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Student-Authored Word Problems and Their Impact on High School Mathematics Students' Engagement

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An Action Research Report

By Jake Heidelberger

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Abstract

The focus of this action research was the impact of writing their own word problems on student engagement and attitudes toward word problems. I focused on two sections of Advanced Algebra 2, mostly junior year students, during the linear functions as mathematical models unit of study. Data were collected from preliminary and concluding surveys, daily exit slips, and student interviews. After reviewing the traditional approach to solving word problems, I asked my students to use the problems we worked through as a guide and to write their own word problem and its solution key. As a result of this action research project, student confidence increased and more students saw the connections between mathematics and the real world. Breaking down the barriers and obstacles that prevent students from succeeding is at the very core of education, and the creative elements inherent within student-authored word problems certainly seem to have benefited my students. Based on my results, I fully intend to explore this teaching method further in my future teaching career, and to share it with my colleagues.

As a mathematics teacher, I find the entire field of mathematics to be equally intriguing and challenging, both from the perspective of a student as well as a teacher. In formulating a problem on which to focus this action research, I found myself returning to student-authored word problems for several reasons: during my time working in the insurance industry, I gained a deep appreciation for the need to work with and interpret written words and descriptions of mathematical concepts as part of actual calculations. As Chapman (2006) explains, "Word problems...can provide practice with real life problem situations, motivate students to understand the importance of mathematics concepts, and help students to develop their creative, critical and problem solving abilities" (p. 212). The appeal of bringing real world applications and scenarios into my classroom via student-authored word problems proved too enticing to dismiss, and thus became the focus of my action research.

While calculators, spreadsheets and other digital/computer-based computational tools are essential in the world of applied mathematics, there are other skills for which there exists no technological equivalent to the human mind. Some examples of such intellectual skills include the following: the ability to identify the key numerical focal points within a given set of data; the summarization of that data into a high level synopsis; and the ability to communicate that summary in words. These processes can only be performed by a highly functional student of mathematics. Many of the same challenges present in the aforementioned processes are either analogous to, or directly paralleled in, the solving of word problems in a mathematics course. Given this intricate relationship, I felt a greater examination of word problems, coupled with an alternative

approach to working with such problems, would be extremely beneficial to my students, as well as to my own teaching practice.

A great deal of attention has been given to word problems and the daunting obstacle they present to many mathematics students. Rather than approach word problems with a customary, top-down procedure, beginning with a thorough reading of the problem, and then following with subsequent problem solving steps, I felt an alternative approach might be more beneficial. Stephens (2003) offers a similar contention: "When asked to translate between word problems and equations in only the 'usual' direction, students often use techniques that allow them to be successful without true understanding" (p. 65). If my students were to create (i.e. write) their own word problems, this learning process might serve a dual purpose in their mathematics education: first, it would expose them to the idea of putting mathematics operations and processes into words rather than the opposite procedure which they have been doing in the bulk of their mathematics education; secondly, writing their own word problems would provide students with a glimpse into the world of applied mathematics where the problem-solving techniques familiar to students, such as solving for a given variable and substituting a number for a variable in an equation, are of little or no use.

Since many students dread word problems, leading to a mighty struggle and oftentimes unpleasant experience in the classroom, my intention is to alleviate some of the common misunderstandings associated with such problems by providing students with an alternative perspective and approach to these problems. Vacaretu (2008) explains that "writing, critiquing, and revising problems comprise another set of strategies that teachers can use to assist students in understanding and solving mathematics problems"

(p. 452). In considering word problems from their formulation and construction, students can gain insights and identify key steps which are useful in finding the solution to such problems. Having these skills and familiarity with word problems will be a great advantage to students in their future endeavors.

I conducted my action research at my first student teaching placement between October 4, 2011 and October 7, 2011. At that time, I was teaching several levels of Algebra at a private high school in the suburbs of Saint Paul, Minnesota. I chose to focus on my two sections of Advanced Algebra 2 students. These classes were comprised primarily of eleventh grade students with a handful of tenth grade students as well. Between the two sections there were 42 students in total, with 21 females and 21 males. While this was not an Advanced Placement course, it was comprised of students who had performed well enough to warrant their being placed in this advanced second year of algebra, rather than a more remedial second year course. The unit of study covered during this action research project focused on linear functions: finding their solutions as well as their application as mathematical models.

In an effort to expand my familiarity with past efforts related to student-authored word problems, I consulted a variety of sources. I investigated some of the frequently encountered challenges faced by students in mathematics courses working with word problems. As Stephens (2003) points out, “examining students’ translation work...from algebraic representations to verbal representations...addresses a shortcoming in the body of research on the connection between algebraic equations and word problems” (p. 63). While this lack of research presents uncharted territory, it also proves to be something of a challenge when gathering background sources and previous research to examine.

A great deal of research has been devoted to examining the effects of personalizing word problems, as well as studies showing the increased success rates and engagement of students who work with word problems that incorporate elements of their own lives (Amit & Klass-Tsirulnikov, 2005; Akinsola & Awofala, 2009; Chapman, 2006; Hart, 1996). While personalizing a word problem, such as modifying the problem's setting or characters, still adheres to the traditional approach of students solving a word problem written by someone else, there are some key common themes between this practice and that of having students write their own word problems. In each case, elements of the students' lives can be incorporated into the problem, and as past research suggests, such personalization can improve students' interest and success in working with word problems.

