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The effects of student journal writing on the mathematics anxiety of female algebra and geometry students.

Carol Schutz Classe

THE EFFECTS OF STUDENT JOURNAL WRITING ON THE MATHEMATICS ANXIETY OF FEMALE ALGEBRA AND GEOMETRY STUDENTS

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CAROL SCHUTZ CLASSE

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ProQuest LLC.
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106 - 1346

THESIS ACCEPTANCE

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Committee

Name	Department
Kathy Danielson	Teacher Ed.
John W. Hill	SPED

Chairman

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Date

ABSTRACT

THE EFFECTS OF STUDENT JOURNAL WRITING ON THE MATHEMATICS ANXIETY OF FEMALE ALGEBRA AND GEOMETRY STUDENTS

The purpose of this study was to determine the effect of student journal writing with teacher feedback on the mathematics anxiety levels of female algebra and geometry students. The one semester study was a pretest-posttest, equivalent-groups design. Two Algebra I and two Geometry classes at a private girls' high school were involved. One Algebra I class and one Geometry class served as control groups and were taught with common techniques (lecture/discussion, cooperative learning, non-journal writing) of the teacher. The remaining Algebra I and Geometry classes formed the experimental groups and were also taught with common techniques. In addition, the experimental groups made regular journal entries in response to teacher written prompts or gave open form comments which were read by the teacher who wrote comments related to the student reflections.

The hypothesis that was investigated in this study is as follows: Implementation of regular student journal writing, with teacher commentary, in Algebra I and Geometry classes will help reduce mathematics anxiety in female students as compared to female students who do not

participate in journal writing exercises.

Investigation results of the one semester study were based on pretest-posttest data gathered through the use of the Mathematics Anxiety Rating Scale-A and the Daly-Miller Writing Apprehension Scale along with anecdotal information from the students in the study. While quantitative data did not produce evidence that one semester of journaling was sufficient to bring about significant change in mathematics anxiety levels, qualitative results were more supportive of the study's hypothesis. At the end of the study, a majority of students in the experimental groups indicated they would like to continue journaling and commented in positive terms regarding their journaling experience.

The results of this study encourage further reseach in the use of journaling with students who experience mathematics anxiety. Overcoming the negative effects of mathematics anxiety, especially on females, can promote several positive effects including additional study in mathematics and an enjoyment and appreciation of this field of study.

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TABLE OF CONTENTS

LIST OF TABLES

CHAPTER ONE

Introduction

Two major areas of interest and research in mathematics education today, communication in mathematics and mathematics anxiety, were explored in this investigation. The use of the communication tool of journaling was explored for its utility in building self-confidence and providing new perspectives for women who experience mathematics anxiety.

Communication in mathematics is an important concern in mathematics education at this time. The National Council of Teachers of Mathematics (NCTM) has posed five educational goals in its Curriculum and Evaluation Standards for School Mathematics (1989). The fourth of these goals encompasses the use of writing and discussion to aid students in learning to communicate mathematically (p. 6). The NCTM believes that a certain power develops in students who learn to communicate using mathematics. This power aids them in reflecting upon and refining their ideas, and to ask clarifying and extending questions to aid their understanding (p. 140).

Written mathematical communication can be expressed in a variety of formats. These formats include the writing of: journal or log entries, conjectures, story problems,

essays, letters, original test items, points of view, paraphrased responses, career exploration reports, and explanations of problem solving methods (Azzolino, 1990; Birken, 1989; Burton, 1985; Linn, 1987; McIntosh, 1991; National Council of Teachers of Mathematics, 1989).

A second and continuing area of interest in mathematics education is the effect of anxiety on students. Mathematics anxiety has been shown to produce several negative effects including: the lowering of achievement, the avoidance of more difficult courses, lack of positive attitudes toward mathematics in general, and narrowing of post-secondary educational and career opportunities (Brush, 1980; Cooper & Robinson, 1991; Hembree, 1990; Tobias, 1978).

Buerk (1985) directed her research towards the avoidance of mathematics by women and the strong negative attitudes and feelings they held. In her writing, Buerk takes the interesting stance that it is "unfortunate that the idea of 'math anxiety' has gained so much popularity in recent years. This publicity has encouraged many women to accept a fear of mathematics as normal for women" (p.65). She goes on to explain that the negativity connoted by the word anxiety can border on pathology, "a way of blaming the victim" (p. 65). She sees the use of terms such as apprehension, avoidance, or aversion as more accurate and

potentially more empowering for women. In this study, anxiety in women refers to each of these more empowering descriptions.

As stated earlier, the proper use of communication can be a powerful tool in mathematics education. The use of journaling, a very personal form of communication and one traditionally attributed to women (Gannett, 1992), has the potential to be a means of helping women make a needed connection with the study of mathematics. Journaling with teacher feedback may bring the personalization and support women need to overcome their mathematics anxiety.

The purpose of this study will be to combine these areas of interest and concern by examining the effect of one form of communication, journaling with feedback, on the mathematics anxiety levels of female secondary students.

Background of the Problem

As defined by Richardson and Suinn, "mathematics anxiety involves feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (1972, p. 551).

The existence of such anxiety has been a concern of mathematics educators for many years. Researchers have

often sought ways to lessen anxiety (Brush, 1981; Buckley, 1982; Genshaft, 1982; Hembree, 1990; Tobias, 1978, 1990).

In 1981, Brush found that students' anxiety toward the study of mathematics increased steadily from about sixth grade. This anxiety has a number of detrimental outcomes including debilitating effects in performance on tests and an unwillingness to study higher mathematics (Tobias, 1978). Tobias addressed mathematics anxiety in the general population, whereas, other studies have addressed the concerns of women. As reported by Genshaft, the explanation most often accepted for the "deterioration of mathematics functioning among females has involved socialization effects, which produce anxious women with expectations of failure in mathematics accompanied by the wish to avoid such activities" (1982, p. 32).

Secada (1990, pp. 136-137) refers to the statistics from Johnston and Packer (1987) regarding changing demographics and their effect on the U.S. work force. "Of the net number of newly created jobs in 1985-2000, a scant 15 percent are projected to be filled by white males. White females will fill 42 percent of these new jobs; native, non-white males and females will fill 7 percent and 13 percent, respectively; immigrant males and females, the remaining 13 percent and 9 percent" (p. xxi). This represents a total need for females of 64% in filling these

new jobs.

As society becomes more dependent on technology and more career options are open to women, a facility with and understanding of mathematics becomes more imperative. A method to reduce mathematics anxiety in its early stages would have far-reaching implications for society. As more people pursue higher-level-mathematics courses, the available pool of qualified people, capable of moving forward in a technological age, may begin to reach projected needs.

Significance of the Problem

Although young women increasingly pursue higher-level-mathematics courses and the career opportunities such courses open to them, young women are still not equally represented in these courses and careers. In addition, those young women with the same mathematics background as young men score higher than the men on lower level cognitive tasks, while the men score higher on more complex cognitive tasks (Fennema, 1981).

In a more recent study by the American Association of University Women (1992), gender differences were found to be small and declining. The study stated that "gender differences in mathematics do exist but are related to the

age of the sample, how academically selective it is, and which cognitive level the test is tapping" (p.24). The research of the AAUW indicated the greatest differences to be found are in students over thirteen and at higher academic and cognitive levels.

In summarizing numerous recent studies, Sadker, Sadker, and Klein (1991) point out that the "magnitude of sex differences in quantitative ability has declined" (p. 310). These authors' conclusion is based on a meta-analytic review of 98 studies done by Friedman (1989).

> The sex difference in favor of males is decreasing over short periods of time. This is evidence for environmental explanation of sex differences, for surely it is not biology but environmental influence that has been changing at the same time that sex differences have been decreasing.... Changes in guidance, hiring, and general admission practices, already well under way, should be accelerated in the years to come. (pp. 205-206)

Though the gap is narrowing, inequities still exist and further study of intervention methods is needed. Buerk (1986) quotes Martin (1985) regarding women and the study of mathematics.

> Martin has suggested that the feminist transformation of the curriculum involves more than the 'very

> legitimate concern over the genderization of the subject matter of the liberal curriculum,' arguing that the values fundamental to liberal education itself may be implicitly genderized. What are the new questions that arise for women in disciplines like mathematics, where the content appears impersonal so that integrating women into the curriculum is not clearly an issue, even while women's alienation from the curriculum does remain an issue? (p. 3).

As stated by the authors of the NCTM's (1989) Curriculum and Evaluations Standards for School Mathematics, "As a pluralistic, democratic society, we cannot continue to discourage women and minority students from the study of mathematics....we challenge all to develop instructional activities and programs to address this issue directly" (p.253). Specifically, studies in the use of methodologies aimed at reducing anxiety and its effects may produce valuable insights into equity and achievement concerns.

One possible methodology, the use of writing to learn, is becoming an area of growing interest "because it suggests the powerful role language plays in the production, as well as the presentation, of knowledge" (Connolly, 1989, p. 2). When writing is done regularly, students can be helped to acquire a personal ownership of

ideas that are conveyed in a course (Connolly, 1989). Could this be the medium that young women need to enable them to be more at ease in mathematics classes? Through the regular use of one long-accepted form of writing, journaling, young women would have a vehicle for commenting on and questioning what is being taught and how it is being taught. This personalization of the mathematics curriculum may have the added benefit of reducing the anxiety levels of these young women.

Brush (1980) found girls wanted to pursue that which would be of use to them and found that they liked classes where they felt comfortable and where they experienced less anxiety. While Belenky, et al. (1986), found young women seeking knowledge by asking how a new experience they had was similar to other experiences. Through writing, young women could find a familiar vehicle to express their individual experiences, understandings, and misunderstandings in mathematics. This could be their means of relating mathematics to their own lives and experiences. When they communicate to their teachers what they have learned, and express any anxieties they feel, their knowledgeable and empathetic teachers can be of greater assistance to them in their learning of mathematics.

