Implementing Writing in a Secondary Math Class to Improve Student Understanding of Math Concepts

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Abstract

The purpose of this project was to determine whether the implementation of writing in a secondary math class would improve students' understanding of math concepts. The researcher implemented the project in a Midwestern state within a high school math class with twenty-four students. These students were required to solve a series of algebra problems and explain, in writing, how they arrived at the solution. The students' written products were assessed using a rubric. The data indicated that writing in a math class might have assisted the students in understanding math concepts.
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Chapter I: Introduction

As a graduate student interested in becoming more informed in using writing in math in the classroom, the researcher implemented the use of writing strategies in this project. Additionally, as an intern teacher, the researcher was wondering if these writing strategies could provide an assessment for the students’ understanding of the math concepts. The researcher wanted to know what writing strategies were effective in a math classroom and how they were used to benefit the students’ understanding of the math concepts. The researcher also wanted to enhance his teaching instruction to support students’ understanding and knowledge of the math concepts.

Statement of the Problem

The purpose of this project was to determine whether the implementation of writing in a secondary math class would improve students’ understanding or the subject. Research questions were:

1. According to the professional reviewed literature how were the writing assignments in math defined?
2. According to the professional reviewed literature, how were the writing assignments used in a math classroom?
3. According to the professional reviewed literature, what were the benefits of writing in math class?
4. Did the implementation of writing in a math class improve student understanding of math concepts?
Justification

High school students typically had a predetermined impression that there was no writing in a mathematics classroom. The researcher wanted to implement writing in a math class to see if, by using these strategies, it helped students understand the information given to them in class. The researcher wanted to improve the understanding and communication in a mathematics class. In addition, the researcher wanted to improve the students’ thinking process when solving math problems. The project explored the different types of writing techniques and which worked best for the students as well as the researcher.

Definition of Terms

The following terms were applicable to the research:

1. Writing strategies – These were the use of learning logs, double entry journals and math journals.

2. Secondary mathematics – These were the grades between 7-12 in which the students study math topics comprised of algebra, geometry, and calculus.

3. Journal writing prompts – These were questions that helped students think critically about math concepts.

Limitations

There were several limitations to this action research project. The first limitation was the researcher conducted the study in one class, period, and thus, it provided the researcher with a small sample size in rural Midwestern state. The next limitation was the short amount of time the researcher had to gather data as the study was conducted within a ten-day period. Therefore, due
to these indentified limitation the results of this study cannot be applied to other instructional settings.
Chapter II: Review of the Literature

Introduction

The purpose of this project was to determine, whether the implementation of writing in a math class improved student understanding of math concepts. Research questions were: 1) According to the professional reviewed literature, how were the writing assignments in math defined? 2) According to the professional reviewed literature, how were the writing assignments used in a math classroom? 3) According to the professional reviewed literature, what were the benefits of writing in math class?

The use of writing strategies in mathematics has been established in the classroom (Pavlovich, 2007). Baxter, Woodward, and Olson (2005) recommended that increased focus on writing would increase the communication between the student and the teacher. The writing strategies that would help increase communication would be logs, journals and reflective writing (Quinn & Wilson, 1997). The review of literature provided a full account of use of the writing strategies and the benefits for the student and teacher.

Research Question 1: According to the professional reviewed literature, how were writing assignments in math defined?

In order to determine how writing strategies in math were defined, the researcher consulted literature on the subject. According to the literature, writing strategies have been called a communication tool for the student as well as the teacher (Liebars, 1999). In addition, Hamdan (2005) called writing strategies a tool for teaching conceptual material in math, that helped improve student attitudes. The writing strategies that were described in the literature were logs, journals, and reflection writing (Quinn & Wilson, 1997).
The first strategy was the logs that were also called learning logs (Liebars, 1999). McIntosh and Draper (2001) described learning logs as a strategy of writing where the teacher has a running record of the students' explanation of a certain problem or question. In addition, Hurst (2005) called learning logs a strategy for students to develop learning from their text through writing. The learning logs’ set-up was described as a line divided down the middle with the left side for notes and the right side for reflection or comments (Hurst, 2005; Steenson, 2006).

