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Effect of expository writing in mathematics with middle school sixth grade students

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Abstract

The effects of expository writing (a writing to learn approach) on achievement in a math unit on fractions was investigated. Two groups of intact sixth grade mathematics classes (N = 44) were chosen and the treatment of expository writing was randomly assigned to one group. The control group received direct instruction for the unit on addition and subtraction of fractions while the treatment group practiced expository writing (a how-to descriptive writing) plus direct instruction. The study lasted four weeks. The same summative post test of the fraction unit was given to both groups when the unit was complete. The null hypothesis states that there is no difference in achievement between students receiving expository writing plus direct instruction as compared to students receiving only direct instruction. A t test was used and the results showed no significant difference in the means of the scores from the two groups on the summative test in fractions (t = 1.5). Therefore, the null hypothesis was not rejected. Expository writing did not significantly affect achievement in a mathematics unit on fractions. Further study is suggested to determine which writing tasks are best suited for which particular learning goals in mathematics or any other content area.

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EFFECT OF EXPOSITORY WRITING IN MATHEMATICS WITH MIDDLE SCHOOL SIXTH GRADE STUDENTS

A Graduate Project

Submitted to the

Department of Curriculum and Instruction

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts in Education

UNIVERSITY OF NORTHERN IOWA

by

Rebecca J. Dickinson

June 29, 1992

This Research Paper by: Rebecca J. Dickinson

Entitled: Effect of Expository Writing in Mathematics With Middle School Sixth Grade Students

has been approved as meeting the research paper requirement for the Degree of Master of Arts in Education.

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Abstract

The effects of expository writing (a writing to learn approach) on achievement in a math unit on fractions was investigated. Two groups of intact sixth grade mathematics classes (N = 44) were chosen and the treatment of expository writing was randomly assigned to one group. The control group received direct instruction for the unit on addition and subtraction of fractions while the treatment group practiced expository writing (a how-to descriptive writing) plus direct instruction. The study lasted four weeks. The same summative post test of the fraction unit was given to both groups when the unit was complete. The null hypothesis states that there is no difference in achievement between students receiving expository writing plus direct instruction as compared to students receiving only direct instruction. A t test was used and the results showed no significant difference in the means of the scores from the two groups on the summative test in fractions (t = 1.5). Therefore, the null hypothesis was not rejected. Expository writing did not significantly affect achievement in a mathematics unit on fractions. Further study is suggested to determine which writing tasks are best suited for which particular learning goals in mathematics or any other content area.

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Effect of Expository Writing in Mathematics With Middle School Sixth Grade Students

The following literature review covers the span of writing across the curriculum, particularly math, from the past to the present. It begins with a statement from the National Council of Teachers of Mathematics to show the importance of communication in mathematics, possibly done through writing. The review summarizes the past literature tied to the beginnings of the writing to learn approach across the curriculum, writing to learn in the mathematics content area, and specific articles presenting perspectives from various practitioners on how to incorporate writing into the mathematics classroom. Last, some issues of using a writing to learn approach in any classroom, not only mathematics, are raised.

Review of the Literature

National Council of Teachers of Mathematics

The National Council of Teachers of Mathematics Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989) have spelled out major goals required to meet mathematics needs in the 21st century. The ability to read, write, listen, think creatively, and communicate mathematics has emerged as one of those goals. Therefore, writing in mathematics has become the increasing trend in education to help students communicate about mathematics. Not only does writing help students clarify their own understanding, but it

provides a strategy for those students who prefer written over quantitative expression (Wood,1992).

Writing to Learn Approach Across the Curriculum

Today there is research support and literature for incorporating writing instruction not only with the teaching of mathematics, but across the curriculum as well. Fifteen years ago, though, the picture was different, as one could find very few articles about the topic of writing in mathematics.

Emig (1977), a pioneer who examined writing as a unique mode of learning, pointed out that writing allows one to visualize thoughts and therefore to examine and modify them. Therefore, conclusions were made by Emig that writing provides a unique mode for self-learning in many academic subjects, including mathematics, since it is active, engaged, and personal in nature. Fifteen years earlier Polanyi (1962) stated that knowledge is genuine only if it somehow is made personal and if the learner is able to construct personal meaning from it.

Geeslin (1977) questioned if getting the answer in mathematics was emphasized to the point in society where students could not talk or write about mathematics. It was his belief that writing about mathematics was useful both as a diagnostic tool for the teacher and a learning device for the student. Suggestions were made for mathematics teachers to encourage students to discuss mathematics. Geeslin speculated further that written explanations of mathematics

have advantages over verbal explanations. He felt that writing encourages the student to be more precise, improves technical writing skills, and provides an opportunity for cooperative activities between mathematics and English classes. To summarize Geeslin's ideas, one could say that as students write more, they begin to form more precise ideas about mathematical concepts.

Herrington (1981) built on Emig's work and took the perspective from English teachers. He concluded that writing as a learning approach implies that students do have something to say and it provides the way for them to discover and communicate concepts and ideas. This approach underscores a responsibility that teachers need to create situations that stimulate student learning. Teachers should design assignments linked to course objectives, preferably assignments that emphasize more than just recall of facts. This can then become a process of discovery through writing.