Statement of the Problem

The problem of this study is then, will the writing of journal entries, with teacher commentary, reduce mathematics anxiety in female algebra and geometry students?

Definition of Terms

Journal exercises refer to activities where students explain, comment on, report on, and discuss mathematical problems or related ideas or their feelings toward lessons or subject matter, in their own words in writing. Students in the two experimental classes were given prompts (writing cues) for journaling exercises at the beginning or the end of a class. Prompts were prepared in advance and were written on transpariency sheets and shown on the overhead for student consideration. (See Appendix D for list of sample prompts.)

Because this was a dialogue journaling situation, students who preferred to write in a letter form were encouraged to do so. Three to five minutes was allowed for writing. If a student had not finished writing when the class presentation began or resumed, she could elect to finish her journal entry at her discretion. Occasionally students were given an opportunity to journal without

receiving a prompt. These exercises were implemented at least twice a week.

Mathematics anxiety is defined as "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical situations" (Richardson & Suinn, 1972, p.551). It was operationally measured by the Mathematics Anxiety Rating Scale for Adolescents (MARS-A). This scale is a 98 item questionnaire for measuring mathematics anxiety in adolescents for use in treatment and research developed by R. M. Suinn and R. Edwards (1982).

Teacher commentary on journal entries refers to written comments by the teacher in response to each student journal entry. The use of the journal is a form of dialogue between the student and the teacher. Teacher comments accompanying journal entries did not consist of cursory words of encouragement or praise. Rather, each response took on the form of a one-to-one conference or mini-lesson. These were not neutral responses, but served as a place to share feelings and experiences, teach and reteach, nudge and question, as well as praise and encourage as exemplified by Thompsen (1990).

The student journals, with feedback, were returned in the next class period. Turn around time is important in a dialogue journal situation to demonstrate to the students that the teacher takes their comments seriously (Thompson,

1990).

A person with high writing apprehension is defined by J. A. Daly and M. D. Miller, as quoted in Aikman, as an individual who is "characterized by a general avoidance of writing and of situations perceived by the individual to potentially require some amount of writing accompanied by the potential for evaluation of that writing (1985, p. 2)."

Writing apprehension is considered here because the writing process itself may cause a degree of anxiety (Daly and Miller, 1975). The writing apprehension of students was measured by the Daly-Miller Writing Apprehension Scale (1975).

Assumptions

The following assumption is associated with this study.

Assumption 1. That other methodologies used in the courses, such as cooperative learning, did not account for a change in the anxiety level of the student-subjects. Control and experimental classes studying the same subject matter, i.e. algebra or geometry, were taught using the same instructional methods, except for journaling, throughout the study.

Limitations/Delimitations

The following limitations are associated with the study.

Limitation 1. The utilization of student-subjects at the ninth, tenth, and eleventh grade levels in an all girls, private school may restrict the study to a similar group for generalization purposes.

Limitation 2. Placement of students in the control and experimental groups was based on student self-enrollment in one of the two classes available to them as dictated by each student's overall schedule. This quasi-experimental design did not permit random assignment of students into experimental and control groups. Pretests were used to help control for initial writing apprehension and mathematics anxiety.

Research Hypothesis

Implementation of writing journal entries, with teacher commentary, will reduce mathematics anxiety in female algebra and geometry students as measured by the Mathematics Anxiety Rating Scale for Adolescents (MARS-A); and as compared to female algebra and geometry students who do not participate in journal writing activities.

Summary

This study examined the use of writing as a tool to aid in the alleviation of mathematics anxiety in female students. Mathematics anxiety is one of several impediments to greater interest, achievement, and utilization of mathematics by women today.

Additional tools, for addressing this problem, such as journaling with feedback, appear desirable to assist women in achieving their potential in the study and use of mathematics. The research and literature related to this study will be discussed in Chapter 2.

CHAPTER TWO

Review of Related Research and Literature

The purpose of this chapter is to provide a framework within which to investigate the effect of student journal writing and teacher commentaries on the anxiety levels of young women in algebra and geometry classes. Much research has been done in the last twenty years in the areas of mathematics anxiety and the use of writing across the curriculum, however, relatively little has been done in combining these two areas.

To better understand the background of this study, which pursues a unique form of integrating these two areas of interest, the following areas were investigated: (a) the effects of mathematics anxiety and some methods of avoiding or overcoming mathmatics anxiety; (b) the use of the communication skill of writing in mathematics; and (c) the use of journal writing with feedback as a medium to ease mathematics anxiety.

The Effects of Mathematics Anxiety and Some Methods of Avoiding or Overcoming Mathematics Anxiety

Students with high anxiety levels tend to lack

confidence in their work. Meyer and Koehler (1990) found that confidence influences students' persistence in pursuing mathematics as concepts and courses become more difficult. "Confidence in mathematics is also reflected by continued participation in mathematics course taking and career aspirations in quantitative fields " (p. 61).

Brush (1981) conducted research with 1500 male and female high school and college students to learn when students are anxious regarding mathematics and what teachers might do to diminish this anxiety. She found little anxiety in the areas of calculations and problem solving, but much greater anxiety with any facet of test taking or being required to work or answer in front of others (p. 37).

In another study, Brush (1980) did a comparison of attitudes toward mathematics and English. Younger students attitudes toward both subjects were similar, but as the mathematics became more abstract and lecture intensive, and the English was taught more through discussion and writing, students expressed anxiety toward mathematics and not English (p. 38).

In this study, Brush found elementary school girls often ranked mathematics as a favorite subject, but in high school, English and social studies took the first places. It is interesting to note that one of the most important

mediums of learning in each of the latter subjects is writing; where things do not have to be black or white, right or wrong, or expressed in symbolism different from the written word so familiar to each person's daily life. English and social studies have traditionally been held as acceptable areas of achievement for women.

Brush (1980) suggests that teachers could ease mathematics difficulties by organizing lessons to ease transitions, giving better explanations to maximize understanding, and to invite many questions especially as material becomes more difficult (p. 39). Brush also advises teachers to include tasks and activities that require creativity. Changes in classroom practices can reduce anxiety levels and when accompanied by encouragement can motivate students to study more mathematics (p. 39).

In a similar study, Tobias (1978) conducted research in mathematics anxiety with adults. She found that those who were math anxious had at some time in their lives suddenly come to a point where they felt they would never go any further in mathematics. They believed a curtain had been drawn. In addition, they believed that everyone else understood and that they would only make things worse by asking questions. From that point on most became passive learners (pp. 44-46).

To counter the effects of mathematics anxiety,

subjects in Tobias' (1987) study kept math diaries with running commentaries of their thoughts, both mathematical and emotional. Subjects were encouraged to divide a page where they were working math problems into two columns, one for their feelings and thoughts and the other for their actual work. The interplay between the two recordings proved helpful for the math-anxious. The goals of this writing exercise were to aid the teacher in finding the recurring mathematical errors of the students and for the students to recognize their own negative, self-defeating self-talk (p. 67).

This work is similar to that of Genshaft (1982). In her study seventh grade females were "trained to use self-instruction to both reduce their anxiety and to help them attend more appropriately to the task, and not to make critical self-evaluative ruminations" (p. 33). An example of these self-statements would be:

> First ask yourself, 'What am I supposed to do in this problem?' Then answer the above question, 'I am supposed to solve this problem on ....' Talk to yourself through each step of the problem. For example, 'First, I need to change this percent to a decimal fraction. Then, I need to set up the problem so I can multply. Next, I ....' Praise yourself when you are finished, 'Good job! I knew I

could do it!' (Genshaft, 1982, p. 33)

This method met with success in a relatively short period of time. As a result, Genshaft encouraged teachers and school psychologists to pursue a program of instruction and intervention to change young women's attitudes and anxieties toward mathematics.

As reported by Dodd (1992), a former English teacher and principal, students need a more personal and process-oriented approach in mathematics. Math anxiety can be created when too much emphasis is placed on memorizing formulas and applying rules (p. 296). Similarly, Borasi (1990) states that we "should not be surprised at mathematics students' overwhelming concern with product and answers when the most important measure of academic success is given by the score received on standardized multiple-choice tests taken under considerable time pressures" (p. 177). Such a focus can lead to many misconceptions regarding the nature of mathematics and lead the student to anxiety.

Kogelman and Warren (1978) point out in Mind Over Math that all anxiety is not debilitating. A little pressure can make a student more effective, creative, and focused. But anger toward math can be suppressed and surface in the form of anxiety that makes it impossible to work. Tension can make a person forget and in turn cause more anxiety and

thus a cycle of negative behavior bringing on further negative behavior begins.

There appears to be a need for replacing this negative cycle with a more positive cycle where confidence and interest could help free the mind for increased achievement. Which in turn could engender more confidence and possibly lead to the desire to study more mathematics. As stated by Fennema and Sherman (1976) when referring to the study of mathematics by young women, "attitudes affect both electing to study mathematics and its learning. Therefore, it is important to study attitudes towards mathematics in order to improve the learning of mathematics" (p.15).

Kogelman and Warren (1978) advise that people with mathematics anxiety must take time to focus on their feelings about mathematics and develop a realistic view of what math is and how it is done. Their research found that when students' attitudes were changed grades improved and more material could be successfully taught in shorter periods of time (p. 171).

Though addressing issues of gender equity rather than anxiety directly, Sadker, Sadker and Klein (1991) report that the research of Brophy (1981) demonstrates that

> ... effective praise delivered by the teacher can

> improve the academic achievement of students. Effective praise, as defined by Brophy, includes specific comments delivered with sincerity, comments directly related to student performance and using past performance as a context, and remarks that inform students about the importance of their accomplishments and attribute their success to ability or effort. Similarly, corrective teacher comments can also be influential in developing student achievement and maintaining positive student attitudes. (p. 300)

This praise to which Brophy refers is not defined as verbal or written, but in several contexts could be taken as verbal. In this present study, all praise and other commentary was delivered to the students in writing. Praise was given when student commentary warranted this type of response or when its presence could possibly enhance student self-esteem.