The second strategy, which also provided a recording for the teacher, was using journals (Pavlovich, 2007). Journal writing was defined as responding to an open-ended question (Liebars, 1999). In addition, McIntosh & Draper (2001) along with Burns (2004) agreed that journals, specifically in math class, were a response to a specific question for that day or week.

The last strategy was the use of reflection papers, which were similar to learning logs and journals. These papers were not written in response to questions or prompts; they were simply written about what the students learned that day or week (Pavlovich, 2007). Pavlovich (2007) continued by stating that reflection papers were an action-based skill to deal with complex math problems.

In conclusion, the writing strategies included logs, journals, and reflection papers. They were defined in the literature as a method for students to explain their thinking (Quinn & Wilson, 1997) and as a record for the teacher to check for student understanding.
Research Question 2: According to the professional reviewed literature, how were writing assignments used in a math classroom?

A review of literature was conducted in order to answer the question of how the writing strategies were used in the classroom. The first thing that the teacher must do in order to use a writing strategy is to show the student how to use the strategy effectively (Steenson, 2006). Burns and Silbey (2001) stated that the use of learning logs and journals should be aligned with what the students had learned in the lesson.

According to the literature, the researcher found that it was important to demonstrate or model the writing strategy before the student attempted the writing assignment (Steenson, 2006). In addition, the teacher should encourage the students to focus on the math process and not on writing style (Heuser, 2005). While time was not a concern, Pavlovich (2007) stated that the student should reflect in the time given about their understanding of the math concept.

The purpose of the use of writing in math, the researcher found, was to develop writing that was related to the topic of the assignment for which the students had to use their own words (Baxter, Woodward, and Olson, 2005). As the students wrote, they should be directed to describe what they did in solving the problem by explaining their steps and any questions they might have had during the lesson (Burns and Silbey, 2001). Liebars (2000) suggested using a quick-to-act question called a prompt to gain positive responses from the students in their journal entries. These quick-to-act questions helped the students retain the information on the new lesson (Quinn and Wilson, 1997).

Although consider a useful too, the use of writing in math was not necessarily an everyday activity, but perhaps at least a weekly activity (McIntosh and Draper, 2001). For
example, Koirala (2002) stated that a journal entry might be complete weekly and be one to three pages long. This gave the student freedom, without being limited to one paragraph or one page, to write about the new math concept or reflect on the new concept.

Furthermore, the student should summarize what the teacher did for the class each week. Along with this, the student would have the chance to ask questions on the material which gave the teacher a chance to give immediate feedback (Liebars, 2000). McIntosh and Draper (2001) suggested that the teacher should write along with the student for the immediate feedback.

As described, the use of writing strategies must first be demonstrated by the teacher (Steenson, 2006). Also, a time limitation for the completion of the writing assignment and a focus on the process of problem solving should be considered (Heuser, 2005). The use of entry journals and learning logs should be used for the content and relationship to the topic of the week (Pavlovich, 2007).

Research Question 3: According to the professional reviewed literature, what were the benefits of writing in math class?

A review of literature was conducted in order to answer the question, what were the benefits of writing in a math class? The researcher found that Quinn and Wilson (1997) discussed several benefits of writing in math class including that the writing done by the student would inform a teacher what the student knew on a particular concept, and to help increase communication between the student and the teacher. The increased communication would, in the long run, help to develop better math students. The research also indicated that writing in a math class gave the students a perception of their own understanding because it forced them to be organized, clear and to be able to reproduce their own thoughts and mathematical understanding.
(Burns, 2004; Liebars, 2000; McIntosh & Draper, 2001). Liebars (1999), Koirala (2002), and Pavlovich (2007) stated that writing gave a student a chance to communicate mathematically, which helped in their development of a deeper understanding of the concepts.