Fulwiler (1980, 1982) became one of the leaders in the movement called "Writing Across the Curriculum" and proposed journal writing and expressive writing as two ways of allowing students to reflect on their attitudes and feelings in all disciplines and as a way to improve knowledge in those disciplines. Writing across the curriculum enthusiasts focused on content rather than the writing itself. Fulwiler (cited in Kurfiss, 1985) contended that writing can help students learn and think about content in any discipline.

About the same time as Fulwiler, Lehr (1980) explained that writing is a means for students to handle new information, discover relationships, and clarify ideas. Like reading, Lehr felt that writing is a vital part of the learning process and should be in every academic classroom. Writing in all areas of the curriculum provides the medium through which learners can practice reproducing one's understanding of a concept. One does not understand an idea fully until one can write about it. Learning to write involves learning to think (Cassady, 1990). Therefore, all teachers need to attend to the teaching of writing as well as to the teaching of content. Sociologists, historians, chemists, and mathematicians across the country have come to the conclusion that students have not mastered course material if they cannot write about it (Ulisse, 1988).

Writing to learn has other benefits. Slater (1988) interviewed five research subjects who were teachers about using writing to learn in their content areas. Each of the five had changed his or her classroom management style because of the work with writing to learn, encouraging more group work and more collaborative learning techniques to make every student responsible for his/her own learning.

Others that contributed to the writing to learn concept believed that the value of writing may be attributed to some combinations of factors such as (a) the permanence of writing, allowing the writer to rethink, to revise, and to develop thoughts over an extended period, (b) the

explicitness required in writing forcing the writer to sharpen hazy thoughts and perceptions so they can be put into words, and (c) writing requiring active participation by the writer (Applebee, 1977; Marland, 1977; Martin, 1984; Applebee, 1984).

More recent studies have examined the writing to learn approach. Copeland (1985) working with sixth graders, found writing led to higher scores on both a transfer measure and a measure of factual recall, when compared with three non-writing activities (answering multiple choice questions, directed rereading, and a control activity).

In another study, low-achieving math students using writing to learn techniques improved their state competency test results to a greater percentage than did average math students in a traditional classroom (Gladstone, 1987). A physics teacher saw a steady 3-year improvement in overall grades in his physics classes when writing to learn techniques were used (Self, 1985). Pearse (1985) used a writing to learn approach in his literature classes and found that the approach placed more learning in students' hands. The writing to learn approach created an environmnent where students could express their feelings about the reactions to their learning, provided students and teacher with ongoing reviews of their understanding and application of course concepts and material along with their thinking processes, and served as a springboard for activities that demonstrated the extent and quality of student learning.

Writing to learn in all content areas also brought Lavoie and Backus (1990) to contend that writing is a significant tool both, to monitor student growth and development as well as to help students overcome stumbling blocks in learning. It was also felt that writing helps students with thinking processes. The relationship of these thinking processes and the idea of journal writing in all content areas, therefore, was incorporated into the arena of writing to learn.

Journal Writing

Although few actual empirical research studies were found on the topic of journals, authoritative statements were located from practitioners of journal writing in all content areas. The notion of learning as being transmitted by the teacher through filling the empty head of the student is rejected in journal writing. Knowledge is seen as being generated by the learner through an interactive, thinking and doing process. Therefore, writing through journals is shown to be a tool for learning (Zacharias, 1990).

Other ideas on journal writing and relationships to the thinking processes have come from Emig (1983), Strong (1983), Olson (1984), and Wolfe and Pope (1985). All concluded that the writing process connects the hand that is doing the writing, the eye that sees what is written, and the brain that is responsible for thinking, sorting out, and absorbing knowledge. Journal writing stimulates thinking, and in thinking one comes to formulate ideas, opinions, and new knowledge. Fulwiler (1985) suggested that when students are really thinking, they use their

own words and not the words of the teacher or anyone else. Therefore, it should stand to reason that students who write with journals will perform better than students who don't. The students themselves have commented that they learn best by listening to their own voices in writing, as documented in a research study of first year writing students (Grace, 1991).

Routman (1991), a practitioner in the whole language approach, felt that journals provided many benefits to teachers and students. These benefits included the promotion of fluency in writing and reading, encouragement of risk taking, reflection opportunities, provision of a safe place to write, and the provision of a vehicle for evaluation.

Since communication is the most important part of mathematics in many respects, the use of journals in mathematics has been on the increase. Mathematicians must be able to receive and understand communications, and they must be able to communicate their results. Recent advances in technology have made computation more appropriately done by machines than the human mind, therefore the use of such machines requires the mathematicians to be able to communicate with machines as well as people (Willoughby, 1990). This is further reinforced in the findings of the NCTM when it was recommended that more communication in mathematics was needed (NCTM, 1989).

Writing to Learn in Mathematics

Steen (1989) believed that the communication NCTM goal could be achieved in mathematics through writing because it helps students clarify their own understanding as they try to put ideas into writing. Steen felt that it provides the student who likes writing better than mathematics, an opportunity to have a vehicle more suited to his/her ability.

