word problems (*M* = 7.11, *SD* = 1.36) and personalized word problems (*M* = 7, *SD* = 1.66) for the average mathematics group; $t(8) = -0.24$, $p = 0.407$. The high mathematics group did not perform significantly higher on the personalized word problems (M = 8.67, SD = 1.41) compared to the non-personalized word problems (M = 8.56, SD = 1.01); $t(8) = 0.22$, $p = 0.417$. The high group performed significantly better than the low group (p = .011) and average group (p = .010) on the non-personalized word problems. However, there were no differences between the average and low mathematics groups for performance on non-personalized word problems, indicating a smaller gap in abilities between the average and low mathematics groups than the average and high mathematics groups. See Figure H1 for the mean performance scores on word problem versions among mathematical and reading subgroups.

The mean for students' correct word problem solutions on non-personalized word problems (*M* = 7.45) out of a maximum of 10 was relatively high, leaving less room for improvement on the personalized word problems. Examining students' mean of correct solutions on each textbook word problem, I selected the five most difficult non-personalized word problems and their counterparts to run a paired t-test. (The non-personalized word problems and

their counterpart, personalized word problems included word problems B, D, E, F, H, 2, 4, 5, 6, and 8.) The maximum correct solutions was therefore 5. Findings indicated no significant differences between the more challenging non-personalized word problems (M = 3.22, SD = 1.31) and the personalized word problems (*M* = 3.52, *SD* = 1.44); *t*(22) = 1.194, *p* = 0.123. Although performance was not significantly higher on the personalized word problems than the non-personalized word problems, there was a greater improvement on the personalized word problem when examining the five most difficult word problems.

The most difficult non-personalized word problems were examined further to investigate each subgroups performance on the non-personalized and personalized word problems. The high reading group demonstrated no significant improvement on the personalized most difficult word problems (*M* = 3.75, *SD* = 1.22) compared to the non-personalized most difficult word problems (*M* = 3.83, *SD* = 1.03); *t*(11) = -0.32, *p* = 0.378. There were no differences in correct scores between the most difficult personalized (*M* = 3.27, *SD* = 1.68) and most difficult non-personalized word problems (*M* = 2.55, *SD* = 1.29) for the low reading group either; *t*(10) = 1.70, *p* = 0.060. The high mathematics group did not perform significantly better on the most difficult personalized word problems (*M* = 2.89, *SD* = 0.87) compared to the most difficult non-personalized word problems (*M* = 3.11, *SD* = 1); *t*(8) = 1.15, *p* = 0.141). Likewise, the average mathematics group did not perform significantly better on the most difficult personalized word problems (*M* = 4.33, *SD* = 1.36) compared to the most difficult non-personalized word problems (*M* = 4, *SD* = 1.17); *t*(8) = -0.48, *p* = 0.323. Conversely, the low mathematics group performed significantly better on the most difficult word problems when they were personalized (*M* = 3.2, *SD* = 1.92), as opposed to non-personalized (*M* = 2, *SD* = 1.22); *t*(4) = 2.45, *p* = 0.035. When the word problem was more difficult, personalization had a positive impact on the students in the

low mathematics group. See Figure I1 for the mean performance scores on the five most difficult word problems for the low reading and low mathematics subgroup.

There were ten questions of each word problem version with a difficulty scale of 1 to 3. Therefore, rating all ten questions as being easy to solve would give a score of 3 x 10 = 30. Although students rated the personalized word problems (M = 26.52, SD = 3.87) easier to solve than the non-personalized word problems (M = 25.78, SD = 4.35), a paired t-test indicated no significant differences at the .05 significance level between word problem versions, $t(22) = 1.55$, $p = 0.067$. See Figure J1 for the mean sum of students' perceived difficulty ratings of word problem versions.

The high reading group did not rate the personalized word problems (M = 26.67, SD = 3.68) easier to solve than the non-personalized word problems (M = 26.5, SD = 4.06); $t(11) = 0.27$, $p = 0.395$. Similarly, the low reading group had no significant differences for difficulty ratings on personalized (M = 26.18, SD = 4.49) and non-personalized word problems (M = 25, SD = 4.71); $t(10) = 1.57$, $p = 0.072$. Although students in both reading groups felt the personalized word problems were easier, they did not rate non-personalized word problems to be significantly more difficult than personalized word problems.

There were no significant differences in difficulty ratings between personalized word problems and non-personalized word problems for mathematics groups. The low mathematics group did not find the personalized word problems (M = 24.4 SD = 4.93) to be significantly easier than the non-personalized word problems (M = 23.2, SD = 5.54); $t(4) = 1.63$, $p = 0.089$. The average mathematics group did not rate personalized word problems (M = 26.25, SD = 3.88) to be easier than the non-personalized word problems, $t(8) = 0.88$, $p = 0.201$. In addition, there was no significant differences in difficulty ratings for the high mathematics group rating

personalized (M = 27.67, SD = 3.12) and non-personalized word problems (M = 26.89, SD = 3.55); $t(8) = 0.72$, $p = 0.245$. See Figure K1 for the mean sum of perceived difficulty ratings on word problem versions among mathematical and reading subgroups.

There were no significant differences in attitude ratings between personalized word problems (M = 24.87, SD = 3.92) and non-personalized word problems (M = 24.35, SD = 4.33) at the .05 significance level, $t(22) = 1.14$, $p = 0.133$. Similar to the difficulty rating scale, the attitude scale was 1 to 3 with the maximum likeability score for 10 questions being 30. The high reading group did not have significantly higher attitudes towards personalized word problems (M = 25.58, SD = 3.80) compared to non-personalized word problems (M = 25.50, SD = 3.78); $t(11) = 0.15$, $p = 0.443$. The low reading group did not have higher attitude ratings toward solving personalized word problems (M = 24.09, SD = 4.09) than non-personalized word problems (M = 23.09, SD = 4.72); $t(10) = 1.38$, $p = 0.099$. Although each reading group rated liking the personalized word problems more than the non-personalized word problems, the differences were not significant. See Figure L1 for the mean sum of students' attitudes toward word problem versions.