The researcher found that another benefit was an improvement in the student’s thinking about math concepts. And since writing in a math class provided the teacher with a record of a student’s thought process, it benefited both the student and the teacher (Hadman, 2005 and Pavlovich, 2007). In addition, Burns and Silbey (2001) claimed that the writing of journals stretched students’ thinking to help them begin to solve the problems that had left them puzzled or discouraged, which in return gave the teacher an indication of the students’ strengths and weaknesses.

The researcher found that the use of writing in the math class often provided the teacher with an immediate understanding of what the students understood and what they found to be difficult (Liebars, 1999). Furthermore, Liebars (1999) explained that writing to explain math concepts helped the students to explain their steps with creativity and confidence. When the students wrote in math class they could reflect on anything good or bad from their math experience (Liebars, 1999).

The issue of time was discussed by Hurst (2005), who explained that the time used on writing in the class was not a huge amount for either the student or the teacher. Because the student was reflecting on the concepts and learned from the teacher’s responses, it provided a great value to the student and the teacher. In addition, it was found that when teachers responded to student’s writing, the student wrote more the next time which provided more information on what they learned (Hurst, 2005). Furthermore, Pavlovich (2007) noted that through experience
with writing students were guided to become independent and determine their own understanding.

In brief, the benefits of communicating through writing in math class helped the students in their mathematical understanding (Koirala, 2002). As suggested by the literature, immediate response to student writing would benefit the student and provide more feedback for them (Liebars, 1999).

Conclusion

The researcher conducted a review of literature to answer the first three questions. What the researcher found was that writing strategies provided benefits for the student as well as for the teacher. The process of writing helped students put their ideas on paper, providing the teacher with a record of what they did (Pavlovich, 2007). The students wrote what they learned or had questions on in class and gained immediate feedback which enabled them to think independently (Liebars, 2000). This in return gave the students a better understanding of what they were learning and solving. The students did not have to worry about grammar or time when they wrote (Heuser, 2005). The student should be focused on correct content, problem solving, and any questions that they might have (Pavlovich, 2007).
Chapter III: Methods and Procedures

The purpose of this project was to determine if the implementation of writing assignments in a secondary math class would improve high school students’ understanding of math concepts. The research questions were:

1. According to the professional reviewed literature, how were the writing assignments in math defined?
2. According to the professional reviewed literature, how were the writing assignments used in a math classroom?
3. According to the professional reviewed literature, what were the benefits of writing in math class?
4. Did the implementation of writing in a math class improve student understanding of math concepts?

Participants

The participants in this study were ninth, tenth and eleventh grade student in an Algebra I class. They were enrolled in a heterogeneous classroom in a small, rural school in a Midwestern state. The class consisted of 24 students of which 16 were males and 8 were females. Of the 24 participants identified there were 18 Caucasian, 1 Hispanic, 1 African-American and 4 multiracial students. The students were chosen as participants for the study because they were enrolled in an Algebra I class assigned to the researcher as part of his student teaching assignment.
Treatment and Intervention

The participants of this study were asked to solve algebra problems during algebra class and then explain in writing, in a step-by-step format, how they solved the problems. These writing assignments allowed the students to express their own understanding of algebraic concepts.

The intervention was implemented during a ten-day period. During the first day of the intervention, the researcher modeled the writing assignment to the class. The researcher displayed a simple algebra problem on the smart board and then showed the students how to solve the problem mathematically. The researcher then wrote out all the steps to the problem in words (see Appendix A for the problem and solution). After the students took the notes on the model, the researcher asked the students to solve a simple algebra problem and write down, in bulleted points, their method of solving the problem (see Appendix B for the problem).

When the students were finished with the assignment they were asked to share their work with a partner and verbally explain how the problem was solved. The students were placed in groups of three to work on a more complex algebra problem. Although the problem was more complex, it reflected algebraic concepts previously mastered by the students (see Appendix B for the more complex problem). The students were directed to solve the problem and on chart paper provided by the researcher, and write out the steps for solving the problem. When the groups had completed the task, one person was asked to review the group’s problem solving with the class.

