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Vocabulary development through math journaling using technology resources in an elementary math classroom

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Abstract
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VOCABULARY DEVELOPMENT THROUGH MATH JOURNALING USING TECHNOLOGY RESOURCES IN AN ELEMENTARY MATH CLASSROOM

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INTRODUCTION

Introduction to the Problem

The typical picture of a student working in mathematics class involves watching the student work with numbers; however, mathematics is not just about numbers. This view of mathematics does not include all the vocabulary that the student encounters. When students are learning mathematical concepts, having an understanding the vocabulary associated with the concepts is important. The development of a mathematical vocabulary is not an easy task for learners. One way of developing this vocabulary is through writing experiences. The use of journaling as a component of the math curriculum can open many doors of information for both the student and the teacher. The use of computer-based journals can benefit the writing process.

Statement of the Problem

The development of mathematical vocabulary is a complex task because the words encountered are uncommon, have meanings that may be different from everyday usage, and may be used in more than one way in math class. This investigation is an action research study examining the possible benefits of developing mathematical vocabulary using technology based math journaling in a second grade classroom. The students that were involved in the study are a group of eight boys and eight girls for a total of sixteen students. Students completed a pre- and post-assessment of their knowledge of mathematical vocabulary in a teaching unit on measurement. Students also completed a pre-attitudinal survey and post-survey of their feelings toward mathematics. Computer-based journal entries were completed by students on a daily basis during the duration of the three week study.

The vocabulary assessment consists of ten-multiple choice questions focusing on the most appropriate unit of measure or the label for a specific measurement. The attitudinal survey asks participants about his/her feelings toward mathematics, work habits, the importance of mathematics, and about his/her favorite and least favorite parts of math class. Journal entries will be completed using the Appleworks word processing program and sixteen computers. Journal entries will be content-based and reflective in nature. Four content entries will be completed followed by one reflective entry during the three weeks in which the study will take place.

At the completion of the study, results of the pre-assessment vocabulary survey will be compared to the post-assessment survey of vocabulary knowledge. The results of the pre-attitudinal survey will be compared to the post-attitudinal survey. Journal entries will be analyzed using the Grounded Theory process (Charmaz, 2006).

Research Questions

This investigation attempted to determine if the use of computer-based content journaling leads to a better understanding of the mathematical vocabulary during a unit of study. The second area of focus of this investigation was to establish if the use of technology-based reflective journals has a positive impact on the students' attitude toward mathematics. The research questions are as follows:

1. How does the use of computer-based content journaling affect the understanding of mathematical vocabulary?
2. Will the use of technology-based reflective journals have an impact on the students' attitudes toward mathematics?

METHODOLOGY

Participants

An action research study was conducted in a second grade mathematics classroom in a non-public elementary. The students included in the study were seven-to-eight years of age. Eight boys and eight girls took part for a total of sixteen students. Based on class performance, six of the students were above average in math ability, four were average ability, and six were below average students. The students participating in this study had not completed any formal standardized tests. The participants had experienced some pencil and paper journaling on various occasions prior to this study.

The students live near or in a small rural community of approximately 5,000 people. All students taking part in this study were Caucasian. The school serves students in grades one through six with 207 students attending. There were 13.3% of students on free or reduced lunches. The average class size at this school was eighteen students.

Instruments

The materials included in this study included assessment instruments, writing prompts, curricular tools, and hardware. The assessment instruments included a pre-assessment and post-assessment of mathematical vocabulary knowledge, as well as, a pre-study and post-study attitude survey. Writing prompts for journal entries in word processed documents were provided as a needed ingredient to carry out this study. The assessment instruments and writing prompts were teacher-generated. Sixteen computers equipped with the Appleworks word processing program were required equipment. The final tools needed were various measuring tools such as rulers, yardsticks, meter sticks, scales, thermometers, and containers for liquid measurement.

The vocabulary assessment (Appendix A) included ten multiple-choice questions. The focus of each question was selecting the most appropriate unit of measurement or the label for a specific measurement. An example question is "If I measure the distance around a plane shape I would be measuring _____?" The student had four or five possible choices from which to choose.

The attitudinal survey (Appendix B) asked participants about their feelings toward mathematics, their work habits during class, their thoughts about the importance of learning math, and their favorite and least favorite parts of class. There was also an opportunity for the participants to add narrative comments. The attitude scale was based on Dutton's Attitude Scale presented on the following website, (www2.msms.k12.ms.us/~ccarter/dutton.htm). The purpose of the attitude survey was to establish the students' feelings toward math. It was also used to establish a pattern of work habits and how they viewed the importance of mathematics. To determine which parts of the math class students liked or disliked was the final purpose of the attitude survey.

The journal entries were composed of two different types. The first type, content journaling, focused on the participants' understanding of the type of measuring being done and was in response to the writing prompt provided by the researcher. The participant would be presented with a writing prompt and asked to react to that prompt. The use of prompts encourages students to write about their understanding in math class and the experiences they meet in a school setting as well as in their everyday lives outside of school (Kaplan, 2001). Writing prompts provided a point where all students could begin their writing process (Mason & McFeetors, 2002). The prompts were generated by the researcher and were based on the vocabulary presented in the measurement unit in the

second grade math curriculum. Participants were required to explain their thought processes using the appropriate vocabulary.

The second type of journal entry was a reflective entry. This type of entry provided the participant an opportunity to reflect on the learning process. These prompts were based on the format presented at the Math Journals website (Math Net, retrieved June 17, 2005).