The importance of communication in mathematics through writing is also reinforced by Mumme and Shepherd (1990) when they concluded that communication through writing helps to enhance understanding along with establishing shared understanding. It was their feeling that writing empowers students as learners, establishes a comfortable learning environment, and assists the teacher in gaining insights into student thinking.

Communication in mathematics also includes engaging students in active learning, challenging them to apply prior knowledge, and providing opportunites for them to experience new and increasingly more difficult situations. Therefore, instructional approaches should be geared to this process of learning so that students in grades 5-8 can see mathematics as an integrated whole (House, 1990).

The idea of holistic integrated mathematics where students approach mathematical tasks that are real to them and become active learners through communication and problem solving has been proposed by Baker (1990). To keep up with the ever changing

demographic work force situation of increasing minorities and women, we need to reduce the attrition rate in mathematics, which is about fifty percent. Of particular importance is a need to look at why women and minorities do not choose to enroll for advanced mathematics courses. Many educators feel the study of mathematics will need to be restructured to draw in more minorities and women (Kirwan, 1990; Pejouhy, 1990). Clinging to the familiar traditional algorithms will have to give way to cooperative situations where students can communicate and maybe then, the curriculum will become interesting enough to keep women and minorities in mathematics.

Mathematics instructors have traditionally seen their task as one of presenting material to students in a clear and precise manner. The students copy a rule and memorize it. This has been referred to as the copy theory of learning (Kenyon, 1988). Mathematicians feel this could be the single most important deterrent to effective education in mathematics. Therefore, a change in recent years with new methods in mathematics has occurred. Those methods are bringing passive students into the learning process where they construct their own knowledge structure through associated writing.

Burns (1988) worked with fifth graders and concluded that by writing, students explore, clarify, confirm, and extend their thinking and understanding. Burns felt that not only does writing help the students to learn, but it helps the teacher to get inside each student's

head and find out what learning is taking place in order to help plan instruction that fosters understanding and mathematical thinking. In another fifth grade general mathematics class of Havens (1989), students who had failed under traditional methods of teaching mathematics for nine or ten years in a row, were given a new dimension of learning through writing. It forced them to understand and apply a concept instead of just having to memorize the trick to each operation. The students not only improved their mathematical abilities, but they expanded their abilities to understand and communicate difficult concepts to others.

Journal Writing in Mathematics

Communicating by writing in mathematics journals externalizes thinking even more than speech by demanding a more accurate expression of ideas. By writing something down, it then becomes outside oneself and can be more easily looked at and reflected upon (Pimm, 1987).

Based on these ideas of journal writing, a study was done to examine the usefulness of expressive journal writing in a first grade mathematics program. Subjects were asked to record in journals what they were learning over an eighteen week period. Results showed that students used writing for self-questioning, organizing information, assimilating and accomodating information, and making guesses. This type of writing made learning active and personal (Wason-Ellam, 1987).

Schmidt (1985) used journal writing in a mathematics class to open lines of communication and to build a sense of community so that students could take risks. Forsman (1985) used journal writing to let the students write about what they already knew in mathematics and then to see how that knowledge fit with new information being studied in the curriculum. Buerk (1986) suggested using mathematics journals as an opportunity for students to reflect on paper about their ideas and feelings about mathematics and their recollections about how they were taught mathematics. This type of writing would help students to overcome a common belief that mathematics was not "person-made" (p. 6), a view that prevents students, particularly women, from finding a way to make mathematics more meaningful.

Linn (1987) passed out journals to a geometry class and wrote a journal question on the blackboard each day that was based on a different level of Bloom's taxonomy (knowledge, comprehension, application, analysis, synthesis, and evaluation). Project results showed that journal writing in this manner had improved the thinking skills of the students. This was documented through statements from the students themselves that writing in this manner had improved their understanding of the material.

Nahrgang and Peterson (1986), strong math journal advocates, defined the journal as a diary like series of writing assignments. Each assignment or entry in the journal is to be a short written response to an instructor's question, statement, or set of instructions. Nahrgang

and Peterson suggested that students use an expressive writing style in journals so that their responses are spontaneous. Three to seven minutes should be used for each entry. If used in this manner, they felt that journals would allow students to proceed at their own rate and converge on an understanding of mathematical concepts using their own experiences.

A journal can also provide a diagnostic tool for teachers. Moore (1991) began using mathematics journals in her second grade class on a weekly basis. It was found that the mathematics journal served as a diagnostic tool, both for student understanding and for teacher effectiveness. When a multiplication concept was presented through a fun activity, although it was thought the students had understood the objective, it was quite an eye-opener through the journal entries to discover that the whole point had been missed by many students. The journals had become a tool for insight into processing in the minds of the students.

Mathematics journals also are referred to as learning logs. Brown (1991) concluded that daily mathematics logs provide a method of individually clarifying concepts through writing. The logs also provide opportunities to restate logical principles, to promote mastery of knowledge, to recognize individual learning styles, to provide a forum for unanswered questions, and to improve student attitudes. These strategies have generated the idea of a new concept called whole mathematics.