One the second day of the intervention, the researcher reviewed the writing process with the class. The students were presented with an algebra problem and were asked to solve it and write out the steps for its solution. When the students were done solving the problem, each student was partnered with a classmate and was given time to discuss the problem. When the researcher
noticed that the discussions came to an end, the students presented the steps in solving the problem verbally to the class.

Following this in-class review, the researcher discussed the notion of rubrics with the students. The students informed the researcher that they were familiar with the use of rubrics through other classes they have taken. The researcher then distributed the writing rubric to the students and explained how this rubric was to be used for assessing the writing assignments. There were four assessment criteria on the rubric; explanation, mechanics, demonstrated knowledge, and completion of the problem, to solve the assigned problem (See appendix C for the rubric).

Starting the third day and through the tenth day, the students were assigned an algebraic problem to be completed. The algebraic problems pertained to factoring and completing the square in the algebra chapter (See appendix F for example problems). The students were instructed to use the step-by-step process that was demonstrated and practiced during days one and two of the intervention.

**Instruments**

In order to answer the research question, Did the implementation of writing in a math class improve student understanding of math concepts? Data was collected from the assessment rubric for the student writing assignment for each student. The data for the study was gathered through review of the students' writing of the problems given during the ten-day period. The writing assignments were assessed by the researcher with the rubric which articulated the criteria for the writing assignment within four categories for a total of sixteen points. The four categories were;
**Explanation** 4 points “A complete response with a detailed explanation” 3 points “Good solid response with clear explanation.” 2 points “Explanation is unclear.” 1 point “Misses key points.”

**Mechanics** 4 points “No math errors” 3 points “No major math errors or serious flaws in reasoning.” 2 points “May be some serious math errors or flaws in reasoning.” 1 point “Major math errors or serious flaws in reasoning.”

**Demonstrated Knowledge** 4 point “Shows complete understanding of the questions, mathematical ideas, and processes.” 3 points “Shows substantial understanding of the problem, ideas, and processes.” 2 points “Response shows some understanding of the problem.” 1 point “Response shows a complete lack of understanding for the problem”

**Requirements** 4 points “Goes beyond the requirements of the problem.” 3 points “Meets the requirements of the problem.” 2 points “Hardly meets the requirements of the problem” 1 point “Does not meet the requirements of the problem”

**Procedures**

Prior to the initiation of the research project, the researcher discussed the process, timeline, and the class selection with the cooperating teacher. Permission was granted for the eighth period class to be involved in the project. A letter was sent to the parents/guardians of the participants explaining the purpose of the research project. The letter asked permission for their child’s involvement in the research project. The parents were to return the signed letter only if they did not wish for their child to participate in the research study (See Appendix E for the parent letter).
One day after the due date indicated on the parent letter, the researcher started the research project with his eighth period Algebra I class. During the next ten days the writing assignment intervention was initiated. The intervention continued for ten days with one algebra problem assigned each day. The algebra problems dealt with completing the square and factoring (Appendix F for the algebra problem). Scores were recorded for each student for each day.

**Timeline**

The researcher met with his student teaching mentor on April 1, 2009 to discuss the implementation of the study. During the week of April 6, 2009 the researcher chose the participants of the study and selected one class in which he would collect individual student entries for data analysis purpose. The math writing assignment intervention was initiated on April 13, 2009 and continued for ten days. The data was analyzed following the intervention period.

**Data Analysis**

The purpose of this study was to determine whether the implementation of writing in a math class improved student understanding of math concepts. Data was collected from the writing assignments from the researcher’s eighth period Algebra I students. The writing assignment was administered during a ten-day period in April. The writing assignments from the days three through ten were assessed and analyzed for the study.