The content journal entries and the reflective journal entries were completed using a computer and the AppleWorks word-processing program. The completed journal entries were printed and filed by the participants.

Research Design and Procedures

The study took place as a part of the regular second grade math curriculum during a unit of measurement in the investigator's classroom. The investigation took place over a three-week period during the final quarter of the school year.

Parents and students were asked to sign a consent form to participate in the study. The form explained that participation was by choice of both a parent and the student. The same process was used with all students since it was part of the curriculum, but the data was compared for only the students whose parents had signed the consent forms.

The informed consent letters were delivered to the parent and child in an envelope placed in the student's folder that went to and from school each day. The parents returned the forms in the sealed envelope by placing it in the same folder. The sealed envelopes were collected and kept in the school office until the completion of the school year. No one was aware of who was or was not participating in the study until the final day of the school year. At the completion of the school year the school administrator opened the envelopes.

The administrator then informed the investigator that all students had permission to participate in the study.

Each student was assigned a letter at random by a third party at the beginning of the study. This letter was used throughout the study for data collection, data analysis, and final summary. The researcher did not have access to the corresponding letter for each student until the completion of the project to avoid any researcher bias. When all analysis was completed the corresponding letter for each student was made known to the investigator.

The data collected at the beginning of the study were the pre-assessment of vocabulary knowledge and the results of the attitudinal survey. The data collected throughout the study were the content journal entries and reflective journal entries. The entries were in response to content-based writing prompts and reflective writing prompts provided by the researcher. All journal entries were completed using a word processing program on computer. Content journal entries were completed four days a week and reflective journals were completed every fifth day.

The students were introduced to measuring tools in a large group setting by the researcher and had opportunity to use those tools in a number of experiences. Students were then invited to complete a content journal entry based on that measuring tool. The students completed the journal entry using a word processing program on computer. When a teacher is looking for specific information about students' learning or when a specific activity is planned around a writing prompt, it is suggested that all students should be given the same writing prompt to complete (McIntosh & Draper, 1997). For example, when the ruler was introduced students had the opportunity to measure using inches, feet, and objects that were longer than a foot. After this experience the participants completed a

journal entry based on the following writing prompt: "How can you measure something that is longer than your ruler? When might you measure using inches instead of feet?" This process was followed for four days. On the fifth day students completed a reflective journal entry based on writing prompts.

At the completion of each journaling experience, each student printed the completed entry, attached it to the sheet with the writing prompt printed and filed it in the corresponding letter folder. The researcher then read and commented on each entry at a later time. Due to the coding system, the researcher was unaware of which work was completed by which student.

At the culmination of the unit of study participants completed a post-assessment of their vocabulary knowledge and a post-attitudinal survey. These results were compared to the pre-study results.

Analysis

The data gathered for analysis focused on the categories of the mathematics vocabulary and the students' attitudes toward mathematics. Information was gathered prior to the study and at the completion of the study.

Mathematics Vocabulary

A comparison of the results of the pre-and post-assessment of vocabulary was used to determine any change in the understanding of the vocabulary. There was a statistical comparison of results of the pre-and post assessment of vocabulary. Journal entries were analyzed using the Grounded Theory process (Charmaz, 2006). The Grounded Theory process was executed using the following steps:

1. As data were collected key ideas were noted.

2. Comparisons and coding of these results was completed.
3. Categories and sub-categories were identified.
4. A core category came out of the categories and sub-categories.
5. Relationships between categories were documented.

The documentation of the relationships occurred in parallel with the collection of data, taking of notes, and coding of information. When sorting, the notes were grouped on the basis of the similar categories and properties they addressed (Charmaz, 2006). Grounded Theory was appropriate for analyzing these data because it is systematic, but provides flexible guidelines for collecting and analyzing qualitative data.

Student's Attitude toward Mathematics

The data gathered from the pre-and post-study attitude surveys were used in comparison to measure any changes that may have taken place. Changes in responses from the pre-and post-study attitude surveys were noted and compared. Data was collected and analyzed from the reflective journal entries and narrative comments from the attitude survey. As data was collected from the reflective journal entries and narrative comments, key ideas were noted and coded. Categories, sub-categories and a core category emerged. Relationships between categories were noted. Notes were grouped on the basis of the properties they addressed (Charmaz, 2006). This process, based on the Grounded Theory, was systematic but flexible.

LITERATURE REVIEW

Introduction

The purpose of this literature review is to address the role of vocabulary development through computer-based journaling in an elementary math classroom. The importance of this review relates to the opportunity for students to use technology resources to develop an acceptable grasp of the math vocabulary. Math vocabulary is used when students are communicating their ideas in writing, when reflecting on the ideas, and when explaining what was learned. An analysis of information from past research is appropriate because by examining the importance of the development of math vocabulary, the benefits of journaling and the use of technology resources to achieve these goals, a background of knowledge can be developed from which to base instructional decisions. The scope of this review includes establishing the importance of vocabulary development in math, the benefits of writing in math class, the integration of technology resources into these strategies, a study conducted on writing in mathematics and a study about the use of word processing in primary grades. The results of this review can be applied in any primary mathematics classroom that has access to a word processing program and computers.

The information presented from the literature review will determine the importance of vocabulary development, the reasons writing should be used in math class and the benefits of doing so. It will also establish the role that technology plays in vocabulary and writing development.