This commentary did not at any time take on an evaluative stance regarding the students' grammar, spelling or punctuation. As reported by Daly and Miller (1975), "individuals with high apprehension of writing would fear evaluation of their writing ..." (p. 244). This present study might have been effected negatively if such writing evaluation had been included.

In the area of mathematics anxiety, the research of Hembree (1990) was based on a meta-analysis of 151 studies. His findings included results that showed mathematics anxiety was inversely related to positive attitudes towards mathematics and was bound to avoidance of the study of mathematics. Females exhibited higher levels of anxiety than males (p. 33). Hembree found classroom interventions and whole-class psychological treatments were not effective. Out-of-class psychological treatments succeeded in reducing mathematics anxiety. These successful treatments included systematic desensitization along with anxiety management training and conditioned inhibition. In most cases, relaxation training was a component along with cognitive modification change of faulty beliefs in order to build self-confidence. When anxiety was reduced, significant increases in mathematics test scores resulted (pp. 42-43).

It would be important to note here that this study addressed mathematics anxiety in adolescent females, but that there are not necessarily sex differences in mathematics anxiety itself (Gliner, 1987). Although females, especially at the college level, exhibited mathematics anxiety more frequently (Hembree, 1990).

Much research points to the importance of students becoming aware of, and reflecting on, their beliefs, as

well as possible alternatives in working in mathematics (Borasi, 1990). Teachers must assist students in this endeavor by supplying the time and learning situations needed. Writing may be one answer to this situation. Cappo and Osterman (1991) state that writing affords the time to think, ponder, and edit.

This present study's use of writing addressed many of these research findings regarding mathematics anxiety and incorporated some of the steps proposed to lessen that anxiety. These anxiety reducing steps, according to Brush (1981), would invite more questions, necessitate creativity in lessons, and offer encouragement. A personal approach with less emphasis on rote learning was suggested by Dodd (1992). Borasi (1990) bought out an awareness of the need for time for reflection in mathematics. While Kogelman and Warren (1978) point out the need for lifting tension and focusing on feelings and a realistic view of what mathematics is and how it is done. The value of effective praise and helpful corrective comments was reviewed by Sadker, et al. (1991). Hembree (1990) suggested anxiety management and changes in faulty beliefs to help build self-confidence. Tobias examined the need for students to be active learners and made use of diaries to record both mathematics and emotions. Genshaft concentrated in the area of self-instruction. Each of these approaches has

potential for incorporation in a journaling with feedback situation, which was formally investigated in the present study.

The Use of the Communication Skill of Writing in Mathematics

Unfortunately, the study and understanding of mathematics for many young people in this country has become an area reserved for an elite group. Mathematics is an area where cultural barriers have prevented minorities and women from particpating in or achieving in proportion to their representation in the population. These thoughts from Botstein (1989) indicate a need for change and led to a conference on "The Role of Writing in Learning Mathematics and Science" at Bard College in 1987. Some of the questions that are being addressed by those concerned with this inequity and who believe writing can play an important role include the following. Can the use of ordinary language help combat the belief that mathematics is for a minority of white males? Can an emphasis on writing in the mathematics classroom empower teachers to reach all students? Can writing activities help overcome impediments for those not succeeding in or not pursuing mathematics studies?

The use of "writing to learn" in the mathematics classroom is a fairly recent phenomena. Early literature was concerned with using writing most often in the area of enrichment with writing projects such as research papers (Woener, 1977). Most research and literature on the topic was written in the last ten years. The use of writing in the mathematics classroom has extended to all levels: elementary and middle school (Cappo, 1991; Ford, 1990; and Wadington, 1992); junior high school (Davison and Pearce, 1988; Gladstone, 1987; and Schmidt, 1985); high school (Havens, 1989; Johnson, 1983; and Miller, 1992); and college (Birken, 1989; Mett, 1987; and Powell and Lopez, 1989).

According to Connolly (1989), using writing to learn in the mathematics classroom is "most basically about developing students' conceptual understanding ... by developing their capacity to use the language ... fluently" (p. 4). Most research involving the use of writing in the mathematics classroom has had goals in the cognitive, rather than affective domains (Carpenter, 1991; Davison, 1988; Geeslin, 1977; and Kenyon, 1989). Increased interest in the liberal arts has resulted in revived interest in multidisciplinary writing (Mett, 1987). "During the 80's, educators and researchers in various disciplines turned their attention to writing to learn in the content areas

(Miller, 1992, p. 329). But as the writing across the curriculum movement grew, mathematics was virtually unaffected. As time passed, some educators realized that the addition of "English, a common language for communication, to the mathematics class has the possibility of allowing more students to enter into the dialogue and find success in mathematical thinking (Birken, 1989, p.35).

Recent years have seen a fundamental shift in the teaching of composition. Similarities between problem solving and expository writing have been recognized and have led to a better understanding of a "problem solving factor involved in expository writing that parallels the one which is found in the corresponding mathematical process - defining the unknown, determining what information one already knows, designing a strategy or plan for solving the problem, reaching a conclusion, and then checking the results" (Bell and Bell, 1985, p. 212).

It is not a coincidence that this process pointed out by Bell, et al., parallels the problem solving sequence presented by George Polya (1957) in his classic text on heuristics, How to Solve It. Polya's four phases in problem solving are: understanding the problem; devising a plan; carrying out the plan; and looking back (pp. 6-15).

The research of Bell and Bell (1985) with ninth

grade students involved teaching problem solving skills using a structured expository writing component. They found that those students who had to formulate their thinking in concrete language terms performed better as mathematical problem solvers than those who did not. In addition, they found that the students who used writing communicated better both directly and indirectly with their teacher, especially when they were having difficulty with concepts. Better two-way communication was established. (Bell and Bell, 1985)

The National Council of Teachers of Mathematics has been in the forefront of recent research and literature designed to improve the quality of school mathematics. In its Curriculum and Evaluation Standards for School Mathematics, the NCTM (1989) addresses a goal of mathematics as communication (p. 6). The expression of mathematical ideas both in oral and written form and the formulation of definitions and generalizations discovered through investigation are encouraged. The National Council of Teachers of Mathematics sees writing as beneficial for all students. Two principal concerns are that all students can "reflect upon and clarify their thinking about mathematical ideas and relationships" (p. 140) and "express mathematical ideas orally and in writing" (p. 140). In the area of assessment, teachers are directed to be sure that

their students can communicate mathematical ideas with precision (p. 216).

In a more recent publication, Professional Standards for Teaching Mathematics, the NCTM (1991) addresses both teacher and student discourse. "Writing is another important component of the discourse. Students learn to use, in a meaningful context, the tools of mathematical discourse ..." (p. 34). One facet of the teacher's role in discourse is "asking students to clarify and justify their ideas orally and in writing" (p. 35). The authors go on to point out that the ability to communicate in various forms including written communication is important in itself. Mathematics can be learned in a social context if students know that their ideas are valued. "Classrooms should be characterized by conversations about mathematics among students and between students and teachers (p. 96). These "conversations" could take on a written form.

Both the affective and cognitive domains can be affected through these forms of communication as described in each of the NCTM publications. Most research and literature on the use of writing in mathematics has centered on writing's usefulness in increasing student achievement (Azzolino, 1990; Birken 1989; Burton, G. 1985; Cappo, 1991; Carpenter, et al., 1991; Davison and Pearce, 1988; Ford, 1990; Geeslin, 1977; Gladstone, 1989; Havens,

1989; Johnson, 1983; Kenyon, 1989; King, 1982; McIntosh, 1991; Mett, 1987,1989; Miller, 1985, 1989, 1992; Pearce, 1988; Powell and Lopez, 1989; Schmidt, 1985; Shaw, 1985; Venne, 1985; Wadlington, et al., 1992; Watson, 1980; Whitesitt, 1990; Wilde, 1991; Woerner, 1977; Yates, 1987; and Zinsser, 1988.)

Writing about math made an impact upon math averages of students who were marginal or below average academically according to Gladstone (1987). The higher order thinking skill of synthesis was developed as students wrote about orderly approaches to problem solving and made up problems to illustrate mathematical rules. This is in agreement with the study of Bell and Bell (1985). Much study has been done in the area of using writing in mathematics to develop thinking and reasoning skills. Nahrgang and Petersen (1986) found the "act of writing gives students opportunities to formulate, organize, internalize, and evaluate concepts" (p. 461).

In the area of creative thinking, Kenyon (1989) comments that students became active learners and more willing to seek alternate approaches to problem solving. Writing required students to reflect, analyze, and synthesize material in a thoughtful and precise way in the research of Davison and Pearce (1988). As stated by Powell and Lopez (1989), "writing is a powerful instrument with

which to reflect on experiences and, like mathematics, is a major tool for thought" (p. 159).

Other needs are facilitated by the use of writing in the mathematics classroom. Those who would pursue a science related career would be developing a needed skill (Yates, 1989). Mett (1987) found that scientists reported that over 30 percent of their time was spent in writing. Another desired change in the mathematics classroom, as pointed out by Tobias (1987) earlier in the section on mathematics anxiety, is making students active rather than passive learners. Kenyon (1989) found writing assisted in this goal. As stated by Pearce and Davison (1988), "Writing is a mode of language that involves the active manipulation of knowledge" (p. 6).

Numerous benefits in mathematics education have been extolled by those using writing in mathematics classes. Among these benfits are the informal assessment of understanding by both students and teachers (Miller, 1992; and McIntosh, 1991). Azzolino (1990) points out that all students get involved and as commented on by Carpenter, et al., (1991) these students are utilizing more of their natural senses in their work.

If writing can help students see mathematics in more human terms (Schmidt, 1985) and help sooth mathematics anxiety (King, 1982), then students will certainly benefit

from its use. Students can bring their own experiences to their mathematics work (Nahrgang and Petersen, 1986) and can become "more reflective, expressive, mathematicians" (Wadlington, 1992, p. 209).