In order to analyze the data from the writing assignments, the researcher assigned each student an identification number. The purpose of assigning the identifier number was to help organize and be unbiased towards any of the students. The results from each student rubric for each of the eight days were tabulated and graphed to determine if there was improvement in the
understanding of the mathematical concept. The researcher used the third day as a baseline to notice if there was an improvement with the student understandings. The researcher took the next seven days scores from the students and averaged them to compare the two. In order to analyze the data, the researcher prepared a table to track the progress of each of the student’s writing assignments. The researcher specifically tallied the total of the points the students received in their writing assignment from the rubrics. The data obtained from the writing assignments were recorded on a chart that consisted of the baseline score and the students’ average (See Appendix D for baseline and average).

Conclusion

This chapter explained the methods and procedures that were used to investigate Research Question #4. Specifically, an action research study was conducted in order to determine if the implementation of writing assignments in a secondary math class would improve high school students’ understanding of math concepts. The participants in the study were 24 high school Algebra I students that were assigned an algebra problem during a ten-day period. The students were to complete the algebra problem by writing out their steps which the researcher helped guide them during the first two days. The researcher assessed the students’ problem with a rubric that totaled up to sixteen points. The rubric criteria were; an explanation of the problem, the students’ mechanics, and the students’ demonstrated knowledge and did the student reach all the requirements. The researcher wants to analyze if the students’ understanding improvement during the study. The researcher took the third day as a baseline and then took the last seven days average to see if there was an improvement. Following the analysis of the data, the results of the study were determined.
Chapter IV: Results

The purpose of this project was to determine if the implementation of writing assignments in a secondary math class would improve high school students understanding of math concepts. The research questions were: 1) How were writing assignments in math defined? 2) How were writing assignments used in a math classroom? 3) What were the benefits of writing in math class? 4) Did the implementation of writing in a math class improve student understanding of math concepts?

A review of literature provided answers to the first three research questions. The researcher used this information to plan and conduct an action research study that answered the question of whether the implementation of writing in a math class improved student understanding of math concepts.

The methods and procedures described in Chapter III were utilized in order to gather the data pertaining to the study. The data obtained from the study were derived from the students' scores that were assessed through the rubric.

The intervention was developed and was conducted by the researcher during a ten-day period. The algebra problems that were completed by the researcher's 24 eighth-period algebra students were analyzed by the researcher. In order to determine whether the students' level of understanding improved over the period of time, the researcher compiled a table of the students' scores, from a rubric, using an Excel spreadsheet to help organize the data. To help determine if there was an improvement in the students' understanding the researcher compared the students' score on the rubric from day three of the intervention and the participant mean score of the final seven days to decide if there was an increase, no change or a decrease in their rubric scores.
The data showed that out of the twenty-four participants; seventeen participants showed an increase, four participants showed no change and three participants showed a decrease in their rubric scores.

The highest rubric score from day three rubric scores was a fourteen out of the possible sixteen, which came from nine of the participants. Of these nine participants three of the participants had their mean decreased to 13.9 for each of them, three had no change in their score, and the other three increased their score by more than one point. The lowest score from day three was eleven out of the possible sixteen, which came from one participant. The participant with the lowest score from day three showed an increase to their mean score by 2.4 points. The data indicated that seventeen of the twenty-four participants showed an increased in their rubric scores.

![Bar chart showing participant score on day 3 compared to participant's mean rubric score of the final 7 days.]

**Day 3 Rubric Score Compared to Participant's Mean Rubric Score of the Final 7 days**

*Figure 1. Comparison of participant’s day 3 rubric score and the participant’s mean rubric score of the final 7 days*
The data indicated that 70.83% of the students showed an increase in scores, with 16.67% showed no change and while 12.5% of the participants decreased in their scores. The data indicated that the majority of the participants showed an increase in their math scores.