Methods to Incorporate Writing into Mathematics Classrooms

Educators in the mathematics field have suggested many forms of classroom writing methods besides journals to incorporate into the mathematics classroom. Strackbein and Tillman (1987) compared four types of writing in regard to the purpose each served. This included (a) diaries (an introspective exercise), (b) creative writing (self expression disciplined into a literary genre), (c) expository writing (to inform and persuade others; a description or a how-to), and (d) journals (increased communication between self and chosen audience to help fluency and clarity). Lavoie and Backus (1990) added the idea of using tests that have free response questions for students as a way to incorporate writing into mathematics along with using outlines, notetaking, and concept maps for each unit.

Other types of writing in mathematics used to synthesize concepts could include daily summaries, formulation of student word problems, explanations of procedures and concepts, and reflections on each day's study material (Brown, 1991). Just the act of verbalization can improve a student's ability to recall and organize information.

Sipka (1988) suggested that all mathematics writing assignments fall into two basic categories: informal and formal. Informal writing is one where the reader's main concern is the substance of what is said, where the content is king. In formal writing the reader is concerned with both the content and the quality of the student's writing. Examples of informal writing are mathematics autobiographies, reading logs,

journals, explanatory letters, and in-class writing where students spend time writing about a particular topic the teacher has chosen. Examples of formal writing are proofs, process papers, summaries, solutions to journal problems, research papers, and lecture notes.

Appropriate mathematics writing exercises encourage greater precision than speaking. Possible mathematics writing assignments discusssed by LeGere (1991) included a personal mathematics history taken at the beginning of each term, an analysis of a problem that the students found difficult on any test, and open-ended writing where the students write what they think they are learning. Open ended statements such as "Yesterday I learned..." or "What I'm finding hardest right now is..." can be used. Wilde (1991) called this open-ended statement mode "reframing knowledge" (p. 39), where students are asked to write about what they have learned. Wilde also suggested using writing as a method of exploring process problems that must be figured out through reasoning, trial and error, or insight rather than using an algorithm. Process problem solving and the use of writing has been discussed by others such as Ford (1990). Since students have difficulty with problems in mathematics that have a lot of words and complex sentence structures, in which information is not presented in the order in which it is used to solve the problem, mathematics teachers need to focus more attention on writing and reasoning. Students should be encouraged to create their own story or process problems geared to their own level of interest and life style so the

student is more inclined to remember and apply the math concepts involved.

Communication is the heart and soul of the world of business, and it should be the same in our classrooms. Therefore, problem solving that utilizes writing skills needs to be present in our mathematics curriculum. Our present curriculum is not preparing graduates for situations they encounter once they leave the classroom (Mitchell, 1990).

Letter writing is another way to incorporate writing into mathematics. Towards the end of a mathematics unit, students are asked to write the teacher a letter about what they are studying in mathematics. The letter should include three points (a) what they understand, (b) what they don't understand, and (c) what they're wondering about (Kennedy, 1985).

McGehe (1991) suggested using word webs in mathematics. After writing a key word or phrase in the middle of their paper, students can then brainstorm words with any knowledge or feelings they have about the key word. Students should then start to see categories from the words listed, therefore it becomes apparent to categorize the ideas. It was felt that this exercise can help students to organize their thoughts about a particular idea.

The question of what students should write about in mathematics often stops many teachers from pursuing the idea. With the wealth of ideas in current literature on this topic, teachers should stop feeling

reluctant. Haggerty and Wolf (1991) suggested 3 types of writing (a) narrative, (b) descriptive, and (c) expository writing. Narrative writing included examples such as writing biographical sketches of noted mathematicians, writing about the use of mathematics in the work world, and writing stories or word problems. Descriptive writing included writing how-to descriptions, defining mathematical vocabulary, summarizing the daily lesson, writing paragraphs using sports statistics, writing directions using measurements, and writing about the usage of mathematics in their daily life. Expository writing included writing explanations as to the meaning of graphs, explaining in words how to correct an incorrect problem, persuading others to change their behavior using statistics, and using feedback statements where students write responses to topics such as "I like mathematics because...", or "I hate mathematics because..." (p. 246).

A study done by Evans (1984) showed that students in a variable mathematics group using three types of writing actually scored higher on a post test than the control group that did not use these three writing methods. The three methods were (a) written explanations, which described how to do something to an uninformed third party, (b) writing their own definitions, and (c) troubleshooting, where students explain errors on their homework before turning in their papers.

Azzolino (1988) used six techniques for accomplishing writing in mathematics without decreasing the time spent on content and without increasing the time spent grading papers. These included

(a) wordbanks, where students wrote sentences using a list of words for the lesson or unit; (b) rewording, where the student rewords or rewrites a statement or procedure in his own words; (c) lead sentence, where the students are given a sentence and they write a second sentence or paragraph; (d) completion of statements; (e) debriefing, where students have to complete a procedure or lecture or list the steps in the procedure just completed; and (f) non-thought warm-ups, which are questions given to students that may be answered without much thought, but then students go on to answer a second question on the same topic that requires more thought.

Wood (1992) used what was called reaction guides for writing in mathematics which consisted of a series of five to eight statements which reflected general concepts about a topic. Students then had to synthesize their understanding of these concepts in order to write a refuting or confirming reaction statement about each.