There are limitations in the use of writing in mathematics education. The students' abilities to express themselves in writing is a key consideration, as is their trust in the person reading their work (Miller, 1992). The use of writing in mathematics gives a new dimension to learning for those for whom traditional methods have failed (Haven, 1989), but change can elicit resistance on the part of students who do not understand its introduction in an area where they have never experienced its use.

The question of teacher resistance needs to be addressed. Mathematics teachers need assistance in integrating writing into their curriculums. Venne (1989) points out the fear of mathematics on the part of many English teachers has kept them from working with mathematics teachers in this area. In addition, there is the perception that the use of writing will require large amounts of time in addition to present needs. Rose (1990) sums up this concern by saying that "granted, writing assignments will require small adjustments in the manner in which teachers use their time, both in and out of the classroom, but the rewards are worth the effort as both the

affective and cognitive needs of students are realized and met" (p. 71).

To fully list the various forms in which writing can be used in mathematics education would be beyond the scope of this study. The following examples give some idea of the variety of uses researchers have reported on in their studies. Cappo and Osterman (1991) list "from logs to letters, conjectures to journals, kids gain understanding when they write about math in their own words (p. 35). Azzolino (1990), while encouraging teachers to do more writing themselves, suggests using writing in sentence completions, warm ups, in rewording, word banks, debriefings, pretest reviews, and in writing on tests.

Freewriting and term papers are suggested by Burton (1985). Carpenter, et al., (1991) used flow charting, file cards, and written explanations for steps taken in problem solving. Linguistic translation, symbols to words, along with summarizing, paraphrasing, writing test questions, and papers on math events or personalities were employed successfully by Davison and Pearce (1988).

Gladstone (1987) combined word processing skills with writing in mathematics. The writing of mathematics autobiographies and the recording of group reports were explained by Mumme and Weissglass (1989). Miller and England (1989) suggest the use of prompts by the teacher to

elicit written responses in the affective domain. The writing form suggested most often by the researchers was the journal (Borasi and Rose, 1989; Burton, 1985; Carpenter, et al., 1991; Davison and Pearce, 1988; Havens, 1989; King, 1982; McIntosh, 1991; Mett, 1987; Mumme and Weisglass, 1989; Nahrgang and Petersen, 1986; Powell and Lopez, 1989; Rose, 1990; Socha, 1989; Wadlington, et al., 1992; Watson, 1980; and Wilde, 1991). It is this writing tool that will be reviewed in greater depth.

Birken (1989) warns that writing should not be treated as a cure for all the ills of the curriculum or of the students. It need not be the answer for all teachers. Unfortunately writing can still be employed in ways that do not allow the student to explore, think, test, take risks, and learn. Birken concludes that writing is a method that should not be forced on teachers, but states that when writing is used correctly its impact will be "that the mystique and privacy of mathematical symbolism can be opened up to a wider student audience" (p. 34).

As more teachers implement writing in their mathematics classes there is a growing need for additional direction, writing ideas, and suggestions for evaluation. Contributors in these areas are growing and include: Tchudi and Yates (1983), Kenyon (1989), Mumme and Weissglass (1989), and Azzolino (1990). Azzolino's

suggestions include such things as not dwelling on spelling, punctuation, and grammar in evaluation and directing teachers to be sure to give meaningful written responses to students to encourage them in their efforts. As mentioned earlier, the teacher commentary in this study did not in any way evaluate student writing or refer in a negative way to the form of student writing.

More references to the use of writing in mathematics classes can now be found, but most of these are personal observations of teachers and not formal studies. True research in this area is still sparse and only recently emerging.

The available studies regarding the use of writing to learn in the mathematics classroom tend to report positive findings in the cognitive and/or affective areas. It may be that using such a tool could be a key for some students to come to know mathematics in a new and rewarding way.

Recent research has demonstrated that writing can be a vital tool in assisting communication in mathematics education. Important lessons have been learned from the use of writing in other disciplines regarding writing's utility in helping students achieve higher level thinking skills. Assessment both on the part of the teacher and student are aided in this form of two-way communicatiom.

Researchers have used numerous forms of writing activities at all grade levels and have found that the benefits far outweigh any limitations in their use.

The Use of Journal Writing as a Medium to Ease Mathematics Anxiety

Dodd (1992) brings to the discussion of journaling in mathematics the point of view of an English teacher and administrator. Her belief is that "math phobics" are "created when teachers place too much emphasis on memorizing formulas and applying rules" and that teachers "fail to realize critical connections between students' academic performances and their feelings about themselves and the subject being studied ... or do not consider individual approaches to learning" (p. 296).

Dodd (1992) states that writing is an especially effective tool to reach those who are anxious or lack confidence because they can talk privately with the teacher. Often a student will write what they are too shy to say in person. Students will communicate their anxiety, confusion, or misconceptions, thus aiding the teacher in identifying the individual student's needs. Help then can be given before a test is failed or the student becomes overly anxious. Dodd also found that motivation was

enhanced because every student had a direct and private link to the teacher (p. 298).

Miller (1992) found that the active process orientation of journaling not only promotes procedural and conceptual understanding, but also benefits students by giving them the chance to "express nonunderstanding in private to the teacher. It establishes an open channel of communication between teacher and student that promotes good rapport and a positive classroom environment" (p. 355).

Selfe, Petersen, & Nahrgang, (1986) tried an experiment to identify the effects of journal writing assignments given on a weekly basis to students in a college-level mathematics class. Though the findings were inconclusive in the area of achievement, the research did find the journals themselves and the open-form comments of the students rich sources of information. Students thought that journal writing had helped them "think about new concepts and rethink concepts that had been presented earlier" (p. 201). They also stated that writing helped them "understand math concepts better and learn the material more thoroughly" (p.201). Their journals confirmed their self-evaluations. In general, students responded positively to the experience, helping the researchers to conclude that there had been positive

results in the affective domain.

Selfe, et al., similar to other researchers who started out with cognitive goals in mind, found significant results in the affective domain. Rose (1990) states that not only is a journal "a place where you can write to and for yourself about mathematics," but that "students wrote twice as much about feelings than any other area" (pp. 63-64).

Considering the use of the journal for dialoguing, Staton (1987) gives the following definition: "Dialogue journals are a responsive form of writing in which the student and teacher carry on a conversation over time, sharing ideas, feelings, and concerns in writing" (p.47). Stanton sees this journaling as genuine conversation that differs from traditional personal journals where teachers might make comments in the margin. In this dialogue, teacher and students interact on mutually interesting topics on a regular basis. These conversations can aid self-understanding and help negotiate classroom relationships and problem solving (p.49).

Working with fifth graders, Thompson (1990) utilized the dialogue journal in mathematics classes. Many benefits were realized in the cognitive and affective areas for her students. Her student were not only helped in developing their questioning and critical thinking skills,

but she tells of her students writing candidly of their feelings about mathematics and of their freedom to critique text, materials, and methods used in class. Students openly shared their confusions, frustrations, and need for help (p. 89).

The emotions shared were not all negative. Students also shared their breakthroughs, discoveries, accomplishments, satisfactions, and genuine pleasure in mathematics (p. 90). As Thompson's experience with student journaling progressed, she states that "I have moved beyond neutral responses to correspondence in which I share my thoughts, feelings, and experiences. In my letters I reassure, teach, reteach, suggest, nudge, and question" (p. 92).

The use of journal writing as a tool for reflection is brought out by Wadlington, et al. (1992), the NCTM (1989), and Borasi (1990). Wadlington sees the journal as not only a place to write personal reflections on mathematics study, but also as a place to record reflections on cooperative learning activities. The NCTM authors state that students need to have an "inclination to monitor and reflect on their own thinking and performance" (p.233). The use of journaling facilitates this monitoring and reflection.

According to Borasi (1990), when teachers design activities in mathematics that make students question and

probe it is important that the time and opportunity to reflect on these experiences be provided. Class discussions are certainly a good means to do so, but there are considerable advantages to complementing them with expressive writing activities. Writing assignments requiring students to report and reflect on their mathematical experiences, perhaps with the help of a few thought-provoking questions by the teacher, will in fact force each individual student to take a stance. This can provide the student with more time and leisure to identify, work out, and express satifactorily one's ideas, and finally will produce a written product that could be exchanged with others and provide a record of development over time (p. 180).

The thought-provoking questions to which Borasi refers can come in the form of prompts or cues given by the teacher. As stated by the NCTM (1991), "The teacher's skill at formulating questions to orchestrate the oral and written discourse in the direction of mathematical reasoning is crucial" (pp. 35-36). The NCTM writers extend this idea and charge teachers with a goal of listening carefully to students' ideas. This listening can come in the form of skillful reading of journal entries followed by thoughtful responses.

Various researchers and practioners in the use of

journals have made numerous suggestions for prompts that have proven effective with students. Buerk (1986) in working with math-avoidant women in a college setting asked students to reflect on, respond to, comment or give thoughts on given topics. At the end of the course, students were asked to journal on the journaling process itself and then to reread their journals and respond. One particular student's journal entries are found in Carolyn Werbel's Journal: Voicing the Struggle to Make Meaning of Mathematics (Buerk, 1986). In this account, one can find the sincere unburdening of a young woman who usually sought to avoid mathematics and who would explain away success as a teacher's over generous gift. In reflecting on her journal, Ms. Werbel concludes that keeping the journal was her favorite part of the course, "A Writing Seminar in Mathematics." "I got to yell, scream, rant, rave, and just plain complain about math....I could express whatever I desired about math and not have you rip it up as slanderous garbage. The journal for me was an outlet of my ideas. More then that, though it forced me - sometimes against my will, to develop those ideas" (pp. 16-17). For Ms. Werbel, the journal made all the difference in her outlook on math and her future participation in mathematics.