There were no significant differences between attitude ratings of personalized and non-personalized word problems for mathematical groups. Students in the low mathematics group did not like the personalized word problems (M = 21.60, SD = 3.51) more than non-personalized word problems (M = 20.4, SD = 3.21); $t(4) = 1.12$, $p = 0.162$. The average mathematical group had no significant differences in attitude ratings between the personalized word problems (M = 26.44, SD = 3.32) and non-personalized word problems (M = 26.56, SD = 3.68); $t(8) = -0.23$, p = 0.412. The students in the average mathematics group liked solving the non-personalized word problems slightly more, although there was no significance. The high mathematics group did not

have significantly more positive attitudes toward personalized word problems (M =25.11, SD =3.95) than non-personalized word problems (M = 24.33, SD = 4.21); $t(8) = 0.86$, $p = 0.209$. Although the low and high mathematics groups rated liking the personalized word problems more than the non-personalized word problems, these differences in attitudes did not differ significantly between word problem versions. See Figure M1 for the mean sum of students' attitudes toward word problem versions among mathematical and reading subgroups.

Discussion

The results from the study indicated the personalization of word problems improved students' performance, lessened the degree of difficulty perceived, and increased the likeability of personalized word problems. Consistent with past research, adding relevance to students' lives through personalization not only increased students' attitudes toward word problems, but also eased their ability to solve the word problems (Hart, 1996; Ku & Sullivan, 2002).

Consistent with previous studies, the students performed better on the personalized word problems compared to the non-personalized word problems (Hart, 1996). However, this finding lacked significance. One reason for the lack of statistical significance could be that the textbook word problems selected for the study were not challenging enough to solve. Students performed what would be considered "average" in most school systems on the non-personalized word problems. Averaging about 75% correct solutions on non-personalized word problems may have been too high of a score to have made a significant difference on personalized word problems. In other words, the students did not have a lot of room for improvement or growth on the personalized word problems.

This limitation may have contributed to the lack of statistical significance of performance scores across mathematics groups and reading levels. There was less improvement on

personalized word problems for the high mathematics group and no improvement on personalized word problems for the average mathematics group and high reading group. Past research has found an increase in performance on personalized two-step word problems, but not on personalized one-step word problems (López & Sullivan, 1992). The difference in performance on personalized word problems compared to non-personalized word problems was largest for both the low reading and low mathematics groups. This suggests that personalization is more essential for solving more challenging word problems (López & Sullivan, 1992).

Another explanation for the lack of statistical significance for performance between personalized and non-personalized word problems could be justified by students' age. Second graders have had less experience solving textbook word problems than upper elementary students. Therefore, they may have more difficulty selecting correct operations and problem solving strategies for different word problems (Davis-Dorsey, Ross, & Morrison, 1991).

Analyzing the most difficult non-personalized word problems based on the word problems with the most incorrect scores yielded the greatest improvement on the personalized counterpart word problems. Lopez's study (1990) found that personalization significantly affected students' performance, but only on the more challenging mathematical word problems. This could explain why the low mathematics group was the only subgroup that performed significantly better on the difficult word problems when they were personalized. The difficult textbook word problems in this study were most challenging for the low mathematics group, but may have not been challenging enough for the other subgroups to improve. This would suggest that the personalized word problems made problem solving easier and more enjoyable for the students who struggle most in mathematics (Lopez, 1990).

Although there was no significance, the second grade class as a whole, as well as each mathematics and reading group rated the personalized word problems to be easier than the textbook word problems. By including information in the word problems that was relevant to students' lives and past experiences, students were able to comprehend the personalized word problems better, making problem solving less difficult (Ku & Sullivan, 2002).

Lacking word problems with greater difficulty was a flaw in the study that may have also resulted in the students' perceived difficulty ratings to have no significant differences between word problem versions (personalized and non-personalized). In combination, the low sensitivity of the smiley scale may have also impacted ratings. Including a smiley scale with more than three faces may have made the differences in difficulty between personalized and non-personalized word problems more apparent.

Easier word problems required students to add a two-digit number, for example, to a one-digit number in order to find the unknown sum. Solving more challenging word problems would have consisted of using various ways to subtract a two-digit number from another two-digit number. This range in level of difficulty, along with the lack of challenging textbook word problems, could have prevented students from performing significantly better on personalized word problems than non-personalized word problems.

Supporting past research, personalization adds familiarity and relevance to students' lives. Relating the context of word problems to students' interests and background information can reduce cognitive load (Bates & Wiests, 2004). This might explain why the high reading group and most noticeably the low reading group perceived the personalized word problems to be less difficult than the non-personalized word problems. When students could connect to the

information in the word problem, comprehension and problem solving were easier (Bates & Wiests, 2004).

Each mathematics subgroup rated the personalized word problems to be less difficult. Incorporating students' names and interests into the word problems may have facilitated students in creating representations in their mind more easily than for the textbook word problems (Hart, 1996). Possibly due to the limitation of including relatively simple word problems, the differences between word problem versions were minimal among the higher mathematical level. The lower mathematics group had a greater opportunity for performance improvement from the non-personalized to the personalized word problems; however, the impact of personalization wasn't positive enough for significance.