METHODOLOGY

The resources used to identify and locate sources of information for this review included: (a) The Educational Resources Information Center (ERIC search), (b) Elton B. Stephen's Company (EBSCO) available through the local Area Education Agency (AEA1) database, (c) the ERIC Silver Platter and Wilson Web databases, and (d) print sources available through the University of Northern Iowa's Rod Library. The author used the following descriptors: journaling, math instruction, vocabulary instruction, technology integration, word processing and elementary education. Many pertinent articles, documents, and reports were found. The first criterion for analyzing journal articles was based on whether the article was published in a juried or peer-reviewed journal. A second criterion was whether the journal article was published within the past five to seven years. The limitation for currency of print sources was within the past ten years. The final criterion for all resources was that the source needed to be relevant to the topic. After each source was read and evaluated, the researcher outlined the topics and categorized the information. All of the chosen articles related to one or more of the following (a) the importance of vocabulary development, (b) technology, (c) the use of math journals in the primary grades, (d) technology integration, and (e) word processing.

Review of the Research

As the students continue to learn and build upon math concepts, it is important that they are able to communicate about the concepts being learned. In order to do this, it is necessary to understand the vocabulary. Monroe and Panchyshyn (1995) stated "The importance of rich and meaningful vocabulary knowledge when developing concepts is well documented and widely-accepted by classroom teachers; vocabulary provides access

to concepts" (¶ 1). Schell stated that math material ". . . with more concepts per word, per sentence, and per paragraph than any other area" (as cited by Monroe & Penchyshn, 1995, ¶ 1) necessitates the need for vocabulary instruction in the mathematics area. Gawned made the point that mathematic vocabulary instruction should not be done in an incidental manner (as cited by Monroe, 1998). It needs a place within the mathematical curriculum. Robb (2003) made this analogy:

> Building vocabulary strength is like pumping iron or training for football or track and field events. By consistently training for and practicing a sport, students improve and develop their breathing muscle strength, tactics, and concentration-allowing them to compete at a higher level. It's the same with learning vocabulary (p. 218).

The focus on mathematical vocabulary establishes access to concepts and should not be done in a manner that is inferior. It needs an established place within the mathematics curriculum.

Challenges of Teaching Math Vocabulary

The task of developing mathematical vocabulary is not a simple one. Monroe and Panchyshyn (1995) explained the most prevalent roadblock is lack of opportunity which makes mathematical vocabulary a challenge to learn. Most of the vocabulary used in the mathematical classroom is rarely a part of daily life for the student. Students therefore are not likely to have background knowledge for these words. Vacca and Vacca believed that because meaningful vocabulary instruction is often neglected by teachers, students do not have the opportunity to learn mathematical vocabulary in the classroom either (as cited by Monroe & Orme, 2002). Another difficulty that Noonan pointed out is that mathematical

words have meanings that differ from everyday use (as cited by Monroe & Orme). Shields, Findlan and Portman (2005) summarized the problem of math vocabulary as a "specialized vocabulary of unfamiliar words, symbols and notations that are not often encountered in everyday life" (p. 37). The development of mathematical vocabulary is an important task but not always an easy task because of lack of opportunity, limited background knowledge, neglected instruction, meanings different from everyday use and the use of a system of symbols.

Categories of Terms

To take a closer look at the type of words encountered in the mathematics curriculum, Monroe and Panchyshyn (1995) identified four categories of words. These categories included technical terms, subtechnical words, general words and symbolic.

Technical terms. The first category of words as identified by Monroe and Panchyshyn is *technical terms*. These terms ". . . convey mathematical concepts that are difficult, if not impossible, to express in everyday language. Each technical term has only one meaning which is specific to mathematics" (¶ 4). Learning technical terms is comparable to learning a foreign language. An example of technical terms might include words such as integer or quadrilateral.

Subtechnical terms. The next category of words is referred to as *subtechnical terms*. These types of words have more than one meaning which varies from one content area to another or from a content area to everyday experience or within a mathematical context. An example of subtechnical terms would be the volume of a cube, the volume control on the television set, and the volume of world trade. These words are especially difficult to conceptualize.

General vocabulary. The third category of mathematical vocabulary identified by Monroe and Panchyshn (1995) is *general vocabulary*. This category of vocabulary words includes those that students encounter in daily reading and language experiences. These categories of words are those typically used in a mathematics textbook but not likely taught in reading class. The terms *number sentences* or *problem solving* would be examples of general vocabulary.

Symbolic vocabulary. The final category of mathematical vocabulary identified by Monroe and Panchyshyn is *symbolic vocabulary*. This category refers to the reader needing to recognize not only the alphabet but also a number of non-alphabet symbols such as the addition symbol, the subtraction symbol or the equal symbol.

Teaching of mathematical vocabulary is a challenge. It includes words that are not a part of the student's daily life. Mathematical vocabulary includes four categories of words that the may differ in meaning from other curricular meanings. Many students lack the background experience needed to understand terms associated with mathematics. Many researchers have explored the needed elements of building vocabulary knowledge.

Vocabulary Instruction

There is no best way to teach vocabulary. "In 2000, after analyzing two decades of research on vocabulary instruction, the National Reading Council concluded that there is no one best method for teaching vocabulary" (Burns, 2006, ¶ 2). Shields, Findlan & Portman (2005) explained that simply assigning students to look up a math term in the dictionary is an ineffective instructional plan. Using context and building on students' prior knowledge is a more effective practice. Students need to have repeated experiences with words in a variety of contexts over a period of time to establish an understanding of a term.