Suggestions of successfully implemented prompts are

offered by other researchers. The following are some representative offerings. Watson (1980) frequently had students complete the sentences, "This is how to ...., " "The problem I am having with ....," and "My feelings about ...." (p. 519). Rose (1990) had students write mathematics autobiographies and a mathematical image beginning with "Math is like ...." (p. 63). Other prompts include: "Summarize in your own words ....," " What do you expect from the teacher ....," and " How should we use class time ..." (p. 63)? Rose offers series of prompts for use before the test; after the test, but before the test is handed back, and after the test is handed back. These prompts as well as those of others seek input in both the cognitive and affective domains. Rose found twice as many responses to be in the affective areas. This was particularly true when students were allowed to do freewriting. This writing without a prompt often elicited student feelings.

In dialogue journaling, "teacher responses (are) vital to success (McIntosh, 1991, p. 1991). In Buerk's (1986) work, her comments and questions to the journal writer "asked for clarification, encouraged deeper thinking, raised alternative points of view, and expressed my support of the students' attempts to understand the material and their individual responses to it (p. 2).

The uses teachers have found for journaling in their

classrooms are many and varied, as are the results they report. Mett (1989) used samples of students' journal entries to illustrate how writing helped the students understand mathematics concepts and terminology. Bemiller (1987) found that journaling encouraged a personal mathematical approach to learning. While journaling was seen by Davison and Pearce (1988) as a device to communicate student reactions, insights, strengths, and weaknesses.

Mumme (1989) stated that students record what they learn, insights into themselves as math thinkers, and their feelings about learning mathematics. Other uses for journaling included "helping students to focus on an assignment, to analyze and synthesize new information, to consider alternate solutions, to confront math anxiety, and to record their processes (King, 1982, p. 44).

Several other references to anxiety related areas include Gannett's (1992) observance regarding women's journaling in academic areas. She found that women did not so much state their anxieties, but rather showed a tendancy to write through their academic stresses (p. 167). Additionally, Rose (1990) mentions students noting the therapeutic benefits of their journal writing (p. 65).

Cappo and Osterman (1991), looked at the results from teachers who were using writing regularly in the classroom.

They found teachers reporting on the successes of this mode of teaching because their students "owned" ideas they wrote about in logs, journals, letters, and conjectures. Much of this was done in conjunction with the writing of conjectures based on data collected from the use of computer software. These teachers often reported real gains in understanding when students wrote about math in their own words. Successes usually result in the heightening of self-esteem and the lowering of anxiety.

When the first year college students taught by Powell and Lopez (1989) reflected critically in writing about mathematics, they gained "greater potential to control their learning and to develop criteria for monitoring their progress" (p. 173). This engendered feelings of accomplishment, which in turn had a positive effect on their affective responses. As they gained greater control over their learning and grew in conceptual understanding, students derived "a great deal of satisfaction with themselves as learners capable of doing and understanding mathematics " (p. 173). These remarks would indicate the use of journaling in mathematics has been used successfully by many educators. From first grade (Wason-Ellam, 1987) to college (Buerk, 1986), those who use this writing technique have found many benefits for both students and teachers. Powell and Lopez (1989) found journaling a powerful vehicle

for dialogue. They found that this form of writing "reassures students that their concerns are considered" (p. 173) and that it provided an excellent opportunity for giving feedback.

Summary

Research has shown that the negative effects of mathematics anxiety on students' mathematics achievement, the desire to study mathematics, and the enjoyment of the study of mathematics can be overcome. With the use of a more personal approach, creative lesson planning, and allowing for time to reflect on mathematics, researchers have found some decrease in math anxiety. The use of praise, the learning of anxiety management, and the involvement of students as active learners have also contributed to overcoming the effects of math anxiety. The use of writing as a communication tool in the mathematics classroom is a more recent addition to the curriculum. As the value of the use of writing across the curriculum has become more widely accepted, more researchers have experimented with the use of various forms of writing. This research has brought out many benefits for the use of writing in mathematics with these favorable outcomes outweighing any limitations connected with the use of writing.

The use of a particular form of writing, journaling, has been employed successfully by many educators to achieve various outcomes in their mathematics classes. Benefits for both students and teachers have been found through this form of communication. Journaling has the potential to give valuable feedback to teachers as well as students. Important dialogue can result from these interchanges. Yet this potential needs to be verified by careful research before wide implementation into the curriculum.

Experts in the teaching of mathematics, such as the National Council of Teachers of Mathematics, are calling for an increased use of communication in the mathematics classroom, including the use of writing. Writing is a valuable skill used in many other subject areas. The use of this skill has traditionally been recognized and encouraged for young women in our society. Research in the use of writing in the classroom, especially the use of journals, has shown promising potential for its successful use in combating mathematics anxiety. This study sought to investigate the particular potential of using journal writing to reduce the mathematics anxiety of female algebra and geometry students. The specific methods and procedures used in this study are presented in Chapter Three.

CHAPTER THREE

Methodology

The methods and procedures that were used in this study are presented in this chapter. The research design for this investigation is outlined, as well as a description of the subjects, the instrumentation and the instructional procedures.

Subjects

The participants in the study were sixty-one ninth, tenth and eleventh grade students enrolled in Algebra I and Geometry classes at an all girls' high school in Omaha, Nebraska. No honors classes were included in the study. The enrollment in each of the experimental and control classes was determined by student enrollment in one of two classes open to them. Their registration for one of the two classes was not based on ability grouping, but rather was determined by the available times due to the remainder of each student's schedule.

Research Design

The research design was a quasi-experimental, Pretest - Posttest Control Group Design.

O X O

O C O

Pretest-Treatment-Posttest

Pretest----------Posttest

The pretests and posttests used were the Mathematics Anxiety Rating Scale for Adolescents (MARS-A) developed by R. M. Suinn and R. Edwards (1982) and the Daly-Miller Writing Apprehension Scale (WAS) developed by J. A. Daly and M. D. Miller (1975). The MARS-A test represents the dependent variables of the study and the use of student journaling with teacher commentary represents the independent variable. As an additional control, the WAS was also administered.

Student journal entries along with anecdotal evidence collected from student comments written during the last week of the study were kept for the length of the study. These latter comments were given in response to prompts eliciting student thoughts regarding the journaling process. Journal entries and commentary were kept as qualitative auxiliary results in the study. A summary of

the student comments on the journaling experience can be found in Chapter 4.

The subjects of the study were divided in two Algebra I classes (one experimental, one control) and two Geometry classes (one experimental, one control). The determination of experimental and control classes was done by the flip of a coin.

Study Procedures

Each of the four classes, two experimental and two control, were taught by the same teacher. The independent variable for the study was represented by the fact that one class in Algebra I and one class in Geometry wrote journal entries with the teacher commenting on each of these entries and the other two classes did not take part in these exercises.

The teacher and the study implementation were continually monitored by Dr. Neal Grandgenett, assistant professor of mathematics education at the University of Nebraska at Omaha. Instructional Review Board approval was sought and received prior to the study's implementation (IRB #004-94).

In addition, the school principal observed in both experimental and control classes. One student, who spent the first quarter in the Algebra I control class and due to

a schedule change spent the second quarter in the Algebra I experimental class, was removed from the data analysis. Three students who were moved from Algebra I to a Prealgebra class were also removed from the data analysis. These four students were not included in the total number of sixty-one students in the study.

The study took place during the first semester of the 1993-1994 school term. The content of the lessons for all four classes consisted of the regular curriculum of the school's mathematics department for Algebra I and Geometry. The Houghton Mifflin Company textbooks, Algebra, Structure and Method, Book 1 published in 1992, and Geometry published in 1985, were used by the respective Algebra and Geometry classes. Scheduling of classes was determined by the overall needs of the scheduling for the whole school.

In the classes using journaling, the teacher regularly responded to or commented on all journal entries. Because timeliness was essential, these messages were returned with the journals at the next class period when a journal entry was made. Journal entries were made at the beginning or end of a class period in response to a question or statement posed by the teacher regarding class, test, homework material, or students' feelings toward these areas. Occasionally, journal entries were free form

without such teacher prompts. A list of the prompts used in the study can be found in Appendix D.

A portfolio of all the journal entries and the comments from an open form questionnaire were kept for the length of the study. The open form questionnaire allowed students to express their feelings toward the journaling experience at the time of the posttest. These documents were also summarized for additional insight into the effects of the journal entry activities. Chapter 4 contains this summary.

Instrumentation and Data Collection

The primary dependent variable in the study was the students' anxiety levels regarding mathematics. As a related control variable, the students writing apprehension was also measured. All students in the study were given the Mathematics Anxiety Rating Scale for Adolescents (MARS-A) and the Daly-Miller Writing Apprehension Scale (WAS).

The Mathematics Anxiety Rating Scale for Adolescents (MARS-A) is a 98 item questionnaire developed by R. M. Suinn and R. Edwards (1982) to measure general mathematics anxiety in adolescents. Research done for this study found this scale to be well respected in the literature. The person taking the scale is instructed that the

questionnaire refers to things and experiences that may cause tension or apprehension. Several examples of scale items which must be rated regarding how anxious the situation would make the person are:

> Adding up a bill for a meal when you think you have been over-charged.
>
> Figuring out your grade average for last term.
>
> Walking into a math class.
>
> Reading and interpreting graphs or charts.
>
> Taking an examination (final) in a math course.
>
> Being given a set of division problems to solve on paper.
>
> Being asked to explain how you arrived at a particular answer for a problem. (Suinn, 1988, pp. 1-8)

The Daly-Miller Writing Apprehension Scale (1975) is a 26 item scale prepared by J. A. Daly and M. D. Miller to measure the degree of writing apprehension in subjects. Writing apprehension was considered in this study because the writing process itself may cause a degree of anxiety. Examples of statements regarding writing apprehension would include the following:

> I look forward to writing down my ideas.
>
> I'm nervous about writing.
>
> I expect to do poorly in composition classes even before I enter them.

> Discussing my writing with other people is an enjoyable experience. (Daly & Miller, 1976, p. 249)

During the last week of journaling in this study, students were asked to scan their previous entries and the teacher comments and to comment on the journaling process. Three prompts were given and included an opportunity for open comment by the students. These prompts are included in Appendix D and in the Chapter 4 presentation of data.