The last method for incorporating writing into mathematics presented in this literature review is called expository writing. This is defined as a form of writing with a primary purpose to set forth or explain (McIntosh, 1991). It is called a how-to writing where students explain step by step the process used to solve a problem or algorithm or how to do a procedure. This forces the student to slow down, think critically about the problem-solving process, and realize there may be no instant solutions.

Issues of the Writing to Learn Approach

Despite all the collected persuasive arguments about the value of writing for learning, there is evidence that suggests that writing is not so easily incorporated into content area classrooms, expecially mathematics, as a means of facilitating learning (Langer & Applebee, 1987). Langer and Applebee conducted a series of case studies of seven experienced content area teachers who incorporated writing into their classes. Only three of the seven continued to use writing in their content areas as a method for learning after the study. This failure to continue writing was attributed partly to the demands for coverage of content in an increasingly overcrowded curriculum. Also, it was contended that teachers must first understand writing and its potential role in learning and secondly, they must be prepared to find satisfactory solutions to the problems of finding time in order for a writing to learn approach in their content area to be successful.

Sorenson (1991) also voiced a concern that the biggest stumbling block for teachers is their concern for precious class time and how they can cover the book or meet the curriculum requirements if they add yet another component to classroom instruction. Writing to learn has to be abandoned in favor of covering "topics" in time for statewide examinations (Gladstone, 1987).

Other teachers are leery of incorporating writing into the content classrooms because they fear extra work or they fear their lack of knowledge in the whole writing process itself (Sachs, 1990). Reasons

for not using writing in mathematics classes as concluded from mathematics teachers are (a) no time to correct writing; (b) insecurity about writing themselves; (c) writing should be taught by English teachers, not mathematics teachers; (d) there is pressure to teach for the test (standardized tests); and (e) how to grade the writing assignments (Worsley & Mayer, 1989).

Creating and implementing writing into mathematics may require extra hours of work for the teacher but Kenney (1988) proposed steps to minimize the amount of time for a successful venture. One can cover fewer topics than one normally covers and those that are treated can be covered in more depth. This does not mean to simply abandon material, but students can be given responsibility for covering some of the material by themselves. Although this may work for college students, some would argue whether middle school students should be left with that resonsibility. Azzonlino (1988) suggested that teachers use writing at the beginning of class when the students are still settling down, when the class is confused on a topic as a way of debriefing, or at the end of class with just a minute or two left to minimize the amount of class time used for writing.

For those teachers that wish to incorporate writing into their mathematics class, Clark (1984) presented a list of suggestions. First, begin by listing the main components of the mathematics content, as well as the kinds of thinking problems the students are to use. Then, from the wealth of kinds of writings presented, choose a form that will

help students master the central concepts in the class. It is important to design the writing assignment carefully so that it will help students learn and that students will understand clearly what they are expected to do. Next, clarify the writer's purpose and the audience for the writing. Also, specify the criteria for evaluating the writing. Once all that is done, then consider how to help students at the various stages of writing if necessary and how to respond to the writing. Another concern about the writing to learn approach was that recent studies, as few as there are, have concentrated on quantitative analysis and grades to measure the effects of writing and hence fail to measure the impact of writing on long term retention or improved study habits (Mett, 1989).

Some practitioners have expressed a need for more research in the study of the complex relationships between writing and learning. Topics that need further research are what kinds of writing tasks are most effective for accomplishing various learning goals and which of these learning goals can be best achieved through writing (Penrose, 1989). Different kinds of writing tasks encourage different kinds of cognitive operations and thus engage students in different kinds of learning. This may suggest that what students learn through writing depends to some extent on the nature of the writing task they are assigned.

Another factor on the amount of learning that takes place through a writing to learn approach is the wide range of abilities of the students.

If one wants students to use writing as a means for learning in mathematics, then one will need to make provisions for those students who don't or can't use writing very well or very easily. More information on this topic will be needed to help educators make decisions as to which students would benefit from writing and which students might benefit from another type of learning activity (Penrose, 1986).

Writing as a way to learn is an assumption that needs two qualifications (a) that it depends on what is meant by "writing" or what kind of writing is being addressed, and (b) it depends on who is doing the writing. Sufficient research has not been completed to suggest for which students writing in mathematics seems to be effective. It is apparent though from some literature that writing in content areas (journaling, for example) does not work for everyone, but that it seems to be an effective learning tool for most people (Zacharias, 1990).

Another issue that must be addressed is that of language and culture. A question that must be asked is how to make sure that students are given the opportunities to process their ideas using a language that allows them to construct meaning whether speaking or writing. This will influence the amount of learning through writing (Mumme & Shepherd, 1990).

An issue that has not been presented in the literature reviewed, even in the most recent articles, is whether students will feel overburdened with writing in not only mathematics class, but all the

other content areas as well. This burden, if in fact it would be felt as such, could ignite a long line of potential writer "drop-outs", being burned out or tuned out with so much writing. Or could it in fact be the other way around where more students would be "tuned-in" to writing.