As a mathematics teacher, it is my responsibility to help students improve their problem-solving skills while also helping them learn to recognize potential instances of application of these skills in the real world. While the traditional approach to solving word problems is not without value, the alternative of student-authored word problems offers unique insights into students' skill-sets, as well as their thought processes and approaches when dealing with word problems (Vacaretu, 2008; Stephens, 2003; Sanders, 2009). Some additional benefits that come from having students write their own word problems include the additional diagnostic perspectives and opportunities that arise from the students' work (Alexander & Ambrose, 2010). Given the wealth of learning opportunities and deeper levels of comprehension and engagement presented by student-authored word problems, I proposed the following question at the outset of my action

research: What impact will writing their own word problems have on students' engagement and attitude toward word problems in high school mathematics?

Incorporating the traditionally right-brained, creative thought processes of writing into a mathematics classroom is a clear juxtaposition to the traditional mathematics curriculum. Certainly, the ambitious nature of an action research topic such as this, no less proposed by a student teacher, could prove intimidating and prohibitively risky to a cooperating teacher. Yet in my case, I had the good fortune of working with a supportive cooperating teacher who not only welcomed my project into her classroom, but who also provided a great deal of insight, suggestions and feedback as I planned and conducted my action research. When Vacaretu (2008) had her students write their own word problems, she found them behaving "more and more like mathematicians-in-the-making" (p. 455). I was very hopeful that my students would respond in like fashion, and I utilized the tools and process described in the following section to measure my students' responses.

Description of Research Process

As a mathematics tutor at a St. Paul junior high school during the 2010-11 school year, my impression that many mathematics students tend to dislike and struggle with word problems was certainly reinforced with real life examples. Having gone through the same courses in my own academic career, and witnessed numerous traditional teaching methods with respect to word problems, I was particularly interested in the possibility of a non-conventional, alternative approach to word problems. Sanders (2009) sums up the potential benefits and value of teaching methods such as student-authored word problems: **"**I believe that students at all ability levels can succeed in mathematics classes that incorporate hands-on exploration and writing, and I am convinced that such projects

can engage students in ways that traditional methods may not" (p. 432). I thus chose to incorporate a student-authored word problem learning segment in my two sections of Advanced Algebra 2 classes during the first week of October 2011.

Prior to the actual implementation of this learning segment, I approached my cooperating teacher, hoping to gain some insights and suggestions while also making sure she was comfortable with the idea. She expressed some hesitation initially, but after discussing the project further, while also examining the course schedule and curriculum, we found a unit of study which fit in perfectly with my topic: solving linear functions as mathematical models. A week before the actual implementation, I discussed this project with my students. While their reactions included a certain degree of trepidation with respect to word problems, they were still quite enthusiastic about the chance to assist me in my project. Having reached a mutual accord with my students and my cooperating teacher, I was prepared to begin implementing my action research.

At the beginning of this learning segment, I distributed a preliminary survey (see Appendix A) to my students. The survey asked the students a variety of questions pertaining to their attitudes and experiences with word problems. On a scale ranging from strongly disagree to strongly agree, I asked the students to rate their interest and confidence levels with respect to word problems. The students were also asked if they had learned multiple techniques for solving word problems, and whether they saw a connection between word problems and the real world. A second survey (see Appendix B) was conducted at the conclusion of this learning unit. In this instance, I asked the students to describe their experiences in this unit as well as estimating the improvements and benefits they may have gained as a result of participating in this project. In addition,

the concluding survey included two open-ended questions. These questions provided the students with an opportunity to describe particular aspects they enjoyed when writing their own word problems, and what recommendations they may have to make the process better for future students.

At the start of the learning segment, we began with a review of the base components and concepts implicit with linear functions, in a full class discussion format. Following this introduction, we went over one possible procedure for approaching and solving word problems in the traditional format. Next, I presented the students with an introductory word problem, based on a linear function, which they could solve on their own or working in groups of two or three. I gave the students approximately five to ten minutes of work time on this sample word problem. Then we began working through the solution to the problem in a whole class format. Students would come up to the board and work through their solution to each of the problem's nine steps. The discussion and questions that arose from this process proved to be very fruitful, but also prohibited us from completing the example problem during that class session. We postponed the completion of this sample problem until the next day's lesson. I then assigned three new word problems as homework for that night.

On the second day, we concluded our whole class work of solving the example word problem from the previous day. In addition, we also covered some additional features and characteristics of linear functions as mathematical models, including dependent and independent variables. Since we had not been able to complete our example word problem on the previous day, there were a number of questions and points of confusion related to the homework problems. So for the remainder of this class, we

went over and worked the students' questions related to the previous night's homework. Here again, these questions and further explanations served to be beneficial and enriching to the students' comprehension of linear functions and solving word problems using traditional methods. At the end of this class period, the students were again assigned three more word problems, which they were to solve using the traditional method.

On the third day of this learning segment, I began class by telling the students a story about an old car I used to drive. Although this story was something of a comic tale, it did include several mathematical elements: most importantly, the components of a linear function were present in this story. Walking the students through that personal example, and then modeling for them how to extract a linear function from a story, I instructed the students to write their own word problem and its solution. I reminded the students that this was the key idea behind my action research. In addition, I offered the class several potential ideas for word problems. I gave them a list of potential topics and areas which they could consider. I also provided them with suggestions of how to begin approaching this seemingly daunting task: procedures to follow, using other word problems as examples, focusing on key features of linear functions and identifying the components that will be present in their word problem. With a list of features to incorporate and potential topics, my students were willing to attempt writing what would be the first draft of their own word problems.