One reason difficulty ratings did not differ significantly between non-personalized and personalized word problems overall, and between subgroups is because of the students' age. When it comes to completing assignments or work, second graders tend to be perfectionists. They dread making mistakes and dislike being given challenges in their learning (Wilson, 2010). Supporting the literature about second graders need for success, most of the students in this study rated non-personalized word problems as easy to solve, even if their solutions were incorrect (Wilson, 2010). In other words, students may have perceived the difficulty ratings "very difficult" and "somewhat difficult" as imperfections in their ability to solve word problems, thus, answering the difficulty question dishonestly. This could explain why there were no significant differences between word problem versions, as well as no varying differences in perceived difficulty between word problems in general.

With regard to attitude, and although not significant, students overall and within each subgroup enjoyed solving the personalized word problems more than the non-personalized word

problems. Similar to Hart's study (1996), students in this study could connect to the personalized information because of relevance to their lives. Story problems with relatable information, were not only comprehended more easily, but were also liked more than textbook word problems (Ku & Sullivan, 2002). In addition, the low reading and low mathematics groups found the personalized word problems to be the most favorable to solve with the largest difference in attitude between word problem versions. Furthermore, this is consistent with the previous finding that personalization has a greater impact on students' performance when word problems are more difficult to solve (López & Sullivan, 1992). If textbook word problems were generally more difficult to solve or comprehend for the lower mathematics and reading students, then word problems of interest to students would make them easier to solve. When word problems are easier to solve, they are much more enjoyable to solve (Hart, 1996).

Reasons for the lack of statistical significance in attitude ratings between word problem versions may be similar to explanations for not having statistically significant difficulty ratings. Second graders' need to be accurate, could relate to students' need to please adults (Wilson, 2010). Although students used ID codes and gave me their completed word problem in folders, they may have rated more positive attitudes toward all word problems just to please me.

Another flaw leading to the lack of statistical significant attitude ratings could be in my personalization technique for second graders. Research has found second graders to have diverse interests or likes and dislikes (Wilson, 2010). Therefore, even the personalized word problems may have not been altered to each student's individual interests. The purpose of the "My Favorite Things" survey was to gather students' interests to personalize textbook word problems for the class. However, I may have not personalized the word problems enough. For example, if

15 of the students wrote “soccer” as their favorite sport, personalizing a word problem to be about soccer would only differentiate 15 out of 23 of the students in the class.

Second graders tend to be self-focused in the classroom, especially when it comes to their different interests (Wilson, 2010). Seeing other classmates’ names in the personalized word problems may have created a sense of dislike toward the word problem. This may be especially true since second graders tend to change friendships regularly (Wilson, 2010). When students solved personalized word problems that included interests different from their own, they may have not enjoyed the personalized word problems any more than the textbook word problems. If the personalized word problems lacked individualized information for each second grader, then these word problems may have been perceived as just another textbook word problem and liked about the same.

Future studies should examine how personalization can affect second grade students’ performance on word problems that are often the most difficult to solve. Past studies have found that students perform better on personalized word problems than on non-personalized word problems, especially when presented with more challenging word problems (López & Sullivan, 1992). However, the impact of personalization on students’ performance using comparison word problems has not yet been explored in the second grade. Comparison word problems tend to be the most difficult for students to solve because of the intricate language that sometimes directs students to solve using an incorrect operation (Chapin & Chapin, 2001; d’Ailly, 1997). Results from future studies could examine second graders’ ability to solve comparison word problems, given that they have less experience solving story problems and may not rely on key words in the problem to select an operation (Bates & Wiests, 2004).

Future studies should also investigate how personalization affects students' explanations for solving word problems. Elementary school students are new to writing, especially for mathematical purposes. Communicating through writing in mathematics is challenging for primary students because it forces students to record their thoughts and ideas. This may be simple task for recording ideas on personal interests; however, this is not an easy task when students are told to record ideas about newly learned mathematical skills (O'Connell & O'Connell, 2007). Hence, personalizing mathematical instruction based on students' interests may make writing more enjoyable for students and easier to express (Hart, 1996; O'Connell & O'Connell, 2007).

Despite the limitations in this study, previous research suggests that personalization significantly affects students' ability to solve word problems correctly (Ku & Sullivan, 2002). Adding to existing literature, results from the current study found greater performance, more positive attitudes, and less difficulty with solving personalized word problems compared to non-personalized word problems (Hart, 1996). Inside the classroom, teachers should use personalization techniques to differentiate and relate academic content to students' lives. If personalized word problems motivate students and are easier to solve, it would seem rational to incorporate them into the mathematics classroom. Personalization, especially among the more mathematically challenged lower elementary grade students may improve performance, instill confidence, and promote positive attitudes toward word problems.

References

Bates, E. T. & Wiest, L. R. (2004). Impact of personalization of mathematical word problems on student performance. *Mathematics Educator*, *14*(2), 17-26.

Chapin, S. & Johnson, A. (2001). Addition and subtraction. In *Math matters: understanding the math you teach. grades K-6*. Sausalito, CA: Math Solutions Publications. Retrieved from http://www.learner.org/courses/learningmath/number/pdfs/session4/a_s_1.pdf

Charles, R. I., Caldwell, J. H., Cavanagh, M., Chancellor, D., Copley, J. V., Crown, J. V., et al. (2012). *Scott Foresman-Addison Wesley envision math: Grade 2*. Glenview, IL: Pearson Scott Foresman.

Cummins, D. D., Kintsch, W., Reusser, K., & Weimer, R. (1988). The role of understanding in solving word problems. *Cognitive psychology*, *20*(4), 405-438.

Davis-Dorsey, J., Ross, S. M., & Morrison, G. R. (1991). The role of rewording and context personalization in the solving of mathematical word problems. *Journal of Educational Psychology*, *83*(1), 61.

d'Ailly, H. H., Simpson, J., & MacKinnon, G. E. (1997). Where should "you" go in a math compare problem?. *Journal of Educational Psychology*, *89*(3), 562.