Whether one is a supporter of writing in the content area, especially mathematics, or not, one needs to be aware of what students say about writing to learn. It may not always be what teachers of either camp want to hear. Stevens (1988) presented statements and responses from high school students in writing to learn content classes. One student said he wanted to drop his English class because his teacher made him think too much. Another student commented, "How can you learn if you don't write?" (p. 211). Many students felt writing made you commit yourself more than talking does. One suggested that if you write about something, you remember it better. A group of students mentioned that journal writing was writing down what you think is important and with this kind of learning, its all yours.

Definition

Expository writing is defined as a how-to descriptive writing. Here students are asked to explain how to do an algorithm using written descriptions or how to do a process using written descriptions. The researcher used expository writing when asking the students to write how to find equivalent fractions, how to reduce fractions to lowest terms, and how to add or subtract fractions, etc.

Rationale for the Study

After reviewing the literature on writing to learn across the curriculum and in mathematics, a problem began to emerge. Very little of what was reviewed supported empirically through actual studies or experiments what it overwhelmingly endorsed in practice. Of all the published books, articles, reports, dissertations, and papers located, the handful of research experiments or studies were by no means conclusive, and raised problems and questions about the nature of writing and learning. The researcher began to wonder why so many teachers were accepting without question the notion that students learn better when they write about what they are learning. Very few disagreed with this notion, not because they did not think it was a good idea, but because of other reasons, as stated in the literature review. But very few had conducted actual studies.

Also, the research reviewed predominantly dealt with high school and college age students or elementary students. Not much was found in a writing to learn approach for middle school students.

Statement of the Problem

This investigation set out to investigate the effect of a writing to learn approach in sixth grade mathematics classes. The purpose of this study was to examine the effects of expository writing (a writing to learn method) on achievement in a mathematics unit on fractions. The research question that guided the study was: Do sixth grade

students taught with expository writing and direct instruction score higher on a summative test in a fraction unit than sixth grade students taught only with direct instruction?

Based on the review of the literature, the researcher suggests the research hypothesis of this study to become: students receiving expository writing along with direct instruction will score higher on a summative test in a fraction unit as compared with those students only receiving direct instruction.

Method

Participants

The 44 middle school students who served as participants were sixth grade mathematics students already intact in two separate mathematics classes with 22 students in one and 22 students in the other. These participants were also matched, meaning each member of one class had his or her counterpart in the other class. The counterpart was matched according to ethnic race, gender, and mathematics/reading ability according to ITBS scores and performance observations. This matching was done at the beginning of the school year 1991 in order to establish two separate equal heterogeneous groups. The participants were also a mix of low, middle, and high socioeconomic classes within each group.

Design

The design of the study was quasi experimental with two intact groups having matched subjects, where one received treatment and

one group did not. The control group was one mathematics class of the researcher. They received direct instruction for a unit in fractions. The treatment group was the other mathematics class which received the independent variable of expository writing along with direct instruction for the unit in fractions. The dependent variable was the post test summative test scores. The researcher randomly assigned which group would get the treatment and which group would not by tossing a coin.

Materials

The objectives and the instructional materials for the fraction unit were from our district's sixth grade mathematics curriculum objectives and from the Addison-Wesley mathematics textbook series, Level 6, 1988. The objectives used were: The student will

1. name fractions expressed as parts of regions and parts of sets.
2. find equivalent fractions.
3. express fractions in lowest terms.
4. write improper fractions as mixed numbers and write mixed numbers as improper fractions.
5. compare and order fractions and mixed numbers.
6. add and subtract fractions and mixed numbers with common denominators.
7. add and subtract fractions and mixed numbers with unlike denominators.

The post test was devised by the researcher and tested only the above objectives. This post test was a modification of the Addison-Wesley book test on the addition and subtraction of fractions. Only the above listed objectives were taught for this unit. The test was not available to any of the participants until after instruction was completed. This instrument is included in the appendix.

The group that used expository writing were supplied with writing paper that the researcher then kept in separate folders each day.

Procedure

Since the mathematics classes were already intact from the beginning of the year with matched subjects according to ethnic race, gender, mathematics ability and socioeconomic circumstances, the first step was to randomly assign the treatment of expository writing to one group or the other. This was done by flipping a coin. Then it was decided to use this study for an upcoming mathematics unit normally taught on fractions. Direct instruction of the unit was the same for both groups, using the district objectives, the Addison-Wesley mathematics series and resources, and other teaching materials normally used to teach this unit. The only thing that was changed was the addition of the expository writing for the treatment group.

The treatment group was given in class expository writing exercises at least three times a week. After a normal instruction time, the researcher would pass out the writing paper and their folders and write a how-to statement on the overhead for them to write about. This

might include: "How do you find a fraction in lowest terms?" or "How do you find equivalent fractions?" The statement would be in direct relation to what was being done in the fraction unit that particular day. Then a timer was set for 8 minutes and the students would write in response to the "how-to" statement asked. They were asked to describe in detail the "how-to" as if someone from another planet was reading this and needed to know how to do the process. After 8 minutes, the students would put the papers in their folders and then the folders were collected.