The next day of this learning segment served as a work day. The class began with a warm up problem. I asked the students to solve a word problem of my own creation, which I had written the previous night. After the students completed the warm up, we worked through the solution together, with students coming up to the board to model

their solution steps. Next, the students were given time to work with their classmates on their own word problems and solutions, while I circulated the classroom and answered individual questions. At the end of the class, I told the students to finish their word problems and answer keys that night, because tomorrow they would be paired up and exchanging their word problems they had written with a classmate. Their solution to their classmate's problem would serve as their admission ticket to take that chapter's exam the following week. Lastly, I asked for two volunteers from each of the two classes to come in before or after school to be interviewed as part of my project. In these interviews (see Appendix C) I asked the students to provide greater detail about their past experiences with word problems, while also soliciting greater feedback and reactions to the student-authored approach. My hope was that the interview responses would serve to validate the results I would gather from my other data sources.

Each day during this learning segment, the students completed an exit slip (see Appendix D) at the end of class. The exit slips asked them to comment on the day's lesson based on its level of engagement, the students' productivity, and the overall quality. These exit slips provided immediate feedback on each class session. In addition, the responses to the exit slips were very useful as I put together the subsequent days' lessons.

At the conclusion of this action research project, the results of the surveys, interviews and exit slips were tabulated and analyzed. The results of this analysis and subsequent conclusions will be discussed in the next section. This analysis will assess the impact of student-authored word problems on these students' engagement and attitude toward word problems.

Analysis of Data

With my study complete, I now had three data sources to review and investigate. My analysis began with a compilation of the responses to the preliminary and concluding surveys. Since the last two items of the concluding survey were open-ended questions, I sorted and organized common responses. I then compiled the responses from the exit slips students completed at the end of each class period. Lastly, I reviewed the results of student interviews, summarizing the students' answers to my questions, while also highlighting some of the more noteworthy remarks and observations. My hope was that these interviews would substantiate the trends and results coming out of the surveys and exit slips. Furthermore, I wanted to see what impact writing their own word problems actually had on my students' engagement.

My preliminary survey offered students the chance to enter their response on a Likert scale coupled with a line segment scale running between the strongly disagree and strongly agree extremes. As each response was in the form of a mark at some point along this line segment, I measured the distance from the leftmost edge to each mark. I then divided this distance by the total length of the segment in order to scale all answers to a 100 point basis. I chose to scale all answers to 100 percent for several reasons. First, this is an easily recognized scale and it allows for relatively quick mental calculations and comparisons for those interpreting the data. Secondly, the actual length of the scale on the two surveys was not uniform. The preliminary scale's line segment was half a centimeter longer than the concluding survey's scale segment. This was an inadvertent error on my part, but I felt that scaling to 100 percent would help to homogenize the responses on the two surveys. My third reason for using a 100% scale is because it allowed me to easily

translate between a numerical percentage and a Likert category. I effectively designated each 20th percentile with the corresponding Likert response: 0 to 20% representing a "strongly disagree" response, 20 to 40% representing a "disagree" response, 40 to 60% representing a "neutral" response, 60 to 80% representing an "agree" response, and 80 to 100% representing a "strongly agree" response.

The preliminary and concluding surveys are not identically worded, and only the first two items appear on both. As a result, I grouped these two items and their responses into a single chart. I then plotted the rest of the preliminary items on their own chart, and did the same for the concluding survey. I compiled all the student scores in a spreadsheet, where I was could easily calculate mean, median, mode, range and standard deviations, and subsequently plot the mean averages in charts. I opted to use the mean as my primary metric since this is a common measure and provides an accurate depiction of the results.

The first two items of each survey dealt with equivalent statements, although in the case of item one the wording was slightly different between the preliminary and concluding surveys. On the preliminary survey, I presented my students with the following statement: "I feel confident in my ability to solve word problems." On the concluding survey, the statement was slightly different: "I feel more confident in my ability to solve word problems now than when this unit began." The second item was identically worded on the two surveys: "I see the connection between mathematics and the real world through word problems." The students' average response to the first statement was 45% (neutral) on the preliminary survey and 67% (agree) on the concluding survey, a 22% increase. The second item showed a similar upward trend: the

students' average response was 47% (neutral) on the preliminary survey and 67% (agree) on the concluding survey, a 20% increase. These results are displayed in Figure 1.