The MARS-A and WAS were given to the students at the beginning of the school year as a pretest and again as a posttest at the end of the semester. A final set of questions, calling for open form comments on the journaling experience, were designed by the teacher, under supervision of the thesis advisor, to accompany the second administration of the rating scale.

Data Analysis

The scores for the two administrations of the MARS-A and WAS surveys were computed at the end of the study. The data analysis was completed by using dependent and independent sample t-test procedures at the .05 level of significance. In addition, a summary of student responses to the final writing prompts were provided as a qualitative auxiliary analysis. The results of the quantitative and qualitative analyses are provided in Chapter Four.

CHAPTER FOUR

Presentation and Analysis of Data

The purpose of this study was to investigate the effect of journal writing with teacher feedback on the mathematics anxiety levels of female Algebra and Geometry students. It was hypothesized that journal writing would facilitate lower mathematics anxiety.

This chapter compares the results of the pretests and posttests that were administered to measure mathematics anxiety (Mathematics Anxiety Rating Scale-A) and writing apprehension (Daly-Miller Writing Apprehension Scale). The pretests were administered during the first week of the semester and the posttests at the end of the semester. The experimental groups journaled and received teacher feedback, while the control groups did not journal. The experimental and control groups were treated similarly in all other aspects of their curriculum and the teaching methodologies employed.

Student qualitative commentary, given in response to teacher prompts at the end of the semester's study, was also considered. Quantitative data is presented in six different tables to facilitate understanding of the study's results. The appropriate raw survey scores, mean survey scores, standard deviations, t-values and probability

values (p) are presented in several different comparisons to facilitate the interpretation of data.

Presentation of Results

The possible range of scores for the Mathematics Anxiety Rating Scale-A (MARS-A) is 98 to 490 with 98 representing the lowest anxiety level and 490 the highest possible level. The pretest range for the four groups in the study was 127 to 350. Posttest survey scores had a range of 130 to 385. The study involved a total of sixty-one students, arranged into two experimental classes (one algebra, one geometry), and two control classes (one algebra and one geometry).

The main dependent variable, mathematics anxiety, was operationally measured by the MARS-A. As reported by Richard M. Suinn (1979), a score of 248 or above by a ninth grade girl or a score of 232 or above for a tenth or eleventh grade girl would indicate the student should receive special attention regarding her level of mathematics anxiety. These scores represent a 75th percentile score at each grade level. Table 1 contains pretest and posttest MARS-A score results considered significant by the above criteria.

After identifying those students who were at the 75th

percentile, a comparison of pretest and posttest results show an overall category increase of one student in the Algebra experimental group, a decrease of four students in the Geometry control group, and no change in the numbers for the other two groups.

Overall, 44% of the young women in the study had a mean score on the MARS-A at or above the 75 percentile level for their respective grade groups on either pretest, posttest, or both, so mathematics anxiety was indeed present in the sample as measured by this instrument.

Table 1

Students Showing Levels of Mathematics Anxiety Above the 75th Percentile

	Pretest >248	Posttest >248
Algebra-Experimental (N = 13)	5	6
Algebra-Control (N = 15)	3	3
	Pretest >232	**Posttest >232**
Geometry-Experimental (N = 16)	5	5
Geometry-Control (N = 17)	8	4

The Daly-Miller Writing Apprehension Scale (WAS) has a possible range of scores of 26 to 150. Low apprehension is represented by a score of 26 and high apprehension is represented by a score of 150. The pretest WAS range was 26 to 117 and the posttest range was 26 to 121 with all four groups included. The mean WAS scores all ranged from 57 - 75, suggesting a relatively low mean level of writing apprehension for all four groups.

Table 2 shows mean scores for the experimental and control Algebra groups and the experimental and control Geometry groups on the pretests and posttests for the MARS-A and WAS.

Table 2

Mean Scores on MARS-A Pretest and Posttest and WAS Pretest and Posttest

	MEAN MARS-A PRE	MEAN MARS-A POST	MEAN WAS PRE	MEAN WAS POST
Algebra-Experimental (N = 13)	248	238	75	76
Algebra-Control (N = 15)	205	209	67	62
Geometry-Experimental (N = 16)	228	226	65	66
Geometry-Control (N = 17)	230	212	60	57

Tables 3 and 4 contain means, standard deviations, t-values, and two-tailed probabilities examining change in pretest and posttest scores for both the experimental and control Algebra and Geometry groups. Comparisons are shown for the Algebra experimental and control groups and the Geometry experimental and control groups for both the MARS-A and WAS. A brief summary of these findings would include the following results.

The only significant difference in mean scores occured with the Algebra experimental and control groups on the MARS-A pretest with a t-value of 2.38 and a probability of 0.025. The standard deviation of the experimental group was 37.44 and the standard deviation of the control group was 53.95. The large difference in these standard deviations suggests that the quasi-experimental design may not have been adequate to detect quantitative differences. The Geometry experimental and control groups did not show a significant difference in mean scores on the same pretest with a t-value of -0.14 and a probability of 0.887.

Pretest mean scores on the WAS for the Algebra experimental and control groups did not indicate a significant difference with a t-value of 0.97 and a probability of 0.343. The Geometry experimental and control groups also did not show significant difference in means with a t-value of 0.74 and a probability of 0.464.

Comparisons of the posttest mean scores for the MARS-A for the Algebra experimental and control groups showed no significant difference with a t-value of 1.50 and a probability of 0.146. Posttest means for the Geometry experimental and control groups again did not indicate a significant difference with a t-value of 0.65 and a probability of 0.522.

WAS posttest mean scores for the Algebra experimental and control groups were not significantly different. The t-value was 1.80 and the probabilty was 0.084. Neither did the Geometry experimental and control groups show a significant difference in means. The t-value was 1.34 and the probability was 0.189.

The overall results of the t-tests did not indicate a significant difference between experimental and control groups as a result of the journaling experience.

Table 3

T-test Comparisons - Pretests

MARS-A				
Algebra	Mean	Std. Dev.	t-Value	P
Experimental (N = 13)	248	37.44		
Control (N = 15)	205	53.95	2.38	0.025*
Geometry				
Experimental (N = 16)	228	47.89		
Control (N = 17)	230	56.33	-0.14	0.887
WAS				
Algebra	Mean	Std. Dev.	t-Value	P
Experimental (N = 13)	75	15.61		
Control (N = 15)	67	23.92	0.97	0.343
Geometry				
Experimental (N = 16)	65	21.29		
Control (N = 17)	60	15.32	0.74	0.464

* Significant at $p < 0.05$

Table 4

T-tests Comparisons - Posttests

MARS-A				
Algebra	**Mean**	**Std. Dev.**	**t-Value**	**P**
Experimental (N = 13)	238	47.01		
Control (N = 15)	209	55.16	1.50	0.146
Geometry				
Experimental (N =16)	226	55.87		
Control (N = 17)	213	66.01	0.65	0.522
WAS				
Algebra	**Mean**	**Std. Dev.**	**t-Value**	**P**
Experimental (N = 13)	76	18.73		
Control (N = 15)	62	21.59	1.80	0.084
Geometry				
Experimental (N = 16)	66	22.76		
Control (N = 17)	57	13.51	1.34	0.189

Tables 5 and 6 contain means, standard deviations, t-values, and two-tailed probabilities examining change in pretest and posttest scores for both the experimental and control Algebra and Geometry groups. Each group is considered separately to compare its paired pretest and postest scores for each of the survey instruments. A brief summary of these findings would include the following results.

The experimental Algebra group indicated no significant difference in mean scores with a t-value of 1.10 and a probability of 0.295 on the MARS-A. The WAS means for the same group also were not significantly different with a t-value of -0.32 and a probability of 0.752. The control Algebra group MARS-A mean scores indicated no significant difference with a t-value of -0.36 and a probability of 0.726, and WAS scores for the same group were not significantly different with a t-value of 1.32 and a probability of 0.209.

Comparisons of the pretest-posttest scores for the experimental Geometry group showed a mean score non-significantly different with a t-value of 0.09 and a probability of 0.927 for the MARS-A. No significant difference in the WAS mean for the same group was indicated by a t-value of -0.11 and a probability of 0.915.

The Geometry control group's MARS-A mean scores were

not significantly different as shown by a t-value of 1.35 and a probability of 0.194, and the WAS mean was also similar, indicating a t-value of 1.29 and a probability of 0.214.

Table 5

T-test Comparisons Pretest to Posttest Change - Algebra Groups

Experimental Algebra (N = 13)	Mean	Std. Dev.	t-Value	P
MARS-A Pretest	248	37.44		
MARS-A Posttest	238	47.01	1.10	0.295
WAS Pretest	75	15.61		
WAS Posttest	76	18.73	-0.32	0.752

Control Algebra (N = 15)	Mean	Std. Dev.	t-Value	P
MARS-A Pretest	205	53.95		
MARS-A Posttest	209	55.16	-0.36	0.726
WAS Pretest	67	23.92		
WAS Posttest	62	21.59	1.32	0.209

Table 6

T-test Comparisons Pretest to Posttest Change - Geometry Groups

Experimental Geometry (N = 16)	Mean	Std. Dev.	t-Value	P
MARS-A Pretest	228	47.89		
MARS-A Posttest	226	55.87	0.09	0.927
WAS Pretest	65	21.29		
WAS Posttest	66	22.76	-0.11	0.915

Control Geometry (N = 17)	Mean	Std. Dev.	t-Value	P
MARS-A Pretest	230	56.33		
MARS-A Posttest	212	66.01	1.35	0.194
WAS Pretest	60	15.32		
WAS Posttest	57	13.51	1.29	0.214

As indicated in the tables, no significant change was indicated between the pretest and posttest scores of each of the two experimental and two control groups.

Qualitative results from this study are given in the form of student responses to prompts given at the end of

the study, and are related primarily to student commentary on the process of journaling with teacher feedback.