Many experiences with a new word in a wide range of contexts provide richness and deepness of meaning. Monroe and Orme (2002) felt that the development of mathematical vocabulary must be a part of the mathematical curriculum. This plan should include experiences of constructing meaning from text and from direct teaching. While there is no one best way to teach vocabulary, it is important to keep students actively involved with a variety of opportunities to interact with the vocabulary. Building upon a student's prior knowledge is important.

Writing to Develop Vocabulary

There are a number of ways to develop mathematics vocabulary. Monroe and Panchyshyn (1995) suggested writing assignments as one way to develop mathematics vocabulary. Powell (1997) also stated that writing is beneficial to developing an understanding of the vocabulary that can be used in comprehending math concepts. "Writing encourages students to examine their ideas and reflect on what they have learned. It helps them deepen and extend their understanding. When students write about mathematics, they are actively involved in thinking and learning about math" (Burns, 1995, p.13). It is important to be actively involved in the learning process. This leads to a deeper level of understanding of the vocabulary associated with mathematics.

The National Council of Teachers of Mathematics (NCTM) acknowledges that writing as a part of the mathematical curriculum is important. The standards set by the NCTM state that instructional programs from pre-kindergarten through grade 12 should enable all students to organize and strengthen their mathematical thinking through communication. These standards affirm that students should be able to communicate their mathematical thinking logically and plainly to peers, teachers, and others. Students should

be able to examine and evaluate the mathematical thinking and strategies of others, as well as use the language of mathematics to express mathematical ideas accurately (National Council of Teachers of Mathematics, retrieved June 17, 2005). Being able to communicate mathematically should be a primary goal for all students.

Reasons for Writing

Mason and McFeetors (2002) explained three reasons students might write as a part of their math class. Students may respond to a teacher's desire for evidence of mathematical understanding. A second reason might be to report to the teacher what they want the teacher to know. It also provides an opportunity to reflect on learning. The final reason for writing could be to develop a partnership with the teacher in their learning. Carter and Carter (1994) believed that the focus of writing is on what the student is thinking rather than having the correct answer.

> Composition is an important tool in mathematics because it allows students to focus their attention on what they are doing. They need not be preoccupied with getting the right answer or asking questions like, "How do I do this one?" but rather they can concentrate on the process of solving a problem or the understanding of mathematical concepts (p. 2).

When journaling, the students may be providing the teacher with a demonstration of their understanding which in turn can develop a partnership. The focus changes from correct answers to thoughts and processes.

Student Benefits

Journaling in math class presents many benefits to the students. O'Brien (1996) sees how writing can take a student's understanding to the next level of thinking.

> Children may be able to do something, may be able to show someone else and explain it, may be able to just tell someone else, or, finally, may be able to explain clearly in writing. To me these are distinctly different skills or levels of understanding. I hoped the journals would be a way to help the students toward the highest level of knowing (p. 155).

Writing in math class requires students to organize, clarify and reflect. All of these are useful processes for making sense of mathematics. When writing, a student can provide a view of his/her understandings, his/her misconceptions and his/her feelings. The writing is not meant to be ready for publication but rather as a way for a student to reflect, explore, extend and confirm the mathematical ideas (Burns, 2004).

In addition to providing information about what a student understands or does not understand, a student's view of math instruction can be revealed through his/her writing. Elementary students must appreciate math, be interested in math, learn to think and reason mathematically, and be ready for math challenges (Burns, 1995). Writing can be used to encourage a positive learning environment where students can gain confidence in their ability to do math (Pugalee, 1998). Writing in math class can provide a student with a vehicle to express his/her likes or dislikes toward math.

Making mathematics relevant is also productive. When children make connections between the real world and mathematical concepts, mathematics becomes relevant to them. "As mathematics becomes relevant, students become more motivated to learn and more interested in the learning process" (Albert & Antos, 2000, ¶ 1). Having confidence, feeling motivated, and seeing relevance in math can provide students with a positive attitude toward mathematics.

Teacher Benefits

When writing is integrated into the mathematics curriculum it is not only beneficial to the student but to the teacher as well. "Writing not only benefits children by contributing to their learning, it benefits teachers by helping them assess what their students are learning" (Burns, 1995, p. 29). Writing can also provide "an open channel of communication between teacher and students and promotes good rapport and a positive classroom environment" (Miller, 1996, p. 80). Writing opportunities serve as a feedback tool between teacher and student (Pugalee, 1998). Journal writing can make a teacher aware of specific concerns or difficulties a student may be experiencing (Carter & Carter, 1994).

Griffiths and Clyne determined that "Writing also provides records for the teacher that assist in the assessment of children's learning and understanding, provides a basis for discussion with the child, and aids in planning for upcoming instructional activities" (as cited by Tichenor & Jewell, 2001, p. 300). Norwood and Carter (1996) found that through journal writing, thoughts and understandings are brought to light that are not typical of normal classroom communication. A test would not lead to such in-depth information.

Students and teachers may receive benefits from journal writing. It is also beneficial for helping to build connections between mathematics and other content areas. "Writing about mathematics helps students see new connections between the various subjects they are studying" (Carter & Carter, 1994, p. 4).

Writing in math class can be beneficial to students and teachers. The NCTM has established standards for communication as a part of the mathematics curriculum. Writing

can assist in developing a higher level of thinking. It helps to build connections to other curriculum areas.

Alternative Form of Assessment

Journal writing can serve as an alternative form of assessment. "Journal writing is a simple, inexpensive tool for alternatively evaluating students' progress" (Norwood & Carter, 1996, p.83). The journaling process can be used as a flexible assessment tool. When students write as a part of mathematics, teachers, as well as parents, can evaluate and examine students' work. Patterns in thinking, reasoning, and learning styles can be established (Stix, 1996).