Hegarty, M., Mayer, R. E., & Monk, C. A. (1995). Comprehension of arithmetic word problems: A comparison of successful and unsuccessful problem solvers. *Journal of educational psychology*, *87*(1), 18.

Hart, J. M. (1996). The effect of personalized word problems. *Teaching Children Mathematics*, *2*(8), 504-505.

Ku, H. Y., & Sullivan, H. J. (2002). Student performance and attitudes using personalized mathematics instruction. *Educational Technology Research and Development*,

50(1), 21-34.

Ku, H. Y., Harter, C. A., Liu, P. L., Thompson, L., & Cheng, Y. C. (2007). The effects of individually personalized computer-based instructional program on solving mathematics problems. *Computers in Human Behavior*, *23*(3), 1195-1210.

Lopez, C. L. (1990). Personalizing Math Word Problems.

López, C. L., & Sullivan, H. J. (1992). Effect of personalization of instructional context on the achievement and attitudes of Hispanic students. Educational Technology Research & Development, 40 (4), 5–13.

Math perspectives: Teacher development center (2011). Retrieved November 15, 2014 from http://www.mathperspectives.com/amc_anywhere.html

O'Connell, S. & O'Connor, K. (2007). *Introduction to Communication: Grades PreK-2.* The math process standards series. Portsmouth, NH: Heinemann.

PALS: Phonological awareness literacy screening. Retrieved November 15, 2014 from https://pals.virginia.edu/

Stern, E. (1993). What makes certain arithmetic word problems involving the comparison of sets so difficult for children?. *Journal of Educational Psychology*, *85*(1), 7.

Stigler, J. W., Lee, S-Y., & Stevenson, H. W. (1990). *Mathematical knowledge of Japanese, Chinese, and American elementary school children.* Reston, VA: National Council of Teachers of Mathematics.

Wilson, M. (2010). *What every 2nd grade teacher needs to know about setting up and running a classroom*. Retrieved April 19, 2014 from https://www.responsiveclassroom.org/sites/default/files/et2intro.pdf.

Witeck, K. S. & Ennis, B. H. (2007). *Introduction to Representation: Grades PreK-2.* The math

process standards series. Portsmouth, NH: Heinemann.

Appendix A

Consent Letter to Parent/Guardians

Dear Parent or Guardian,

My name is Brianna D'Agata, and I am a student teacher in your child's classroom. I am currently in the University of Mary Washington's graduate program studying to obtain my Master of Science in Elementary Education. A requirement of our program is to conduct an action research study in an area related to our studies. *I am inviting your child to participate in a research study that I am conducting. Involvement in the study is voluntary, so you may choose to have your child participate or not. I am going to explain the study to you.*

I am interested in learning about the effects that personalized mathematical word problems have on students' achievement, perceived difficulty, and attitudes toward word problems compared to non-personalized word problems. I will also be examining this across various subgroups. I will select textbook word problems and change the content so that they are personalized to the class's interests. Personalization includes the use of students' interests, names, humor, self-referencing, and school relevance in word problems. For five weeks as morning work, your child's class will experience both types of word problems, from their mathematics' textbook and personalized word problems. ***This project will be part of your child's work for class and will not require extra work for him or her.***

The confidentiality of your child's work will be ensured. His or her name will not appear in any rubrics for the study because names will be coded. Following the study, all samples of student work I collect will be destroyed. Participation in this project will not affect your child's grade in any way. His or her participation in the study is voluntary, and you have a right to keep your child out of the study. Also, your child is free to stop participating in the study at any time. Your child would still participate in the classroom project, but data for my research will not be collected from him.

My hope for this study is that your child will enjoy solving word problems from my study because they will be personalized to his or her interests. The benefit of this research is that you will be helping me understand the effects of personalizing word problems in mathematics. This study will add to the current body of knowledge on the advantages of personalization on students' performance and attitudes toward mathematics.

If you have any further questions or concerns, please do not hesitate to contact my University Supervisor, Dr. Marie Sheckels (msheckel@umw.edu) or myself (bdagata@mail.umw.edu). Please return this form by January 20, 2014 or ASAP. I look forward to working with you and your student!

Thank you,
Brianna D'Agata

I have read the above letter and give my child, _____, permission to participate in this project.

_____
(Parent/Guardian Signature)

Appendix B

Student Assent Letter

Dear Students,

I am very excited to be your student teacher throughout the spring! For part of our morning work, we will be solving math word problems. I will be collecting your work on these word problems for a research project that I am doing to see how word problem techniques make you feel about word problems in math and how well you perform on them. You will not be graded for your help in my study, and this will not require you to have extra work. The only thing you will do is complete one word problem each morning for a few weeks.

Your parents were given a letter about taking part in this study. If your parents did not allow you to participate in this study, you will not be asked to sign this form. However, if your parents did allow you to participate, I encourage you to participate in this study.

You do not have to be in this study. If you decide not to do this project, no one will be mad at you. Nothing bad will happen if you decide to be a part of this study or not. If you decide to do this project, you can always stop at any point in the project. However, if you decide not to participate, you will still work in groups and complete work that others will do without your work being used in my research. You may ask questions about the study.

If you decide to be in this study, I will keep your information confidential or private. This means that I will not use your names or the name of the school in anything I write and I will not reveal any personal, identifying information about you.

Signing this form means that you have read it or have had it read to you, and that you are willing to be in this study. If at any point you have any questions, please ask me!

Thanks,
Miss D'Agata

I have read or been read the above letter and all of my questions have been answered. I agree to participate in the project.

_____

(Student signature)

Appendix C

Self Interests Survey

My Favorite Things ☺

List your favorite for each!