The treatment class was told in the beginning what was going to happen and that the writing papers would not be graded but that they were expected to complete the in-class writing to the best of their ability. When someone's writing paper result was a good example of explaining how to do something, it would be shared with the class to give examples of good expository writing.

The control subjects had more time to work on their homework assignments in class than did the treatment class. This was due to the extra time that was inserted for the treatment group to do their writing.

The treatment was carried on for the length of the unit. The unit lasted four weeks. Mathematics classes for both groups met daily for these four weeks at their normal forty minute sessions. Three or four writing exercises per week for the treatment group gave a total of 16 treatment sessions at the maximum.

The objectives were covered completely at the end of the four weeks. The day that the unit was finished, the treatment group did one last expository writing exercise. The following day, the post test was given to both groups under the same conditions and on the same day. They finished the test within one class period.

Results

Achievement in addition and subtraction of fractions for both the control and treatment group was defined by students' total scores on the summative post test. There were 22 students in each group. Out of 50 possible points on the post test, the mean for the control group was 41.0 and the mean for the treatment group was 44.3. There was no significant difference between these two means using a statistical t test at the probability level of .05 ($t = 1.5$; $p > .05$). This data is presented in Table I.

Table I Achievement In Summative Fraction Test Following Two Teaching Methods

TEACHING METHOD	n	M	SD	t
Expository Writing	22	44.3	6.4	1.5
Non-Expository Writing	22	41.0	7.4	

$p > .05$ $df = 42.0$

The differences that were predicted for the two groups were based on the assumption that the treatment group using the expository writing plus direct instruction would score higher on its post test than the control group only using direct instruction. No significant difference was found, therefore the research hypothesis was not accepted.

Discussion

The research question that guided this study was: Do sixth grade students taught with expository writing (a how-to descriptive writing) and direct instruction score higher on a summative test in a fraction unit than sixth grade students taught only with direct instruction? The major findings of the study showed no significant difference in the means for the control or treatment group on the summative test: therefore, the research hypothesis was not confirmed. This would appear to be in disagreement with the previous related research according to the literature review. The numbers of mathematics practitioners and educators that support the writing to learn approach according to the review of literature is ever growing in the field of education. The researcher also supports this approach in mathematics although the study at hand was inconclusive to support this approach. Many factors could attribute to the findings of this study as compared to previous research dealing with writing in mathematics. These factors are the topic in the following discussion.

Most of the writing methods used across the curriculum and in mathematics in the review of the literature were over a long period of time. Much of the writing took place all year long. This study was done for a four week period of time. This could have been one of the factors in the results: Not enough time allowed for the treatment to have an effect.

Also, it appears that the different types of writing tasks involved to accomplish various learning goals could be a factor. Many different approaches were reviewed in the literature. The researcher chose expository writing to accomplish the particular goal of scoring higher on a fraction post test. Maybe a different type of writing task would have produced different results, say journal writing. Therefore, it is strongly suggested that further research should be done to determine which writing tasks are best suited for which learning goals. What students learn through writing could depend on what type of writing task they are assigned (Penrose, 1989).

So many of the educators reviewed felt strongly that journal writing is an effective learning tool for most people. They would measure this idea qualitatively through student interviews as to their understanding of the material, through grade improvement at the end of a semester or year, and through the students' ability to communicate concepts to others. Not many had done empirical studies to measure growth using journal writing. Therefore, the results of this study could be based on the fact that it simply was empirical or experimental and

not based on qualitative observations. This could lead to the differences in the findings in itself. Again, it is suggested more empirical and qualitative studies be done to determine the effectiveness of writing in mathematics, not just using qualitative observations.

The research suggested using a combination of writing techniques across the curriculum to improve learning. Therefore, in mathematics, using journals plus expository, troubleshooting, or other methods along with it, would be considered beneficial. This study tested only expository writing, therefore, another factor could be attributed here in the way that the results are different than anticipated.

The sample size used could be another factor in the rejection of the research hypothesis. A larger sample may have produced a more significant difference in the means through a t test. Also, the fact that the groups were intact and matched samples is still not as valid as if the groups would have been randomly selected.

The intact groups in this study had a large proportion of students who were poor writers to begin with. Writing was difficult for these students in their other classes. This factor could also have affected the results of the study. As the researcher observed the expository writing of these particular students, diagnostic conclusions could be drawn that these students could not express through their writing how to do a particular task in the unit. Whether writing was beneficial for these students is still a question that needs to be answered. More research

needs to be done on this topic to help educators make the decision whether writing would beneifit a particular student in a content area like mathematics or whether that student would benefit from another learning activity (Penrose, 1986). Writing may not work for everyone.

The last factor affecting this study could be the amount of writing the groups already do in a normal school day. Both the control and treatment groups had been involved in writing in language arts, science, and personal development quite extensively all year. It is possible that one more content area was an overload and affected the outcome of their learning, expecially if their heart wasn't in it. This whole issue needs further study to determine just how much writing is beneficial and at what level a regression could occur.

In conclusion, although the research hypothesis was rejected in this study, it was seen how continued research is important and suggestions were made for these areas. More empirical studies are needed, not just qualitative observations to support the idea that a writing to learn approach in the content area is beneficial.