Burns (1995) established three assessment purposes for math journals. The first was for the teacher to evaluate how beneficial the instructional program is in supporting the learning goals after reading students' writing. The second purpose was to determine an individual student's understanding of a skill. The third purpose was to provide a concrete artifact when interacting with parents about what a child was learning and the progress being made or lack of progress being made.

Beliefs and Practices

In 1997, Quinn and Wilson conducted a study to determine teacher's beliefs and practices in the use of writing while teaching of mathematics. The researchers wanted to find out what teachers' attitudes were concerning the use of writing in mathematics instruction and if these attitudes varied among teachers in elementary, middle school and high school. Quinn and Wilson also wanted to determine the types of writing believed to be most important and types of writing that were used at each age level. Advantages and disadvantages as seen by teachers were also explored.

Five elementary schools, five middle schools and four high schools participated in the study on a volunteer basis. The schools were from a combination of lower, middle and upper socio-economic levels. The grade levels used were second, seventh, and eleventh, for a total of eighty-four teachers. The study included a questionnaire with 75% of the teachers completing it. The questionnaire was a 5-anchor Likert scale on the potential advantages and disadvantages of writing. The average teacher responses on the advantage statements were *agree* or *strongly agree*. The average answers on the disadvantage statements were *disagree* or *strongly disagree*. The participating teachers also completed a questionnaire on the importance of a variety of writing activities. Using a 5-anchor Likert scale, the researchers found that the lowest average rating were logs for understanding, reflective journals, expository writing and creative writing. The higher averages were for writing word problems and explaining solutions. These findings seem to indicate that the forms of writing that had lower averages were viewed as nontraditional types of writing. The higher scores indicated that the teachers in the study supported their use as traditional types of writing.

The next area that the researchers focused on was the frequency with which the teachers used a variety of writing activities. It was found that each type of writing activity was used less than once every two weeks in all three grade levels. The exception to this finding was the use of writing to explain solutions to problems. Writing to explain the solutions to problems was used with more frequency. Teachers indicated that they felt that writing benefited the student's understanding of mathematical concepts. Some teachers felt this way still did not include writing in math class because of students' poor writing skills. There were a number of other reasons given as to why writing was not incorporated. One

teacher felt that it was difficult enough getting through the material without adding something more. Another stated that it was a problem because of limited class time. The extra time that it would take to grade all journals was the concern of another. A high school teacher made the following comment, "The English teachers do not do math in their classes." The results of this research demonstrated that teachers are updating their beliefs regarding the ways in which mathematics should be taught but are not changing the ways in which they teach.

Integration of Technology

With the integration of technology, teachers may change the way they are teaching. Integrating technology is a way to achieve communication standards. Writing across the curriculum can be encouraged through the use of a word processing program. The development of a professional looking writing sample using technology can engage the learner. The beginning writing process demonstrates benefits from the use of technology. Word processing allows for changes of ideas with little effort by using the cut and paste features to rearrange text or by deleting or adding content (Roblyer, 2003). If a student has poor handwriting the use of a word processing program can decrease student embarrassment.

The National Education Technology Standards for Students (International Society for Technology in Education, 2000) has established standards for which the use of word processing fulfills the performance indicators. These performance indicators can serve as a guide in creating quality learning environments enriched by technology. The environment engages students in behaviors that have educational technology skills and appropriate curricular substance interwoven. Using input devices and output devices to successfully

operate computers, VCRs, audiotapes, and other technology are performances in Standard One that should be completed by the end of grade two. The use of a variety of media and technology resources for directed and independent learning activities is another performance indicator. The use of developmentally appropriate multimedia resources to support learning is an expectation. Integrating technology joins conventional and fresh instructional methods to assist in the learning of important content while addressing individual needs.

Computer-based writing has demonstrated benefits. Using technology resources, word processing in particular, can have positive effects on the writing process. Building writing and mathematical skills at the same time with the use of technology was an attractive idea. Researchers found that written expression was more fluent and there was improvement in writing mechanics (Tichenor & Jewell, 2001).

Using word processors in the primary grades was examined by Jones (1994). An area of interest was the possible effect on the children's literacy skills. Jones believed that the use of technology has a pleasing effect on the student's writing skills. A study with second grade students that focused on the use of word processing in the writing process found that students demonstrated progress in both the quality and quantity of writing. Jones concluded that the using of word processors assists the writing process even with young children. There appears to be a relationship between the use of word processing and improvement in the young writers pencil and paper writing. It is believed to focus on the composition and the revision stages of writing.

Beck and Fetherston (2003) added this thought about the topic: "Word processing can promote students' motivation to write, engage the children in editing, assist proof-

reading, help printing techniques, help students produce longer texts, and assist reluctant writers to write" (p. 142). Using technology in the beginning writing process appears to be beneficial.

Conclusions

A well-developed understanding of mathematical vocabulary is necessary to communicate about the concepts being learned. Research shows that that there are many challenges in developing this understanding. The challenges include the lack of opportunity for students to use the words and words with meanings that differ from everyday use. Learners may have limited background knowledge of vocabulary associated with mathematics. The development of the vocabulary associated with mathematics requires a place in the curriculum.