Color: _____

Game during morning meeting: _____

Subject in school: _____

Animal: _____

Special in school:_____

Candy: _____

Something you do not like about school:_____

Something you love about school: _____

Dessert: _____

Sport:_____

Classroom job: _____

Food: _____

Breakfast food: _____

Hobby:_____

Shade the Smiley you agree with

Recess: ☹ 😐 ☺	Bugs: ☹ 😐 ☺
School lunches: ☹ 😐 ☺	Bridge Ball: ☹ 😐 ☺
Reading books: ☹ 😐 ☺	Movies: ☹ 😐 ☺

Appendix D

Word Problem Versions

Non-personalized, Textbook Word Problems	Personalized Word Problems
Cindy has 27 toy planes. She buys 12 more. How many toy planes does Cindy have now?	You ate 27 chicken nuggets for lunch. Then you ate 12 more. How many chicken nuggets did you eat in all?
Robin made 34 rings. She sold 20 of them. How many rings does Robin have now?	Ms. Carnette made 34 pizzas. She gave 20 of them to her class. How many pizzas does Ms. Carnette have now?
Brett has 38 postcards. He mails 10 of them. How many postcards does Brett have left?	Sidney brought 38 hot pink pigs to school. She gave 10 of them to Alessa. How many hot pink pigs does Sidney have now?
There are 50 states in the United States. Sandra knows the names of 32 states. How many more names does she have to learn to know them all?	Solomon got 50 scoops of ice cream. He gave 32 scoops to his friends at school. How many scoops does he have left?
Jamie goes bird watching. He sees 31 sparrows and 15 blue jays. How many birds does Jamie see in all?	Davion won a game of Zap 31 times. Then he won 15 more times. How many times did Davion win Zap in all?
Kim had 23 dolls. Her father gives her 18 more dolls. Now how many dolls does she have?	There are 23 snacks in the snack bucket. Miss D'Agata adds 18 more to the snack bucket. How many snacks are in the snack bucket now?
Juan has 38 seeds. He gives 8 seeds to his friend. How many seeds does Juan have now?	Taylor made 38 necklaces in the necklace factory today. Then she sold 8. How many does Taylor have now?
Rico builds a fort with 36 blocks. Tony uses 38 blocks to make it bigger. How many blocks are used in all?	The Hartwood Hornets won the soccer game yesterday. Oscar scored 36 goals. Cameron scored 38 goals. How many goals did they score in all?
Jody has 17 cans to recycle. He collects 5 more. How many cans does Jody have in all?	Logan drove his car 17 miles. Then he drove 5 more. How many miles did Logan drive in all?
There are 11 birds swimming. 7 birds fly away.	Ethan had 11 *Fly Guy* books. Then he gave 7

How many birds are swimming now?	to Kayla. How many *Fly Guy* books does Ethan have now?

Appendix E

Name:_____

Write the equation with answer:

Show your work!

Explain your work!

How difficult was this story problem? ☹ 😐 ☺

How much did you like this story problem? ☹ 😐 ☺

Appendix F

Rubric

Student Code: _____ Set:_____

Subset: HM AM LM HR LR

P: Humor Student Names You Their Name School Relevance Interests

	Personalized	**Non-personalized**
Correct Answer?	Y / N	Y / N
Operation Correct?	Y / N	Y / N
Equation Correct?	Y / N	Y / N
Difficulty Rating?	☹ 😐 ☺	☹ 😐 ☺
Attitude Rating?	☹ 😐 ☺	☹ 😐 ☺
Any Other Details		

Notes:

Appendix G

Students' Performance Word Problem Versions

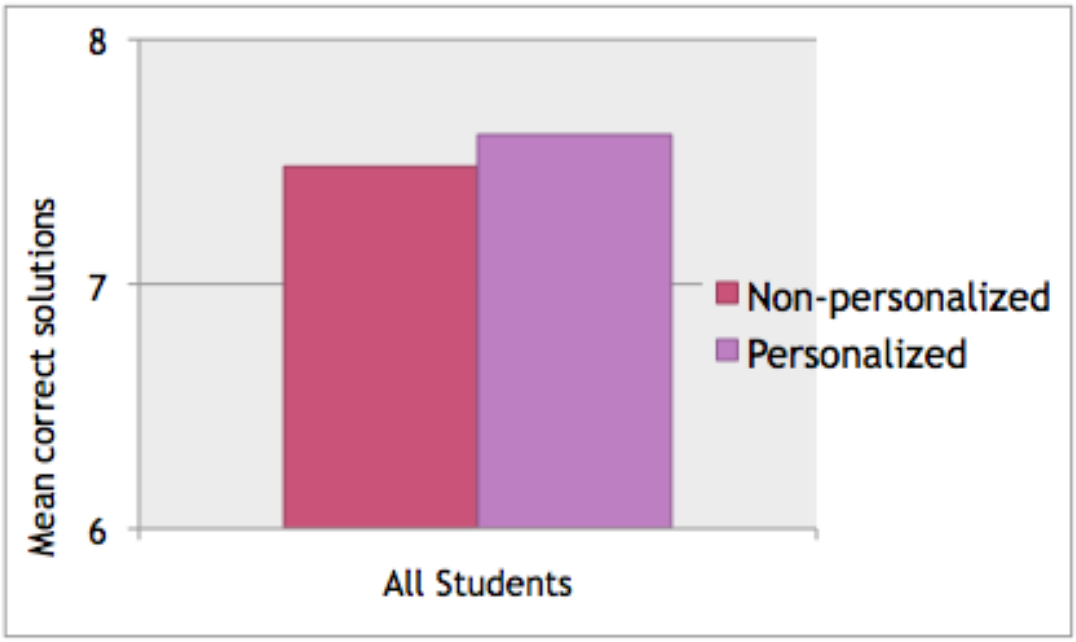

Figure G1. This figure displays the means of students' performance on non-personalized and personalized word problems.