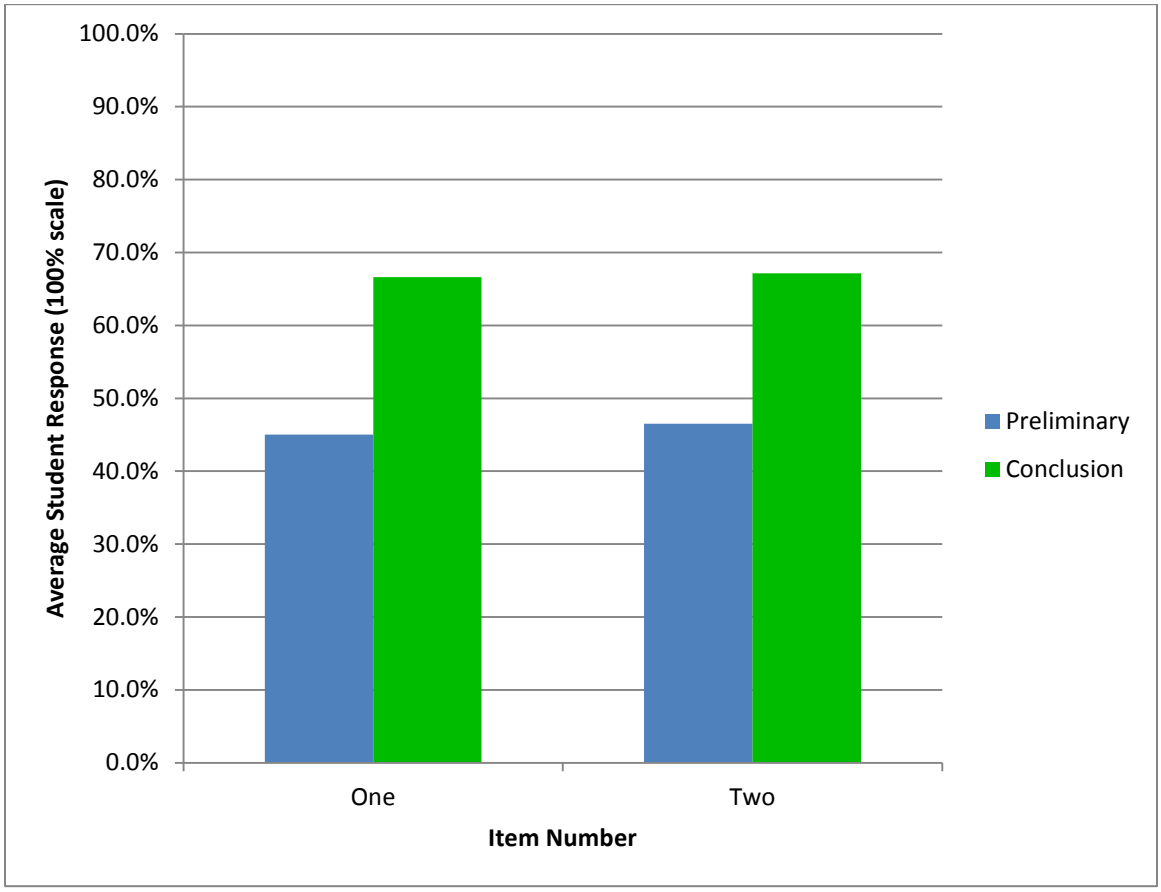

Figure 1. Items one and two from preliminary and concluding surveys.

The remaining items from the preliminary survey probed into the students' experiences with and attitudes toward word problems. Item three stated "I look forward to working on word problems." The average student response to this statement was 22% (disagree) at the start of this learning unit. In the fourth item, students responded to the following statement: "I have learned multiple strategies for solving word problems." In this case, the average student response was 48% (neutral) when we began working on word problems. Item five stated "I prefer solving numerical problems to word problems." In this case, the average student response was 75% (agree) at the beginning of this unit.

The sixth item contained the following statement: “I think the details in word problems can be confusing.” The average student response was 67% (agree) to item six. Item seven stated “I believe my teachers help me learn how to solve word problems.” On item seven, the average student response was 56% (neutral). These results are shown in Figure 2:

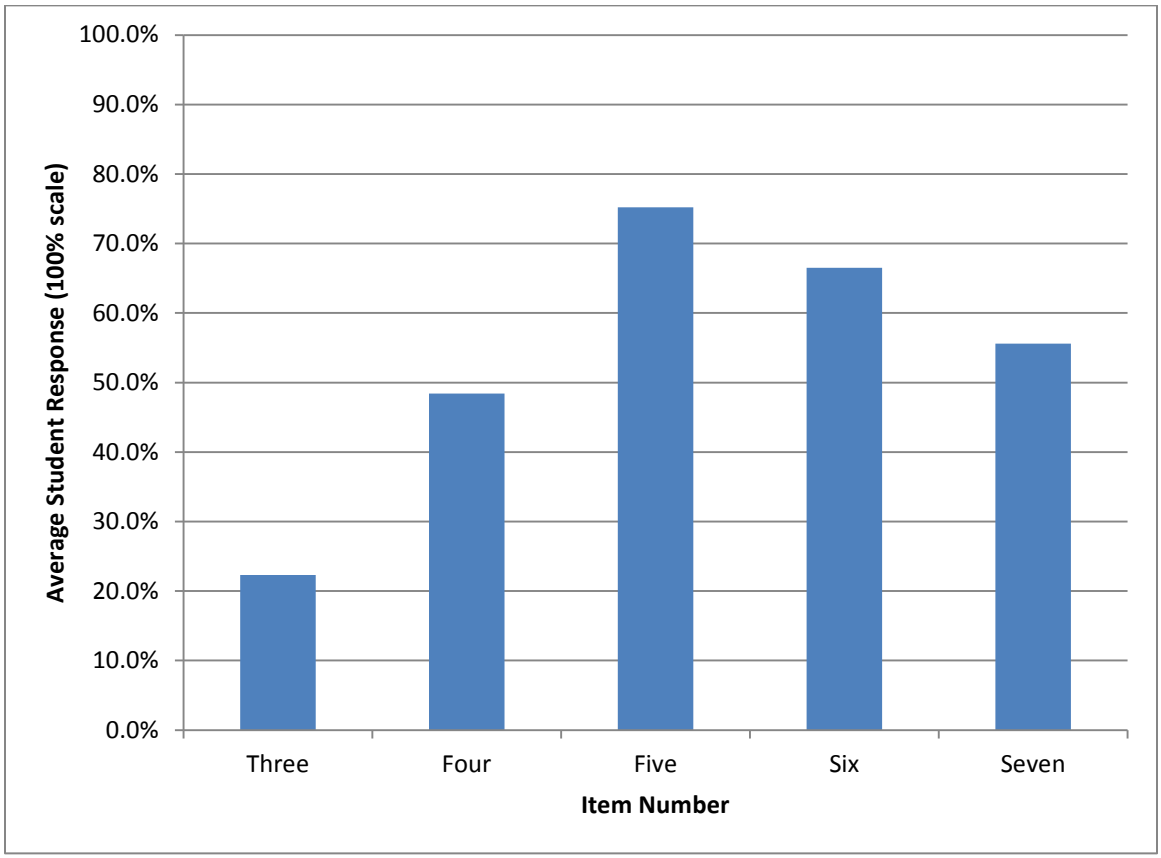

Figure 2. Preliminary survey items three through seven.

In the concluding survey, I invited students to reflect on their skills and comfort level in working with word problems after having authored their own word problems. Item three stated: “I think I have a better sense of what to look for in a word problem in order to convert it to numerical calculations.” Now that the students had written their own word problems, my hope was that they would improve the ability to locate and focus on the key components of a word problem. Students’ responses yielded an average of 69%

(agree) suggesting that they had improved in identifying a word problem's key information. Item four stated: “I have improved my ability to identify unnecessary information in word problems now.” This statement shares the same inherent idea as item three, looking to see if the students had improved their ability to discriminate between various components and facts within a word problem. Once again, the responses imply some degree of improvement, as the average student response was 68% (agree). In item five, I prompted the students to consider the reasoning behind the inclusion of a word problem unit in the curriculum: “I have a better understanding of why we work on word problems in mathematics.” In writing their own word problems, students were given first-hand experience in applied mathematics and I wanted them to begin to see the connections between mathematical processes and the scenarios where logical thinking and mathematical reasoning could be applied in real life situations. The average student response to this item was 65% (agree) indicating that the students had gained some degree of appreciation for the usefulness and applicability of word problems. Item six captures the essence of the entire student-authored word problem learning segment by prompting the students to respond to the following statement: “I believe my ability to solve word problems has improved by writing my own word problems.” While the prospect of creating a word problem from scratch can be intimidating, the possibility of improved comprehension and confidence were very appealing to me as I planned and prepared for this unit. The average student response to item six was 66% (agree) suggesting that some intellectual growth had occurred. These results are summarized in Figure 3:

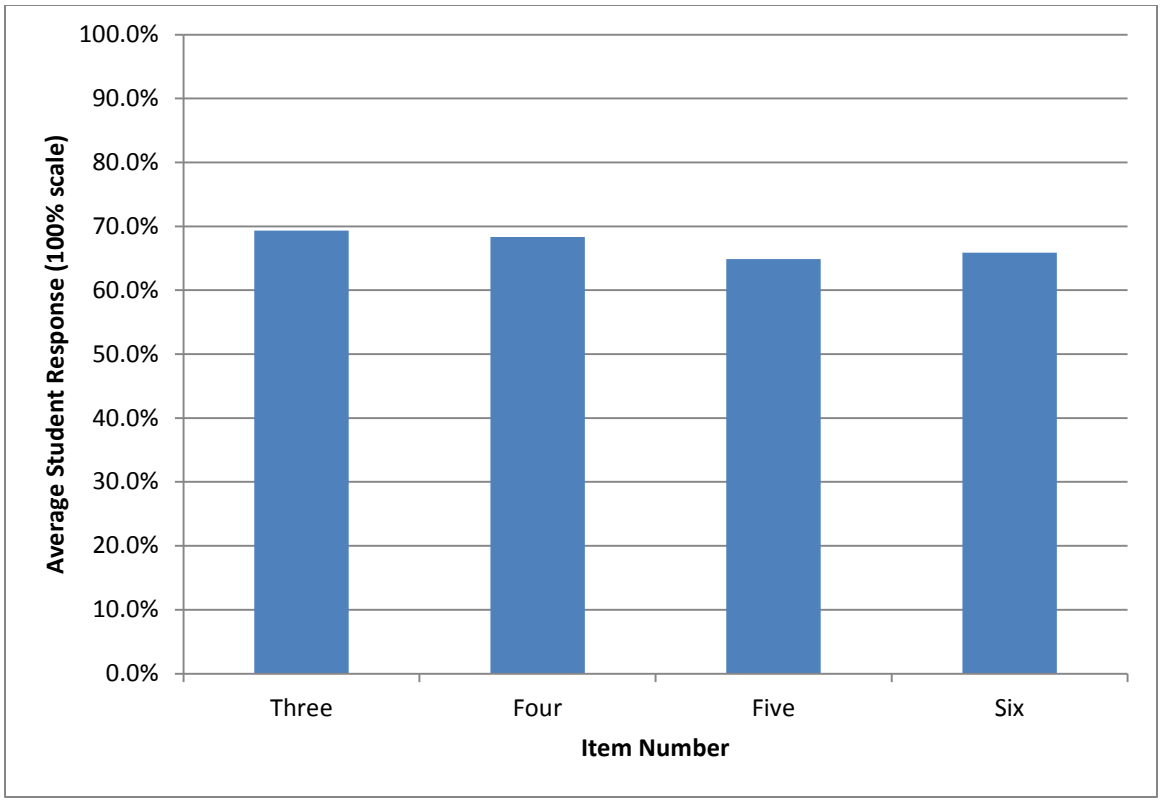

Figure 3. Concluding survey items three through six.