At the end of the study students in the two experimental groups were asked to comment on the journaling process by writing responses to the following prompt:

> Please scan your journal comments and the teacher comments for this semester.
>
> 1. What have you learned about yourself, your teacher, and this course through journaling this semester?
> 2. Should we continue journaling next semester? Why or why not?
> 3. Feel free to make any other comments you would like to make regarding this process.

Ten of the ninth grade Algebra students responded that they would like to continue journaling, while two said they were unsure, and one said she would prefer not to continue, but that journaling might be offered as an optional exercise. The following quotes are representative of this group's responses. The quotations include all student errors in spelling, grammar, and punctuation.

Student #1 "... I learned that you like to know how each of us is doing individually."

"Yes, I'd like to continue it. That way I know your feelings and you know mine."

Student #2 "I think journaling has helped me express my concerns. I can always tell you if I have a problem in math."

"Yes, I would because I think it helps me with my work, and the tests we take."

"I like this process, we did not have this last year. I think if we would have had the journal I would have done a little better. I think journal notes are a very good thing."

Student #3 "Yes, I would certainly enjoy writing in these next semester. I think that they help you as a teacher by letting you know more about me as a student and my background of Algebra. It also lets me know about you as a teacher."

Student #4 "What I've learned about myself through journaling was that if there is a weekly time set aside for me to keep 'in contact' with a teach(er) it a) helps build a 'Relationship' & breaks the boundaries b/tween a teacher and student. It allowed me to ask questions and talk about problems I was having in the course or outside of class. b) What I learned about my teacher was that she was willing to take time out of her work to communicate and keep in touch with her students. I know writing gave me a sence of security w/ talking in class to the teacher & writing. c) I enjoyed being able to write in the journal. It wasn't like

'real school work' it was more like your own personal time to talk w/ the teacher."

Student #5 "Yes, because it's a good way to get to know each other and seek advice."

Student #6 "Thank you so much for helping me all those times when I had no clue what I was doing!"

"Journaling has helped me because then I know your feelings as well as mine about Algebra."

Student #7 "I have learned about the teacher doesn't just thrown something on the paper that you seem to take the time to give long, but to the point questions and answers."

Student #8 "No, because I really don't like doing this. It is kind of boring and I don't like to writing things like this. It is also a waste of class time that we could be using to answer questions."

"For some people this might be good. Maybe you can give us an option. Say we want to tell you something but not out loud we can write it in our journals then give it to you."

Student #9 "I have learned that you take time to comment in the journals to help us."

Student #10 "Doing this journaling hasn't really showed me anything new about myself. But I have learned

that you care for each and every one of your students and that you would go out of your way to help them."

"I don't know if I would like to continue journaling. It has no point to me but I don't really mind it."

Student #11 "I feel through this journal exercise I have learned a great deal about you. I don't really get to know my math teacher as well as like a religion teacher simply because we don't converse about much but math. I understand you better as a person than just any teacher. I have learned that I can express my thoughts very well on paper almost better than in person. I definately hope to continue this throughout second semester. I always look forward to finding out some of your remarks. You have helped me with certain algebra problems in my journal."

"I love to write in my journal and I like to go back and read what was written before. I think you should ask some more personal questions such as hobbies, friends, extracurriculars and then I feel we could get to know you better. Thanks for being so good with your remarks about what I have to say."

Student #12 "I would really like to keep writting in our journals. It gives me a chance to write down my opinions and express my feelings. I think it is a great idea!"

Student #13 "I have learned that you are their for people to come in & get help & teachers at (school name) actually care, unlike last year."

"It does not matter to me whether we do our journals or not."

The Geometry experimental group was made up of tenth and eleventh grade students. Fifteen of the students responded that they would like to continue journaling and one said that it did not make a difference to her whether she continued to journal or not. The following comments were made by members of the experimental Geometry class to the last prompts of the study as listed previously.

Student #1 "I learned through journaling that I can easily tell my teacher what the problem is w/ my work or if I even understand it. So for myself I learned that it is not hard to communicate with a teacher. About my teacher I learned that she cared enough to take the time and answer every question individually devoting time to my problems. I learned that the teacher is trying to understand our viewpoints and how we feel."

Student #2 "Yes, I would like to continue because it gives you a chance to kind of calm down and organize your thoughts. It gives you a chance to relax and settle down."

"I think it is a good idea. It helps me feel better about my classes."

Student #3 "Yes, I would because I enjoy getting responses from the teachers on their ideas about me, it helps me to understand what I am learning & if I am doing okay."

Student #4 "Yes, b/c I do like getting your 1 to 1 commentary."

Student #5 "Through journaling I get the sense that you really care about our process in geometry."

"Yes, but not so frequently -- only when there is something important to write about."

"It might be helpful to have the journals out for us to write whenever we need."

Student #6 "I have learned that my teacher cares about me and is willing to help, she and I have some things in common."

"Yes I would like to journal, it helps me to explain to my teacher and get her input and advice."

Student #7 "Journaling has helped me be more open and talk about things that I never would in class."

"Yes! Because it helps me as a person understand my problems better by writing it out and having someone help me."

Student #8 "Yes, I would like to continue the journal b/c it helps me get my ideas out."

"Whenever I read one of your replies I

feel a little better and more able to do the work."

Student #9 "It doesn't really matter to me or not if we continue to write in these journals. It doesn't bother me one way or the other."

"Sometimes by writing journals it helps me think of ways to improve my study habits."

Student #10 "I have learned that I learn when I see a picture and write big. If I write big I won't get confused or forget something. The journaling helped me see this."

"I would like to continue journaling because then I can tell you if I have a problem. I can also think ahead about what I should study for and be more prepared for a test."

Student #11 "I've learned more about the fact that I can express my ideas. I'm not always the best at doing that and this journal writing helps me. I have also learned that by reading these entries I can somewhat figure out how I'm doing in class."

"I like the journaling and wouldn't mind doing it next semester either. I feel that there is more of a friend to friend relationship through the journaling, instead of a teacher student."

Student #12 "Yes, I would like to continue journalling next semester b/c I can share what I am feeling with you. And its good to get things off your chest."

Student #13 "Mrs. Classe, I've learned that you are not only a Geometry teacher. You are also a supporter and a friend."

"Sure, I'd like to continue journaling 2nd semester because it gives me a chance to evaluate my progress. - sometimes I wouldn't take time out by myself."

Student #14 "I enjoy writing so it is nice to write down my feelings. Most importantly it is a nice way to communicate with my teacher."

"Yes, because I like writing my feelings down."

Student #15 "Yes, because as I said before if we have a problem with how we are or aren't learning then we tell you and receive."

"I really enjoy writing journals, even though I don't enjoy writing (for grades). I would like to see this keep going throughout the next semester. If you don't keep it going for us, definately next yr for the freshmen it would help. I know as a frosh, I was so lost, this would of helped."

Student #16 "It also gives a chance to say what you like or what does not help you."

"Yes, I would like to continue. Not only does homework and studying help you in math, but also reassurance. The journal helps that."

"Math class this year has helped me learn better from last year. The journaling was a good idea!"

Twenty-nine of the sixty-one students who participated in the study were in the Algebra and Geometry experimental groups whose commentary is summarized above. Of the twenty-nine girls in the two experimental groups, twenty-five indicated they would like to continue to journal second semester. Only three girls indicated that they were undecided regarding a decision to continue, and one said no, but qualified her response indicating that participation should be made optional.

These results suggest a positive response to the journaling process and a desire to continue. In addition, several students mentioned how important it was to them that their teacher know how they were feeling. One mentioned how journaling helped calm her down and another said that it was important to be able to express her concerns. Being able to write down ones feelings was given as important, while another student said she liked journal writing, but not writing for a grade. Another said she received reassurance from the teacher responses. One ninth grader and one tenth grader said that they wished they had begun journaling the year before because of the benefits they had experienced this year. Further comments on these anecdotal qualitative results can be found in Chapter 5.

Summary

This study sought to determine whether journal writing with teacher commentary written in response to journal entries could assist in lowering mathematics anxiety levels in young women in algebra and geometry classes. The quantitative data gathered through the use of the Mathematics Anxiety Rating Scale-A did not produce evidence that one semester of journaling with ninth, tenth, and eleventh grade young women was sufficient to bring about significant changes in mathematics anxiety levels, as measured by that instrument.

This was a quasi-experimental study and did not provide for randomization of the students involved; instead pretests were used as treatment controls. Placement of a student in one of the four classes in the study was determined entirely by student registration for a particular class that fit her overall schedule. Other factors such as ability level and previous experience in mathematics were not considered; and are listed as study limitations. A flip of a coin determined which groups would be experimental and which would be control groups.

Qualitative results were more supportive of the study's hypothesis. The majority of the students in the experimental classes indicated they would like to continue journaling the second semester. Many commented about their

desire to express their feelings or concerns regarding their study of mathematics. Each one listed at least some positive results or reactions to journaling.

The following chapter, Chapter Five, offers discussion and conclusions about this inquiry. Recommendations are also made for areas of further consideration regarding this study's hypothesis.

CHAPTER FIVE

Discussion, Conclusions, and Recommendations

Chapter 5 offers discussion of the survey results, data analysis, and student commentary summary as well as conclusions. Recommendations are also offered for further study in the area of overcoming mathematics anxiety through the use of journaling with teacher feedback.

Discussion and Conclusions

The analysis of the mean survey scores, t-values and probabilities for the Mathematics Anxiety Rating Scale-A indicates that the young women who journaled did not significantly decrease their anxiety levels in comparison with the groups that did not journal. On the basis of this quantitative information, the hypothesis of this study would not be supported. Thus, journaling with feedback did not reduce mathematics anxiety as measured by the quantitative results.

However, in contrast, the qualitative input gathered from the experimental groups at the end of the study showed that a majority of the journaling students wanted to continue journaling and evidenced positive reactions to the process. Though the term anxiety was not used by the

students, many expressed a desire to share their feelings, concerns, or to have an opportuntity to calm down before class began. Over and over, students expressed gratitude for having someone respond to their thoughts and concerns. Having a place to pose questions they might not want to ask in class was also listed as an advantage.