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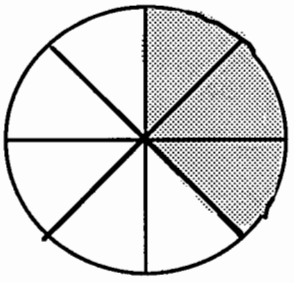
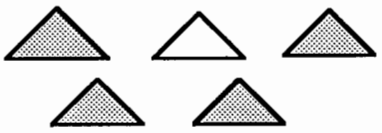
APPENDIX A

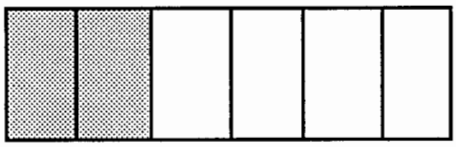
POSTTEST
FRACTIONS Addition/Subtraction
BLOCK _____
DATE _____

OBJECTIVE: Name fractions expressed as parts of regions and parts of sets.

I. Write a fraction for each □.

1.  □ of the circle is shaded.

2.  □ of the triangles are shaded.

3.  □ of the strip is shaded.

OBJECTIVE: Find equivalent fractions.

II. Find the missing numerator or denominator to show an equivalent fraction.

4. $\frac{2}{3} = \frac{\square}{12}$ **5.** $\frac{5}{8} = \frac{\square}{24}$ **6.** $\frac{1}{4} = \frac{3}{\square}$

7. $\frac{2}{3} = \frac{\square}{9}$ **8.** $\frac{4}{5} = \frac{12}{\square}$ **9.** $\frac{3}{10} = \frac{\square}{100}$

III. Give the next two equivalent fractions.

10. $\frac{1}{3}, \frac{\square}{\square}, \frac{\square}{\square}$ **11.** $\frac{1}{5}, \frac{\square}{\square}, \frac{\square}{\square}$

12. $\frac{3}{4}, \frac{\square}{\square}, \frac{\square}{\square}$ **13.** $\frac{1}{6}, \frac{\square}{\square}, \frac{\square}{\square}$

14. $\frac{3}{8}, \frac{\square}{\square}, \frac{\square}{\square}$ **15.** $\frac{2}{7}, \frac{4}{14}, \frac{6}{21}, \frac{\square}{\square}, \frac{\square}{\square}$

OBJECTIVE: Express fractions in lowest terms.

IV. Express each of the following fractions in lowest terms.

16. $\frac{6}{8}$ **17.** $\frac{8}{12}$ **18.** $\frac{8}{16}$ **19.** $\frac{3}{9}$

20. $\frac{4}{10}$ **21.** $\frac{9}{12}$ **22.** $\frac{5}{50}$

OBJECTIVE: Write improper fractions as mixed numbers and write mixed numbers as improper fractions.

V. Write each improper fraction as a mixed number or whole number.

23. $\frac{27}{5}$ **24.** $\frac{32}{8}$ **25.** $\frac{51}{3}$

26. $\frac{719}{100}$ **27.** $\frac{200}{25}$ **28.** $\frac{15}{4}$

VI. Write each mixed number as an improper fraction.

29. $2\frac{3}{5}$ **30.** $4\frac{1}{4}$ **31.** $2\frac{5}{8}$

32. $14\frac{1}{2}$ **33.** $6\frac{17}{100}$ **34.** $9\frac{9}{10}$

OBJECTIVE: Compare and order fractions and mixed numbers.

VII. Write <, >, or = for each $\square$.

35. $\frac{4}{5} \square \frac{4}{7}$ **36.** $\frac{8}{15} \square \frac{3}{5}$ **37.** $2\frac{5}{8} \square 2\frac{1}{2}$

38. $7\frac{3}{10} \square 8\frac{3}{10}$ **39.** $5\frac{7}{10} \square 5\frac{7}{8}$ **40.** $\frac{1}{5} \square \frac{1}{6}$

OBJECTIVE: Add and subtract fractions and mixed numbers with common and unlike denominators.

VIII. Add or subtract. Give answer in lowest terms. Show all work.

41. $\frac{3}{8} + \frac{3}{8} =$

42. $\frac{5}{6} - \frac{1}{6} =$

43. $1\frac{1}{5} + 3\frac{2}{5} =$

44. $11\frac{7}{12} - 3\frac{5}{12} =$

45. $4\frac{1}{6} + 3\frac{5}{6} =$

46. $\frac{7}{8} - \frac{1}{2} =$

47. $\frac{4}{5} + \frac{3}{10} =$

48. $6\frac{3}{4} - 2\frac{1}{3} =$

49. $7\frac{1}{4} + 2\frac{5}{6} =$

50. $16\frac{2}{3} - 5\frac{8}{9} =$

Summative Post Test Scores
(Out of a possible 50 points)

Control Group	Treatment Group
50	50
49	50
49	50
48	50
47	49
47	49
47	49
46	49
46	48
46	48
42	47
41	46
41	45
40	45
40	43
37	42
36	41
34	40
32	40
32	34
30	32
23	27
Mean = 41.0	Mean = 44.3