At the end of each class period, I asked the students to complete an exit slip or comment card which listed six statements or prompts. The students were able to respond with a numerical score ranging from one (strongly disagree) to six (strongly agree). I compiled the responses to each of these six statements, and calculated the average student scores for each of the four days of this learning segment. The results are displayed in Figure 4.

The first prompt stated: “I understood the goals of today’s lesson.” The average student response to this prompt ranged from a minimum of 4.7 (slightly agree) on day three, up to a maximum of 5.3 (agree) on days two and four. The second prompt stated: "I knew what I was supposed to do.” The average student responses to this prompt were a minimum of 4.6 (slightly agree) on day three and a maximum of 5.3 (agree) on day four.

In the third prompt the students were invited to respond to the following statement: “I was on-task and productive.” The average student response to this prompt started off on day one at its lowest point of 4.5 (slightly agree) and gradually improved each day until it reached a high point of 5.0 (agree) on day four. The fourth prompt stated: “The class was on-task and productive.” The average daily student responses to this prompt were all in the slightly agree range, from a low of 4.4 to a high of 4.9. In the fifth prompt, I prompted my students to respond to the following statement: “I felt respected and valued.” This prompt had both the highest and most consistent responses over the course of the unit. The average student response was always in the agree range, with three days having an average of 5.5, and one day ending up with an average of 5.4. The sixth and last prompt stated: “I had to use some ‘deep thinking’ to be successful today.” This prompt yielded the largest range of averages, with a minimum of 4.1 (slightly agree) on day one and a maximum of 5.1 (agree) on day three.

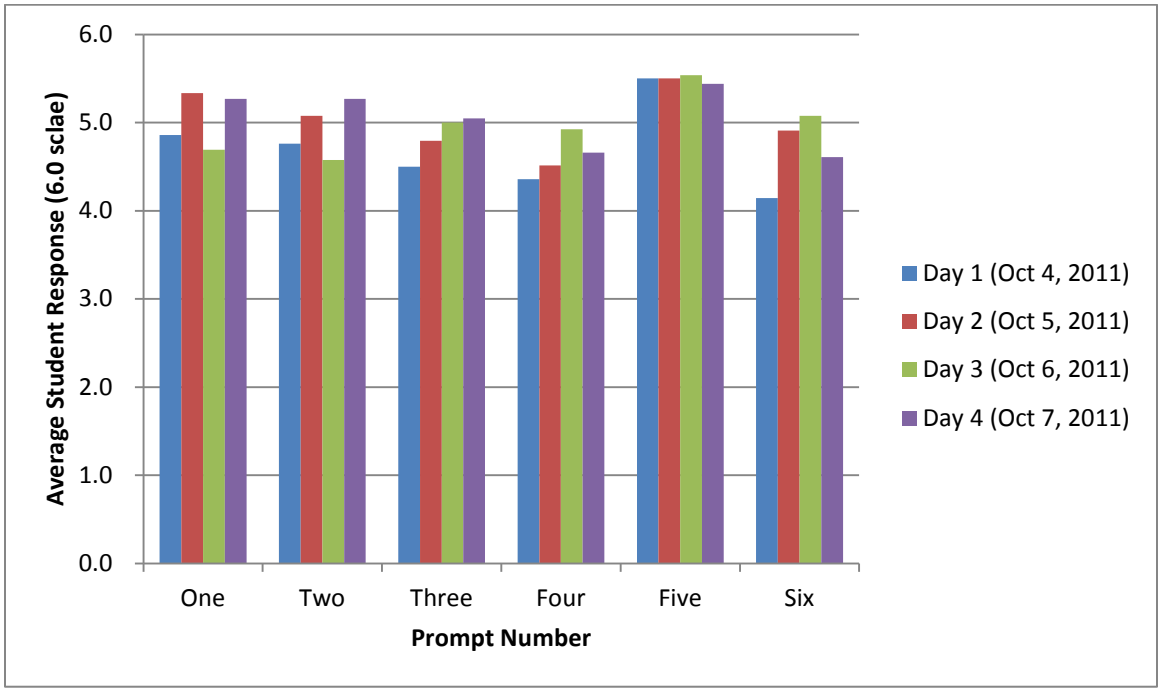

Figure 4. Exit slips.

I found some of the most intriguing and insightful results of this action research came from the short answer responses to items six and seven of the concluding survey. Having devoted four class periods to word problems, both from a traditional perspective of solving a given problem, as well as the creation of their own word problem, I was very interested to hear what my students' impressions were of the unit, both in terms of what they enjoyed as well as looking for suggestions of improvements.

In an effort to draw some meaningful conclusions from these open-ended questions, I again used a spreadsheet to summarize and consolidate the responses into a few subsets, which allowed me to look for trends and common themes. In item seven of the concluding survey, I asked students the following: "What are some of the things you liked about the process of writing your own word problems?" Approximately 43% of the students responded that it improved their ability to solve word problems. The next most common response, showing up in almost 17% of the responses, was that students enjoyed the chance to be creative in writing their own word problems. The third most common response was that students appreciated the ability to choose numbers which would work out to whole number solutions rather than fractions or decimals—this was listed on 12% of the responses.