Appendix H

Performance Among Mathematics and Reading Subgroups

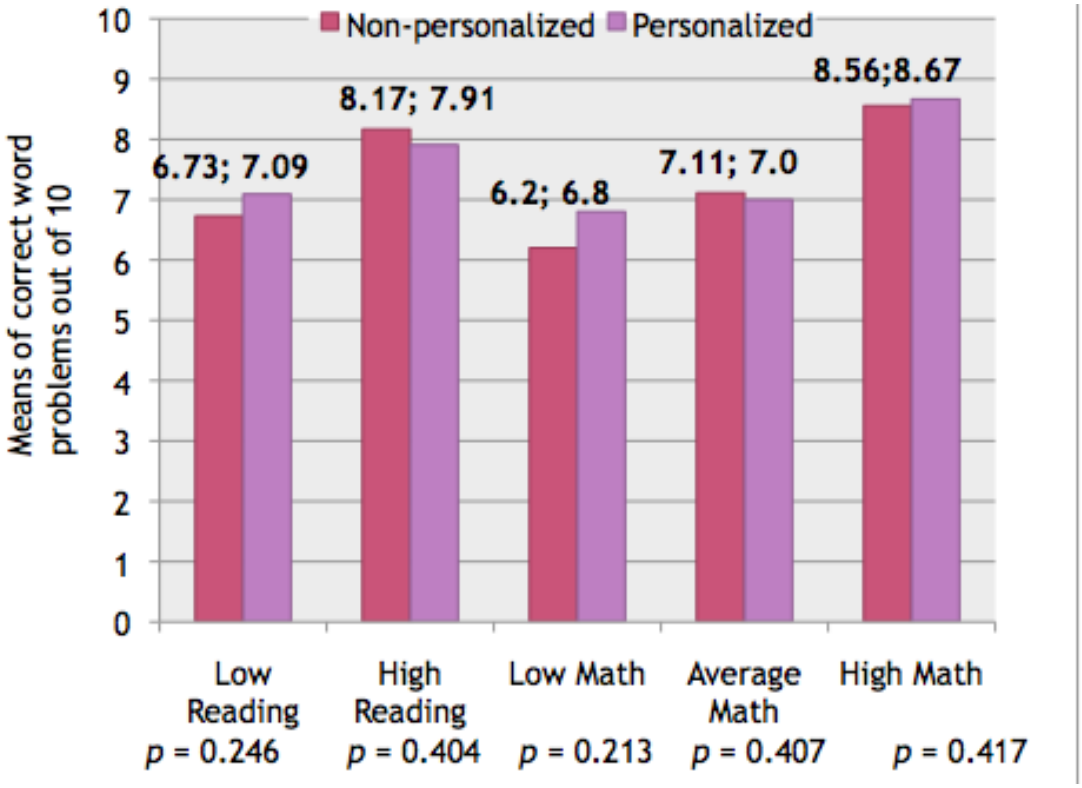

Figure H1. This figure displays the means of students' performance scores in mathematics and reading subgroups.

Appendix I

Performance on the Five Most Difficult Word Problems

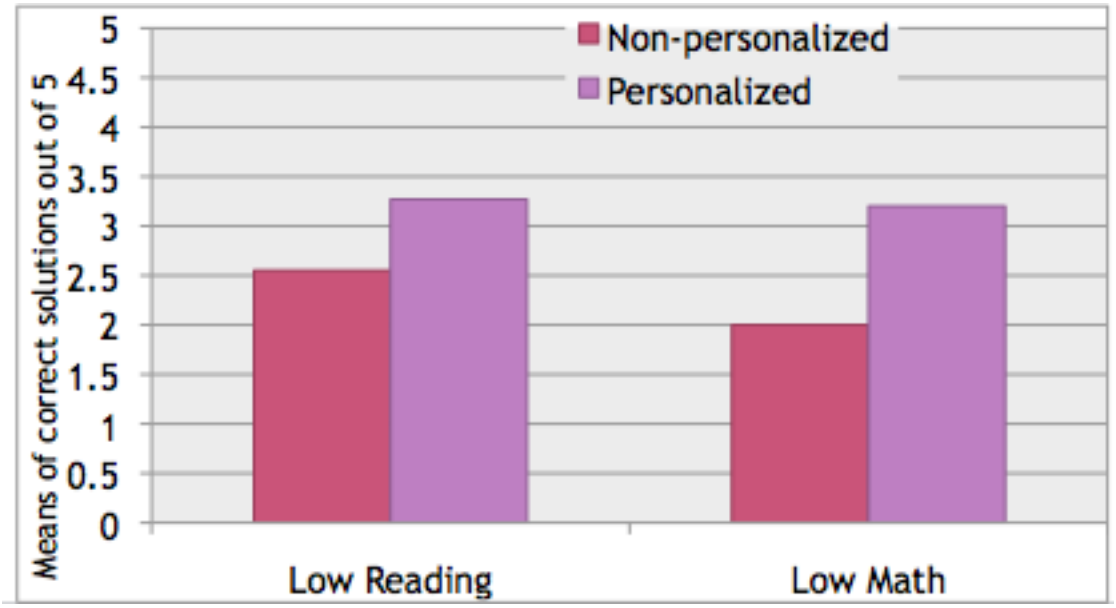

Figure I1. This figure displays the means of the low reading and low mathematics students' performance on the five most difficult word problems.