**Figure 2.** Percentage of participants who had an Increase, No Change, or Decrease in their scores.

The data indicated that most of the participants increased their rubric score from day 3 to day 7.
Summary

Instruments and procedures were developed to determine if the implementation of writing assignments in a math class improved student understanding of math concepts. The data collected during this project indicated that the majority of the participants experienced an increase between the day 3 rubric score and the mean rubric score of the following 7 days.
Chapter V: Discussion

The purpose of this project was to determine if the implementation of writing assignments in a secondary math class would improve high school students’ understanding of math concepts. The research questions were: 1) How were writing assignments in math defined? 2) How were writing assignments used in a math classroom? 3) What were the benefits of writing in math class? 4) Did the implementation of writing in a math class improve student understanding of math concepts?

Meaning of Findings

The review of the professional literature identified several reasons for implementing math writing strategies in the classroom. The literature indicated the math writing was a beneficial instrument for both the student and the teacher alike and that the math writing strategy influenced positive responses and understanding. The researcher’s results from the intervention indicated some support for the view of the professional literature. The improvement in the students’ understanding of the concepts was observed when the writing was implemented in the classroom.

The researcher was interested in implementing a math writing strategy in the classroom to discover if writing could improve the students’ understanding of a concept in math. The researcher wanted to utilize the strategy as a communication tool for the students to express their mathematical ideas and understandings. The researcher noted that some of the students were hesitant at first to put in words their steps for the algebra problems. Also, a few students felt that the writing would not help them in the understanding of solving the problem. The math writing
strategy provided the researcher with new ideas for class instruction and class participation. The researcher’s findings supported the idea that writing in math assisted in the students’ understanding.

The researcher analyzed the results from the writing assignments and discovered that most of the students demonstrated encouraging outcomes in the problems. The researcher agrees with the professional literature that if the writing strategy were to continue after the project was concluded that it could be used in other concepts.

The data from the writing assignments were compared to analyze question number four. The data emerged to show that students’ understanding of the math concept over the time period of the study. The understanding of the concept may be attributed to the repetition of the problems and not taking anything away from class time.

The finding from the writing assignments reflected some of the beliefs that the professional literature expressed. The results concurred with Hurst (2005) that the recurrence of writing strategies would assist the student in a concept.

The writing assignments helped increased understanding of the students’ knowledge of the mathematical concept. The study demonstrated that students’ understanding of math changed when writing assignments were engaged in the classroom.

Summary

The purpose of this project was to determine if the implementation of writing assignments in a secondary math class would improve high school students understanding of
math concepts. There were twenty-four participants in this study. All participants were in enrolled in Algebra I and attended a small, rural school.

The researcher used a series of writing assignments as the treatment/intervention, math problems were assigned to assess the students’ thinking during the writing assignments. There were seven algebra problems that the students were to solve algebraically and then in writing, explain how they arrived at the answer.

The algebra problems were developed to help determine if the students’ understanding of the math concept improved as a result of the implementation of the writing assignment. The writing assignments consisted of an algebra problem each day for a time period of ten days. The algebra problems pertained to factoring and completing the square.

At the end of the study the researcher analyzed the data collected from the writing assignments. The findings suggested that the majority of the students showed an understanding of the math concept. Of the twenty-four participants in the study 70.83% of them increased their mean score from rubric, and while 16.67% had no change in their score. Finding concurred with the professional literature in that writing in math would help improve student understanding in the classroom.

**Recommendations**

Some ideas that could be implemented to improve the project were determined. The length of the time period for the research project was a factor that needed to be altered. The researcher would recommend that math writing should continue for at least half of the school year to the entire school year.
The researcher would also suggest implementing the writing assignments with all math topics concepts. Another recommendation would be to include a greater number of participants since the sample size of the participants was small and not representative of all student populations because of the location of the research, in a small, rural, Midwestern school.