As an educator, it is my role to both teach and learn right along with my students. There is no better judge of what could be improved in a lesson than the student you are trying to teach, and my students did not disappoint in their responses to item eight, where I asked the following: "What would you change about this process to improve it and make it better?" While 33% of the responses said that nothing should be changed, there was less parity in the remaining responses. Twelve percent of the students said they

would like more in-class instruction on how to solve word problems. Three students actually recommended an additional day where they could correct their classmate's answer to their word problem, and also discuss the problem to learn from one another. One student displayed clear evidence of learning: "I would give more problems where we make a connection with the y-intercept. I was confused about that until I wrote my own word problem." In this student's case, she only had a clear idea of the meaning of a y-intercept and its real-world interpretation when she was faced with the prospect of incorporating the concept in her own word problem.

I met with four of my students, two female students and two male students, and conducted interviews at the end of this learning unit. The script for the interview questions is included in Appendix C. It is important to note that two of the students were interviewed at the same time since that was the only available time slot in our respective schedules. While I am certain those students' interview responses were honest and forthright, I am equally convinced that neither of them responded in the same manner, or perhaps even with as much detail, as they would have if each of them had been interviewed individually. My hope in conducting all four of these interviews was to gather direct, student-specific data and responses which would corroborate with the average survey and exit slip data sources.

In one of the interview questions, I asked each student to describe their initial reaction when I told them they would be writing their own word problems. Given the preliminary survey responses to item three which stated "I look forward to working on word problems" and where the average student response of 22% registered just above the strongly disagree category, the interviewees certainly reinforced this sentiment. One

student stated “I've never really liked word problems because they always seemed really hard, but it's easier when you have a process of steps to follow.” Another student suggested that the process actually became easier for her: “I was less than excited [at first]. I thought they were going to be hard and require a lot more critical thinking than they actually did.” These responses also lend support to the responses on item six of the concluding survey, where the average response was 66% (agree) to the statement “I believe my ability to solve word problems has improved by writing my own word problems.” These responses certainly seem to be consistent and offer some degree of validation.

Recalling the particular unit of study in which this activity was set, linear functions, I was both intrigued and impressed to hear my interviewees respond with such practical knowledge and foresight when I asked the following question: “Do you feel more comfortable with word problems now versus at the start of this unit?” One student responded as follows: “I feel comfortable with these types of word problems, but I know there are other types out there which I may not understand.” A second interviewee echoed this sentiment, stating “If it wasn't a graphing [linear function] problem, then I would feel a little lost since the format was different.” In these two independent interviews, both students recognized the variety of potential word problems in mathematics. While they felt more comfortable and confident with linear function word problems, they were less certain that the techniques and skills they had acquired in this unit would transfer over to other types of problems and different scenarios. While I would contend that many of the skills they learned in this unit can easily be applied elsewhere, these interviewees did not have concrete evidence of their own work to

validate such a claim. These responses may suggest a degree of realistic maturity in the students, or perhaps practical cynicism knowing that they will be challenged again by other mathematics problems. Either way, they definitely tell me that I, along with my students, have more to learn during our respective academic careers.

With my action research summarized into data which I analyzed, I could move forward with my own learning. The themes and trends present within the data point out several skills in my teaching practice where I excel, while also calling attention to areas where I can grow and improve. As a result of summarizing and analyzing the data, I now have an action plan which I will utilize to further hone and refine my teaching craft.

Action Plan

As I revisited this action research and contemplated its meaning, I became even more confident that teaching is the right career choice for me. I was also reminded of how much I actually miss the daily interactions with my students. While I am by no means an expert instructor, I certainly feel inspired when helping my students conquer their fears and make advances in their knowledge and comprehension of mathematics. This project has allowed me to review my teaching methods with actual data and results providing evidence to support some of my strengths and weaknesses. I certainly will learn from these lessons and I fully intend to apply this knowledge as I develop and expand my teaching skills in the future.

As previously mentioned, I discovered a few areas of weakness in my current teaching approach, and one area where I need to improve is my willingness to allow students time to struggle with a problem. At several points during this learning unit, I found myself offering suggestions and hints to students who were in the midst of

grappling with the word problem they were writing. My concern is that I may be too accommodating and overly anxious to come to the aid of my students and offer them guidance too soon. As one student informed me, “It was almost too easy to write your own word problem because you could make it really easy, but [then] whoever got [your problem] to solve didn’t learn anything.” In my attempt to ease student fear and trepidation at the prospect of creating a problem from scratch, I almost immediately suggested the idea of using some of the problems students had seen in their homework as a guide, without giving them time to make the cognitive leaps which are at the crux of learning. During an interview, one of my students raised this very point, stating the following:

> Instead of using examples from the book as a guide, try to have students go without an example and write their own problem. It's much easier to imitate another word problem versus creating your own from scratch, but starting with nothing leads you to do deeper thinking.

My desire to see my students succeed tends to compel me to interrupt some of the necessary struggling that is an absolutely essential part of intellectual growth.

While recounting this unit of study and summarizing the results of my action research, I realized that I was attempting to measure increases in engagement based on students’ interest and confidence levels. While these two metrics are certainly reasonable and appropriate, in my opinion, I can also foresee other potential aspects and means of measurement. There are too many potential alternatives to list here, but some that are of particular interest to me include the following: setting up before and after comparisons of student assessments which incorporate word problems. Another option would be to repeat

the student-authored word problem exercise in multiple units of study. This approach would allow for comparison of student work between units, helping to increase student confidence with a broader array of word problems, as alluded to in the student interviews. Additional student-authored units of study could also provide insights into the impact and roll that the topic of the unit plays in the resulting word problems.