Appendix J

Students' Perceived Difficulty Ratings of Word Problems

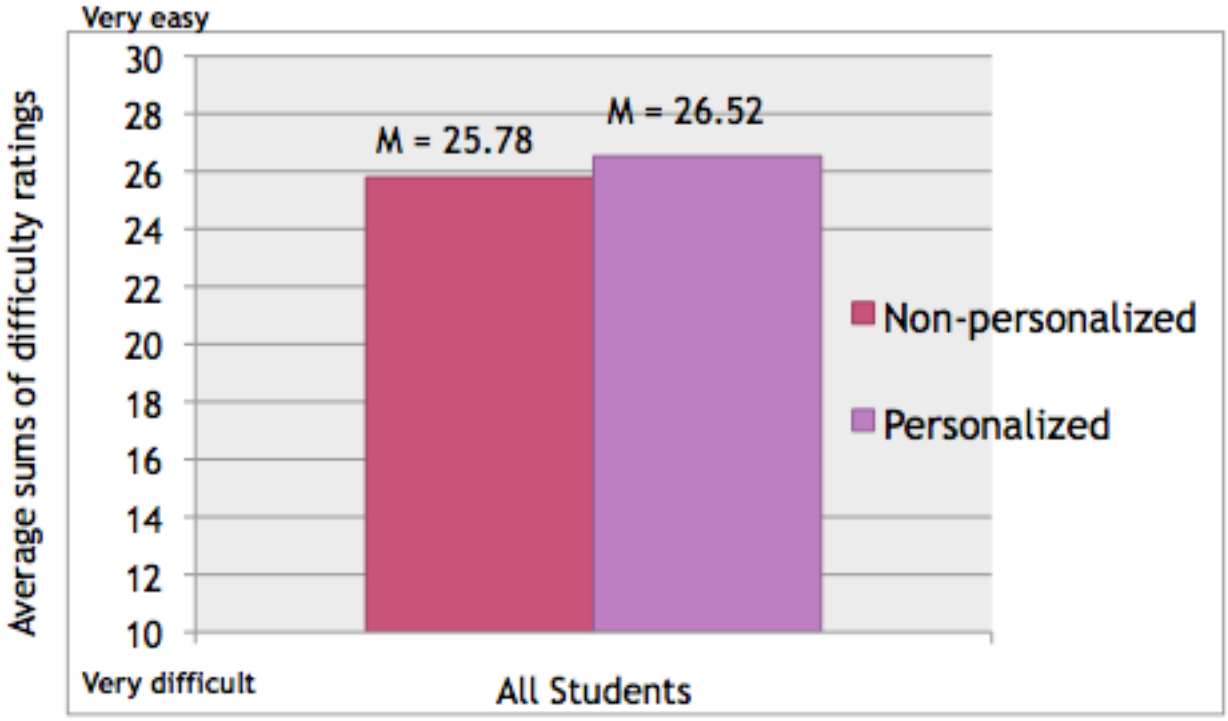

Figure J1. This figure displays the mean sums of students' perceived difficulty ratings for each word problem version.

Appendix K

Perceived Difficulty Ratings Among Subgroups

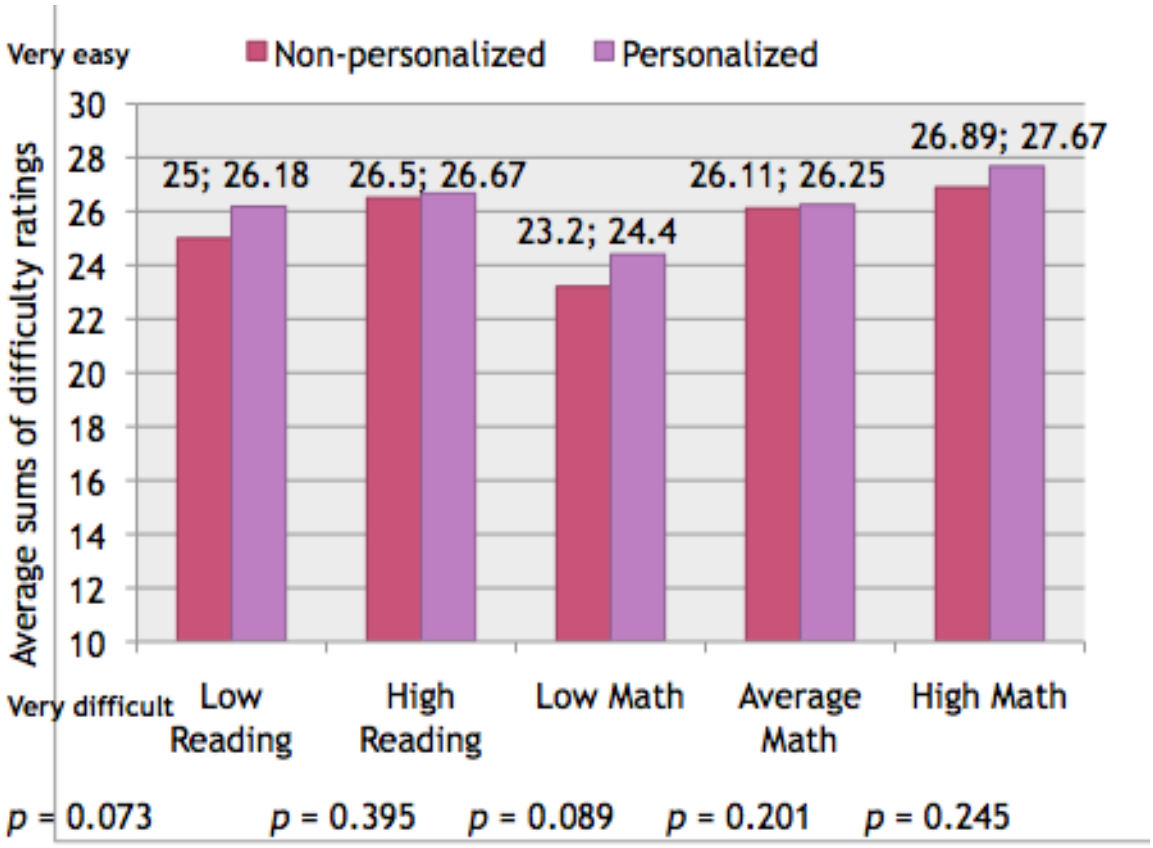

Figure K1. This figure displays the mean sums of students' perceived difficulty ratings among subgroups.