Some believe that writing assignments are beneficial in developing an understanding of vocabulary. The National Council of Teachers of Mathematics (NCTM) has established standards that affirm that students should be able to communicate their mathematical thinking. This communication requires using mathematical language. When journaling is a part of the mathematics curriculum, the students may be providing the teacher with valuable information about their comprehension and understanding of a particular concept. Journaling can serve as an alternative form of assessment. Reflecting journaling can open a line of communication between teacher and student to express their thoughts and feelings about mathematics and the concepts being studied. In a study conducted by Quinn and Wilson (1997) it was found that while many teachers understand the benefits of writing as a part of math class, writing was not integrated into the mathematics curriculum by many teachers.

Integrating technology into the writing process is one method that encourages using writing during math class. Technology can engage the learner through production work. Use of a word processing program can improve written expressions. Researchers found that using word processing yielded written expression that was more fluent and there were more improvements in the writing mechanics. Jones (1994) found that this was true even with young writers.

Recommendations

To develop an understanding of mathematical vocabulary it is recommended to provide a variety of opportunities to use the words in real context. Journaling is one opportunity to achieve this goal. By using both content and reflective journaling, teachers can assess the students' understanding and how they are feeling about a particular concept. Technology integration can serve as a logical tool to use in the writing process. Students take pride in their writing and can make a variety of revisions as necessary. Understanding mathematical vocabulary can be enhanced through the writing process. The writing process is enhanced through the use of technology resources.

RESULTS

The purpose of this study in a second grade math class was to examine the possible benefits of developing mathematical vocabulary using computer-based journaling. Students were surveyed to collect information on how this experience changed their feelings toward mathematics. Table 1 displays data gathered from the content journal with the responses made by one or more students and can be found on the following page.

At the conclusion of the study the scores from the pre-study assessment of vocabulary knowledge were compared to the scores from the post-assessment. The average score on the pre-study assessment was 32 of 44 points or 73% accuracy. The median score was also 32 points. The scores on the pre-assessment ranged from 28 to 39 points. The average score on the post-study assessment was 37 of 44 points or 84% accuracy. The median score was 38 points and the scores ranged from 30 to 42 points.

The data gathered from the content journal entries demonstrated that when asked about a time when the student needed to know the length of an object was 44% of the students related it to prior experiences, and 31% of the students expressed curiosity about length in real life. Some students related measuring experiences provided at school. For example, "I needed to know how long my math book was to see if it fit in the desk." Other students related measuring to experiences at home. "My dad told me to get a board about two feet long from the shop for him." There were also replies expressing curiosity about the height or length of objects experiences in life. "How long is my dad's pump truck?"

When demonstrating an appropriate unit of measurement, there was a relationship established between the size of the object and the size of the unit of measurement.

Table 1

Content Journal Responses

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Total
Relate to prior experience	1	1		1		1	1			1	1						7
Express curiosity				1	1				1			1				1	5
Unit of measurement based on size of object	2	1	2	2	1	1	1	2	1	1	1	2	1	1	2	1	22
Use ruler as guide to determine unit				1					1								2
Unit of measurement depends on size of object	1	3	3	2	4	2	2	3	2	2	2	2	3	3	2	3	39
Unit of measurement based on time to carry out the task					1	1				1	1			1			5
Comparison based on established knowledge	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	30
Tie to other curriculum areas			1	1			1								1		4
Explains steps in a process	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	32

All the students used this way of thinking at least once in the journal entries and 38% of the students used this relationship twice. There was also a relationship established by 31% of the students between using a larger unit of measurement when measuring a larger item because it required less time. Some students (13%) suggested using a ruler for a guide. "I would measure using inches when something is shorter than my ruler. I would measure using feet if something is longer than my ruler." When asked which units of measurement would be best to measure the length of the classroom a number of students made a connection between the size of the object and the size of the unit of measure. "You would use meters and yards because a classroom is big and those measurements are the biggest." This type of thinking also held true when considering liquid measurement. "It would be better to use gallons because a bathtub is really big and gallons are the biggest." This generalization was also used when estimating the area of a plane shape. "I can use square inches to cover up the shape. If it's a big shape I will need lots of squares and if it's a little shape not so many." Students also concluded that the amount of time needed was dependent on the unit of measurement. "It would be better to use cups instead of ounces to fill your fishbowl. It is even better to use gallons because it wouldn't take so long." When students are interacting with words that label units of measurement, the data demonstrates that small items are measured using small units of measure while large items are measured using larger units of measurement. This relationship was used by 6% of the students one time, 50% of students on two occasions, and 44% of the students on three occasions when journaling. There is also evidence demonstrating that the unit of measurement that takes the least amount of time is preferred over other units of measurement.

The student data from journal writing demonstrated a comparison being used based upon established knowledge by 88% of the students participating in the study. "The string is long enough because a foot is twelve inches. Thirteen is more than twelve." Another example, "Four feet is greater than one yard because there is three feet in one yard." It is also an opportunity to change units of measurement into a common unit. "There are 3 feet in a yard. 3 yards is bigger because 3 yards is 9 feet. But 9 feet is longer than a yard." Journal writing provides the opportunity for students to communicate the knowledge gained throughout the unit of study.

Journaling also provided opportunity to establish connections to other curricular areas for 25% of the students. The students participating in the study were also working in the unit titled "Earth through Time." Many of the students made the connections between the areas. "What is the length of a dinosaur compared to the length of our classroom?"

Students were also provided with an opportunity to explain steps in a process. All students were able to do this successfully. "The perimeter is the distance around the shapes. The sides are 4+2+4+2 so the perimeter would be 12 inches." This response provides much more information than simply a response of "12 inches."