At a time when far too many of us are desperately seeking a magic bullet to remedy so many of the ills we encounter and face, it would be tempting to assume student-authored word problems are the perfect solution to students' lack of engagement with such problems. While I am certainly encouraged by the results of my action research, and fully intend to explore this method and topic further in my future teaching career, I am not prepared to oversell the potential of this teaching method. I have often said that cookie-cutter teaching is equally inadequate and inappropriate, and attempting to meet all my students' needs with a single teaching method, such as student-authored word problems, would most certainly deprive them of many learning opportunities. However, a reverse approach to the traditional method can be enlightening to students, and in my case it definitely generated student advances and learning. At times the students themselves were not even aware of the advances they had made. As one student said in his concluding survey, "I didn't like having to figure out how to correct flaws in my word problem in order to have it make sense." This student was focused on the additional effort that was required, and failed to recognize that in revising his flaws, he was learning the deeper meaning behind linear functions and their real-world interpretations.

Another key insight I took away from this action research is the marked increase in student enthusiasm resulting from the opportunity to be creative, make their own choices, incorporate elements of their lives, and construct their word problem to work out the way they desired. The look of excitement on one of my student's faces was quite evident when he showed me his word problem, which was about the rate at which a balding man loses his hair. This student had thought the process through to the point that his linear function ended at precisely zero hairs when the subject of his problem had reach a given birthday. I opted against asking this student if I served as inspiration for the subject of his word problem, but I was nevertheless very encouraged to see the pride and enthusiasm he felt toward his problem. This experience only served to reinforce what Akinsola & Awofala (2009) point out:

> Personalized treatment may have adequately addressed at least two out of the three reasons commonly offered for students' inability to solve word problems. The three reasons are limited student experience with word problems, lack of motivation to solve the word problems and irrelevance of word problems to students' lives. (p. 396)

Breaking down the barriers and obstacles that prevent students from succeeding is at the very core of education, and the creative elements inherent within student-authored word problems certainly seem to have benefited my students.

As I conducted my research, a number of potential future studies and points of analysis presented themselves. As some of my own students suggested, the addition of a third step to this learning segment, where the original author would correct their classmate's solution, and then discuss the whole process, could prove to be very

beneficial. Such an activity could lead to even greater cognitive leaps as two peers discuss their respective problems, pointing out mistakes and triumphs which had occurred along the way. There is rich potential for additional learning to take place in such a scenario, and I would be very interested to explore it.

Another possible area of exploration relates to interdisciplinary projects. Introducing writing into a traditional mathematics curriculum already presents an element of cross-disciplinary activity. Thus, student-authored word problems could easily fit into an interdisciplinary unit. It would be interesting to see if the additional creative impetus implicit within an interdisciplinary project would yield additional advances in student engagement and confidence when working with word problems.

Looking ahead to my future teaching career, the unknowns are vast and some of them certainly will require life-long investigation and study to even begin making advances and growth. The challenge can appear daunting and intimidating if considered in total, but the single greatest benefit of the action research process is the knowledge that it provides a means of addressing these challenges. The action research process, scoping out a specific project, determining the area of investigation, conducting and implementing the action research, and the subsequent analysis of the resultant data, provides invaluable guidance to teachers at all stages of their careers. I truly look forward to my own education journey, and I fully intend to use action research to further enhance my teaching skills and practice.

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Preliminary

Please respond to the statements concerning word problems. Place a mark on the line corresponding to your choice, using the rating scale listed above the line.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1 I feel confident in my ability to solve word problems					
2 I see the connections between mathematics and the real world through word problems					
3 I look forward to working on word problems					
4 I have learned multiple strategies for solving word problems					
5 I prefer solving numerical problems rather than word problems					
6 I think the details in word problems can be confusing					
7 I believe my teachers help me learn how to solve word problems					

Conclusion

Please respond to the statements concerning word problems. Place a mark on the line corresponding to your choice, using the rating scale listed above the line.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1 I feel more confident in my ability to solve word problems now than when this unit began					
2 I see the connections between mathematics and the real world through word problems					
3 I think I have a better sense of what to look for in a word problem in order to convert it to numerical calculations					
4 I have improved my ability to identify unnecessary information in word problems now					
5 I have a better understanding of why we work on word problems in mathematics					
6 I believe my ability to solve word problems has improved by writing my own word problems					

Please provide a few sentences in response to each of the following questions:

7 What are some of the things you liked about the process of writing your own word problems?

8 What would you change about this process to improve it and make it better?

Appendix C

Interview Questions

Have any of your previous mathematics teachers emphasized word problems? Please explain and describe how this was done.

Please describe your process or method for approaching word problems currently.

What was your initial reaction to the idea of writing word problems on your own? (What did you think? How did you feel?)

Did your understanding of word problems and solving them change as the unit progressed? If so, please elaborate.

Do you feel more comfortable with word problems now versus at the start of this unit?

Please feel free to share any other general feedback or comments you may have.

Thank you for your time!

STUDENT COMMENT CARD

DATE:____/_____/_____

6=STRONGLY AGREE
5=AGREE
4=SLIGHTLY AGREE
3=SLIGHTLY DISAGREE
2=DISAGREE
1=STRONGLY DISAGREE

_____I understood the goals of today's lesson.

_____I knew what I was supposed to do.

_____I was on-task and productive.

_____The class was on-task and productive.

_____I felt respected and valued.

_____I had to use some "deep thinking" to be successful today.

USE THE BACK FOR QUESTIONS, COMMENTS, OR MESSAGES FOR THE INSTRUCTOR.

_____

Your name (optional)