Appendix L

Attitudes Toward Word Problems

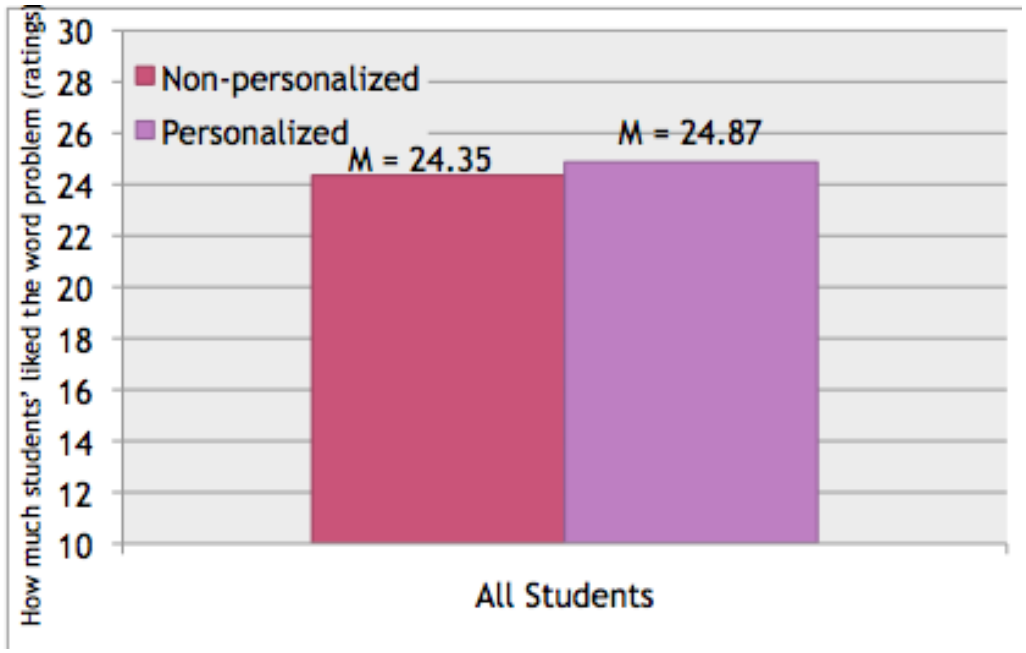

Figure L1. This figure displays the mean sums of students' attitudes toward non-personalized and personalized word problems.

Appendix M

Attitudes Among Mathematical and Reading Subgroups

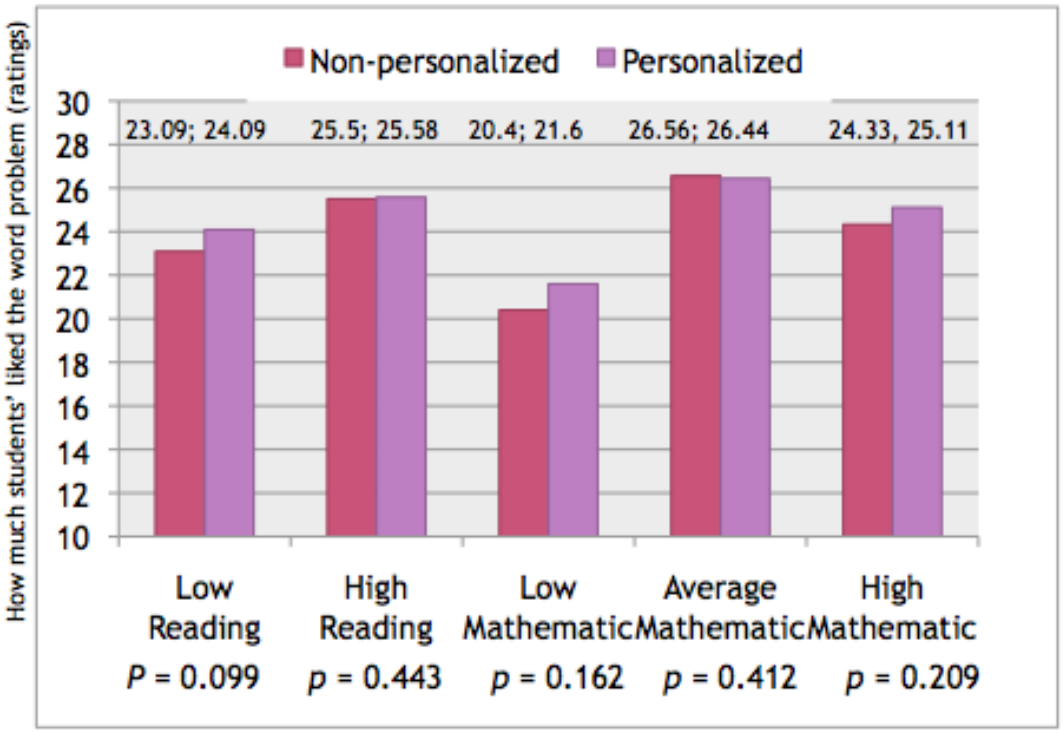

Figure M1. This figure displays the mean sum of students' attitude ratings toward word problems among mathematical and reading subgroups.