The computer-based reflective journals had some impact on students' attitudes toward mathematics. Table 2 illustrates the comparisons between the pre-study assessment and the post-study assessment.

Two students improved their opinion about their abilities in mathematics but one more student did not feel so competent in mathematics. After completing the instructional unit of work, 75% of the students thought mathematics was easy or just right. This compares to 81% having this opinion before participating in the study. Students take their

time when completing their work which is demonstrated in both the pre-study and post-study results. The attitudinal survey showed that 69% of the students thought that math class was just the right length before participating in the study, with 50% having this opinion after completing the study. The importance of math class stayed consistent when comparing pre-study information to the post-study information.

Table 2

Pre- and Post-Study Attitude Survey Comparisons

Survey Prompt	Responses	Pre-study	Post-study
I think I am _____ at math.			
	Awesome	2	4
	Good	7	4
	OK	6	8
	Not so good	1	2
I think that math class is _____.			
	Easy	1	1
	Just right	12	11
	Hard	3	3
	Impossible	0	1
When I do my math work I _____.			
	Hurry	0	0
	Take my time	13	13
	Get help	2	3
	Wait for help	1	0
I wish we could have math class _____.			
	Longer	4	3
	Shorter	0	2
	Never	1	3
	It is just right	11	8
How important do you feel that learning math is?			
	Really important	7	5
	Not important	0	1
	Kind of important	0	1
	As important as other classes.	9	9

Table 3 shows the results of a survey when students were asked to select their three favorite parts of math class. This information can be compared to students' selection of the three least favorite parts of math class in Table 4.

Table 3

Favorite Part of Math Class

Favorite part of math class	Pre-study	Post-study
Taking time tests	6	6
Doing word problems	4	4
Learning how to do new things	14	12
Journal writing	3	12
Working in my book	6	4
Completing homework	6	4
Daily Reviews	9	6

The most significant change was the increase of students selecting journaling as one of the favorite parts of math class. The journaling experiences that were used prior to this research were often met with resistance and were a struggle to motivate students to complete the pencil and paper activity. Three students indicated that journaling was a favorite part of math class before participating in the study and twelve students selected journaling after participating in the study. There was only a slight change in the other categories.

Table 4

Least Favorite Part of Math Class

Least favorite part of math class	Pre-study	Post-study
Taking time tests	8	8
Doing word problems	10	10
Learning how to do new things	8	10
Journal writing	9	2
Working in my book	4	5
Completing homework	7	9
Daily Reviews	2	4

As Table 4 shows, before participating in the study, nine students selected journaling as a least favorite part of math class. After participating in the study, two students continued to feel this way.

The reflective journals provided an opportunity to ask the teacher questions that students were unsure about or things they were curious about. This opportunity was used by 88% of the students. Some students asked about measuring the area of an irregular shape. Two students asked how to measure the area of a bowling ball. This type of journal entry also provided an opening for sharing their likes and dislikes of previous classes during the time period. This opportunity was used by 63% of the students. It was also a chance to inform the teacher of the concepts that were challenging for them. This option was used by 88% of the students.

DISCUSSION

Conclusions

Just as in the language arts curriculum, vocabulary and expressing one's thoughts in written form is also important in mathematics. Vocabulary development is important as a tool for understanding and communicating mathematical ideas. One way of developing a rich mathematical vocabulary is through journaling. Determining if the use of computer-based content journaling led to a better understanding of the mathematical vocabulary during a unit of study was a focus of this investigation.

This investigation set out to determine if the use of computer-based content journaling led to a better understanding of the mathematical vocabulary during a unit of study. Based on the comparison of pre- and post-assessment of vocabulary knowledge there was an increase in the scores. The average accuracy on the pre-study vocabulary assessment was 32 of 44 points or 73% accuracy. The average score on the post-study assessment was 37 of 44 points or 84% accuracy. There were also some patterns identified in the content journal entries. Prior knowledge was used by 44% of the students when identifying things to measure. Some students (31%) expressed curiosity about the measurement of an object when determining which item to measure. All students were able to formulate and use a rule that the unit of measurement to be used was dependent on the size of the object in at least one of their journal entries. This rule was used to establish the idea that it takes less time to measure big items with large units of measure. For 25% of the students, math journaling also provided a link to other curriculum areas. Students had the opportunity to explain their thinking when completing a math journal entry.

Journaling with a variety of different types of writing prompts appeared to keep the students actively engaged by providing variety in the method of vocabulary instruction. Journaling gave the students an opportunity to connect with prior knowledge. and interact with the vocabulary.

The second area of focus of this investigation was to establish if the technology-based reflective journals had a positive impact on the students' attitudes toward mathematics. After the students were involved in writing the technology-based reflective journals there was6 a significant change in the selection of journaling as a favorite part of math class. When completing pen-and-paper journal activities prior to the study it was a challenge to motivate all students to want to complete their journal entry. The results of the pre-study survey showed 19% of the students selecting journaling as one of their favorite parts of math class. This compares to 75% of the students feeling this way the conclusion of the study. When asked to select their least favorite parts of math class prior to the study, 56% of the students selected journaling. When asked the same question at the conclusion of the study there were 13% of the students that made this selection. There were only slight changes in the other areas of the attitude survey.

Writing experiences in the form of journals have demonstrated possible benefits to students. Students are able to discuss thinking and understanding of a particular concept. Journaling can also be a vehicle for students to express their feelings toward mathematics and mathematics instruction.