**Conclusion**

Math writing assignments as an intervention were implemented in a math classroom. It appeared that the use of writing in math helped the students’ understanding on a math concept. Based on the data collected during the project, the researched agreed with Pavlovich (2007), that a student who is given a tool for communication will benefit in their understanding with repetition and practice.
Reference


### Example Problem

\[ x^2 + 4x - 2 = 0 \]

<table>
<thead>
<tr>
<th>Algebraically</th>
<th>In word</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ( x^2 + 4x = 2 )</td>
<td>1. Add 2 to both sides</td>
</tr>
<tr>
<td>2. ( x^2 + \frac{4x}{2} = 2 )</td>
<td>2. Divide 4x by 2 to get 2</td>
</tr>
<tr>
<td>3. ( x^2 + 4x + 4 = 2 + 4 )</td>
<td>3. Square step 2 answer add to both sides</td>
</tr>
<tr>
<td>4. ( x^2 + 4x + 4 = 6 )</td>
<td>4. Add 2 and 4 together to make 6</td>
</tr>
<tr>
<td>5. ( (x+2)(x+2) = 6 )</td>
<td>5. factor the polynomial</td>
</tr>
<tr>
<td>6. ( (x+2)^2 = 6 )</td>
<td>6. combine the ( (x+2) ) to make it squared.</td>
</tr>
</tbody>
</table>
**Appendix B**

**Simple and Complex Example Algebra Problem**

### Simple Example Problem

\[ x^2 + 2x - 1 = 0 \]

<table>
<thead>
<tr>
<th>Algebraically</th>
<th>In word</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Complex Example Problem

\[-12x + 3x^2 + 15 = 0\]

<table>
<thead>
<tr>
<th>Algebraically</th>
<th>In word</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix C

The Writing Assignment Rubric

<table>
<thead>
<tr>
<th>Criteria</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Explanation</strong></td>
<td>A complete response with a detailed explanation.</td>
<td>Good solid response with clear explanation.</td>
<td>Explanation is unclear.</td>
<td>Misses key points.</td>
</tr>
<tr>
<td><strong>Mechanics</strong></td>
<td>No math errors.</td>
<td>No major math errors or serious flaws in reasoning.</td>
<td>May be some serious math errors or flaws in reasoning.</td>
<td>Major math errors or serious flaws in reasoning.</td>
</tr>
<tr>
<td><strong>Demonstrated Knowledge</strong></td>
<td>Shows complete understanding of the questions, mathematical ideas, and processes.</td>
<td>Shows substantial understanding of the problem, ideas, and processes.</td>
<td>Response shows some understanding of the problem.</td>
<td>Response shows a complete lack of understanding for the problem.</td>
</tr>
<tr>
<td><strong>Requirements</strong></td>
<td>Goes beyond the requirements of the problem.</td>
<td>Meets the requirements of the problem.</td>
<td>Hardly meets the requirements of the problem.</td>
<td>Does not meet the requirements of the problem.</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total: [__]
Appendix D

Day 3 Rubric Score Participant’s Mean Rubric Score of the Final 7 days

<table>
<thead>
<tr>
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Appendix E
Parent’s Letter

To: 8th period Algebra I class parents

From: Mr. Lynn, Mr. Flory’s student teacher

April 6, 2009

Dear Parents/Guardians:

Hello and good day to you. My name is Derek Lynn and I am a teach intern from Defiance College. As you may have heard from your son or daughter, I am interning this semester with your child’s math teacher, Mr. Flory. While completing my internship, I will be collecting data for my master’s research project. The purpose of my project was the implementation of writing in a math class improve student understanding of math concepts.

Your child’s class has been selected to participate in the research project. Your son or daughter will not be required to complete any additional homework nor will his or her writings will be presented for a grade. The project will take place during a 10 day period where your son or daughter will be answering a problem at the end of class.

If you do not wish for your child to participate, please sign and return the form below by April 13, 2009. Thank you for your understanding and cooperation. If you would like any further information please feel free to contact me.

Thank you,

Derek Lynn

I would not like my son or daughter to participate in the research project.

________________________  ______________________  __________
Parent’s Signature            Student’s Name            Date
## Appendix F

### Writing Problems for Each Day

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\[
\frac{1}{2} x^2 + 4x - 7 = 0
\]

\[
\frac{1}{3} x^2 + 6x - 8 = 0
\]