Recommendations

The researcher recommends that this study be continued throughout other units within the math curriculum to compare the results. It is also recommended to focus more

on the attitude of the students as they are completing the journaling entries. Conferencing with the students about their journal entries and providing specific feedback to individual students would have been beneficial but not practical since students were asked to stay anonymous to the researcher. The researcher would recommend that future studies involve larger populations so that an experimental research design using an experimental and control group could be used to quantify differences that journaling might make in students' learning rates.

Other recommendations would include the research into the area of the use of graphic organizers in the development of mathematical vocabulary. The benefits of writing during mathematics instruction could be explored during teacher in-service and a pre-determined trial period be explored so that teachers not only hear about the benefits but explore this idea in their own classroom. In addition to the exploration of writing in mathematics, the use of technological resources to carry out this writing experience should continue to be explored for integration into other areas of instruction.

SUMMARY

The purpose of this of the study was to examine any changes in the students' understanding of mathematical vocabulary after experiencing computer-based journaling. A second purpose of the study was to examine any changes that occurred in their feelings toward mathematics after experiencing computer-based journaling. The participants completed two types of journal entry. Content journaling focused on the participants' understanding of the type of measuring being done and was in response to the writing prompt provided by the researcher. Reflective journaling provided the participant an opportunity to reflect on the learning process.

After engaging in computer-based journal writing, grade 2 students demonstrated a change in scores on assessment of mathematics vocabulary knowledge. The comparison of scores from the pre-assessment and post-assessment of vocabulary knowledge demonstrated an average score increase of 11%. The average score for the pre-assessment was 73% compared to the post-assessment where students demonstrated an average score of 84% accuracy.

The data gathered and analyzed from the content journals demonstrated examples of students integrating information gained with background knowledge that they gained from their prior experiences. They also expressed curiosity about how these skills could be applied to their real world situations. Journaling helped students arrive at the generalizations relating the size of what was to be measured with the unit of measure. It also helped to establish the role that time plays in determining the most appropriate unit of measurement. The final benefit demonstrated was the opportunity it provided for the

students to explain their thought processes. All these benefits required the students to use words, labels, and processes.

The math attitude survey showed a significant increase in the selection of journal writing as a favorite activity in math class. Pencil-and-paper journaling that was done prior to the research was often met with resistance. Journaling was selected by 19% of the students in the pre-study survey and by 75% in the post-study survey. No significant changes were noted in other areas of favorite or least favorite math class activities. The reflective journals did provide students the opportunity to ask questions, express curiosity, share what they liked and disliked about certain aspects of math class, and identify the concepts that proved to be challenging for them.

Understanding mathematical vocabulary is one of the keys to understanding mathematics. Journaling provides an opportunity to focus on the mathematical vocabulary and to use these words in context. The vocabulary associated with mathematics cannot be ignored and by using the journaling strategy it can be learned.

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APPENDICES

A. Vocabulary Assessment

1. Which of these units of measurement would you use to find the length of your pencil? (You can mark more than one.)
   - o Inch
   - o Foot
   - o Centimeters
   - o Meters
   - o Yard

2. Which of these units of measurement would you use to find the distance between the second grade classrooms? (You can mark more than one.)
   - o Inch
   - o Foot
   - o Centimeters
   - o Meters
   - o Yard

3. Which of these tools would you use to find out how warm it was outside today?
   - o Cup
   - o Yardstick
   - o Scales
   - o Thermometer

4. If I measure the distance around a plane shape I would be measuring
   - o Area
   - o Perimeter
   - o Weight
   - o Length

5. If I wanted to know how much milk was in my glass at lunch I would measure it using
   - o Quarts
   - o Pints
   - o Cups
   - o Gallons

6. If I wanted to know how many pounds of potatoes are in the bag I would want to know their
   - o Temperature
   - o Length
   - o Weight
   - o Capacity

7. If I wanted to buy a large bottle of water to take to a birthday party what size would I buy?
   - o 1 cup
   - o 1 liter
   - o 1 ounce
   - o 1 milliliter

8. If I am going to measure the number of square units that cover a plane shape I am measuring
   - o Perimeter
   - o Length
   - o Area
   - o Weight

9. Which of these units of measure would be on a thermometer? (You can mark more than one.)
   - o Inches
   - o Centimeters
   - o Degrees Fahrenheit
   - o Degrees Celsius
   - o Pounds

10. Which of these units of measure would be on a meter stick?
    - o Inches
    - o Centimeters
    - o Degrees Fahrenheit
    - o Degrees Celsius
    - o Pounds

B. Attitude Survey

I think that I am _____ at math.

- Awesome
- Good
- Ok
- Not so good

I think that math class is

- Hard
- Easy
- Just right
- Impossible

When I do my math work I

- Hurry and get done quick
- Take my time and work through each problem carefully
- Get help from someone because it is too hard
- Wait and have the teacher or a volunteer help me

I wish that we could have math class

- Longer
- Shorter
- Never
- It's just the right length

How important do you feel that learning math is?

- Really important
- Not important at all
- Kind of important
- As important as any other class

My favorite parts of math class are (you can check more than one)

- Taking time tests
- Doing word problems
- Learning how to do new things
- Journal writing
- Working in my book
- Completing my homework
- Daily reviews

My least favorite parts of math class are

- Taking time tests
- Doing word problems

- Learning ho to do new things
- Journal writing
- Working in my book
- Completing my homework
- Doing daily reviews

Tell me anything else you that you want me to know about Math class.