Several representative quotes from this commentary would serve as a good summary of the overall response of the students related to mathematics anxiety and journaling. When asked if they would like to continue journaling second semester, these responses were written.

" Yes, I would because I think it helps me with my work, and the tests we take."

" I think journaling has helped me express my concerns. I can always tell you if I have a problem in math."

"Yes, I would like to continue journaling because it helps me ask questions. If I want to say something but am afraid to ask I could ask in my journal. I really enjoy journaling."

"Yes, I would like to continue because it gives you a chance to kind of calm down and organize your thoughts. It gives you a chance to relax and settle down."

Regarding the aspect of teacher feedback in the journals, all students had some positive reactions to this

facet of the study in their commentaries. Some student responses include the following.

"Through journaling I get the sense that you really care about our process in geometry."

"I have learned that my teacher cares about me and is willing to help, she and I have some things in common."

"Whenever I read one of your replies I feel a little better and more able to do the work."

Data gathered from the Daly-Miller Writing Apprehension Scale showed no significant difference in writing apprehension mean scores for either of the experimental groups from the time of the pretest to the posttest. However, the full interaction of writing apprehension and mathematics anxiety is still unclear, and would be an area of research worthy of future study.

One ninth grade algebra student spent the first quarter in the control class and due to a schedule change transferred to the experimental class. She had to be eliminated from the formal study, but at the end of the study she responded in writing to several questions posed by the researcher as an additional check on study internal validity. These questions requested commentary from her regarding any differences she might have observed between the two groups and the treatment of each. Her comments can be found in Appendix E. Of particular interest was

whether she perceived the treatment of the two groups to be different or if the content covered in the two groups had been different. In both of these areas, she indicated no difference. As with all classes, the two Algebra groups each had their own personalities. The control group was more outgoing from the first day of class and proved to have more extensive algebra backgrounds than the experimental group. The student who commented on the differences in the groups saw these differences as connected to journaling at times. The researcher is not in agreement on this point.

Although the quantitative analysis showed no significant differences with journaling, the qualitative student comments indicated that there were beneficial effects related to reducing mathematics anxiety not identified by the quantitative analysis.

Recommendations

Recommendations for further study. Recommendations for further study related to this inquiry include the use of journaling with teacher feedback at a younger age for girls and boys who demonstrate anxiety toward the study of mathematics or the use of mathematics. The needs of young men in high school who evidence mathematics anxiety would be another area of inquiry. Would they be as comfortable

with the journaling process as the young women in this study appeared to be?

This study involved ninth, tenth, and eleventh grade young women. Several students commented at the end of the study that they wished they had done journaling in math class the previous year. Their comments, found in Chapter 4, often indicated their appreciation for teacher feedback. These teacher comments helped them believe that someone cared about their concerns and was willing to take the time to offer them encouragement and reassurance.

Research has indicated that girls like mathematics and believe they can do well until about the sixth grade (American Association of University Women, 1992). The Educational Testing Service reports negative perceptions regarding being good at mathematics increases with age for girls. (Educational Testing Service, 1990). Offering journaling with teacher feedback opportunities to girls and boys in the middle grades or junior high school who evidence the beginnings of mathematics anxiety, or before any apprehension can develop, could prove to be the ideal.

The 26 item survey, Mathematics Anxiety Rating Scale - E (MARS-E) developed by Richard M. Suinn (1991), might be a possible alternate tool for checking anxiety in younger students. The target group for this survey is fourth through sixth graders. Another instrument prepared

for upper elementary and middle grades would be the Mathematics Anxiety Scale for Children (MASC) developed by Lian-Hwang Chiu and Loren L. Henry (1990)

Further investigation of the proper scale to use in measuring mathematics anxiety levels particularly in high school females would seem essential, based on the results of the study. Many of the items on the MARS-A were not entirely pertinent to the classroom setting of this study, and may have been a contributing reason for the contrast between the quantitative and qualitative results. Several examples of these questions would be items that ask how anxious the student is when deciding how much change they should get back from buying several items or from counting a pile of change. Although definitely related to mathematics anxiety, they are less related to the anxiety students may feel when engaged in learning mathematics. A shorter version of this scale that focused on the classroom experience might be more appropriate. The twenty-four item shortened version of the ninety-eight item MARS developed by Plake and Parker (1982) centers more directly on mathematics course-related anxiety. This instrument might provide a more appropriate set of items for use with students in a classroom situation. Additionally, it would seem necessary to include several items to help single out sex related mathematics anxiety issues.

Another area of further investigation might be to examine the evolution of the mathematical language within the student journal entries, as they progress through the semester's instruction. Changes in mathematics achievement as well as anxiety may be discernable in the terminology used and concepts discussed.

The length of this study was just one semester. If a young woman in ninth, tenth or eleventh grade had experienced mathematics anxiety for several years prior to journaling, one semester of journaling experience might not be long enough to lower anxiety levels as measured by a scale such as the MARS-A, which includes more global aspects of mathematics anxiety. A study of at least one to two years of journaling might be needed. It would seem that the older the student, the longer the process should be observed to note its impact.

The timing of the posttest may also be of significance, and a possible reason for no indicated change in the quantitative results. This study's posttest was given shortly before final examinations for the semester. Anxiety levels appeared to be rather high among all students in many classes at that time. In a full year study, posttests could be given in late spring several weeks before final examinations.

For actual implementation of journaling, there are

several practical factors to consider. Some concerns would include the amount of time involved for teachers to write commentary in large classes; who, if not everyone, should journal; and the time taken from lessons for journaling. This study was carried out in rather ideal circumstances regarding class size. When classes are larger, teachers may need to have students journal only once a week or have only those students who have evidenced mathematics anxiety take part in journaling. Students with strong writing apprehension might not take part easily in the journaling activity. Input from previous teachers could also offer criteria for deciding whether a particular student would journal. A portfolio of journal entries might also be passed along from grade to grade with students.

Teachers might model the value of journaling by writing in their own journals while students journaled. This time spent in reflection on teaching may be beneficial for the teacher as well. If some students are not journaling, appropriate activities, for example, warm-up activities for the day's lesson, should be offered during the time that some journal. This would insure that time is not wasted and journaling students do not feel awkward. If some teachers would see the loss of class time as a problem, they might consider whether the use of three to five minutes of lesson time for journaling could be a sound

investment of time. After journaling, students might come to the remainder of the lesson more relaxed and open to the subject matter.

As journaling is presently used in many areas in education, teachers often do not respond or give any feedback to students. When trying to assist those with mathematics anxiety, the responses of the students in this study would indicate that it is absolutely necessary for the teacher to read and respond to journal commentary. Ideally this would take place on the same day that the entry is made to insure that the teacher is aware of difficulties and might follow up in person as needed. For example, if a student indicated that she was very upset or concerned and in need of encouragement or extra help before journals would be returned, the teacher might arrange to speak with her that same day. This might occur more frequently before testing times or as more difficult course matter was encountered.

Ideally, journaling should occur at least once a week, but two or more times would be preferable. Journaling might be made optional, especially for older students, after a certain period of time has passed and they have had a chance to consider the help the experience offers them. Also, an anxiety questionnaire might be given to transfer students as they enter a class. A change in school or

class could be a particularly vulnerable time for students who may already be anxious about their mathematics studies.

The writing of prompts should be done on a weekly basis and individualized to meet the needs and concerns of each particular class group. Standardizing these cues would eliminate the teacher's opportunity to write prompts that are appropriate to current content and situations. This could be a problem, however, because some teachers may be less adept at writing prompts or write them spontaneously without reflecting on class needs, but this should not be a problem for most teachers. Occasionally, the teacher could request student written prompts or collect them on an ongoing basis anonamously through a suggestion box.

A list of the prompts used in this study can be found in Appendix D. Prompts were written on transparencies and put on the overhead projector so that students could read them as they entered the room before class or later in the class. This served as a signal for students to get their journals and begin writing. When prompts were given before class, many students completed most of their journal entries before the bell rang for class to begin. Most were anxious to read the responses to their last comments.

No student in the study was ever required to journal, but throughout the whole semester there were only two or

three times when a student did not make, at least, a short entry. Entries varied in length from two or three sentences to a full page and were dated by the students. Teacher commentary was also dated and always began with the student's name as one would begin a letter or memo.

As evidenced by student commentary in this study, it is necessary that teacher feedback reflect a careful reading of the journal entry and that empathy and understanding of student statements be shown. If a comment is not clear to the teacher, s/he can pose a question in the response or speak with the student if this would not appear to add any anxiety to the situation. In this study, responses were always written on the same day that the comments were made. This allowed for person-to-person follow up, when necessary, and insured that students always had a teacher response when they next retrieved their journals.

On a whole, students were not observed getting their journals on days when no prompt appeared on the overhead screen. Most treated their entries like letters for which one must wait to receive a response. One exception would be the story of "Suzi," which is included here as a representation of the potential of journaling in the mathematics classroom.

One day after the formal study had been concluded and

no prompt had been given for journaling, the researcher noticed a geometry student busily writing what appeared to be a letter. Since important new material was being introduced at the time, there was an instinctive need to walk toward her to ask her to put away the letter and begin taking notes. Upon closer inspection, it appeared that she was writing in a spiral notebook similar to her journal. No student had previously picked up a journal for spontaneous journaling. A decision was made to retreat and within a few minutes she was taking notes with the others. After class, her journal was found on the teacher's desk. It contained a lengthy entry regarding the problems the student was having with her geometry and other course work due to some outside causes. She did not appear to need a response, though a response was given, because she ended by saying that just writing about her feelings had improved her outlook. That incident alone seemed to reinforce for this researcher that the journaling process was indeed impactful and worthwhile from an anecdotal perspective despite the quantitative results.

These recommendations are but a few of the possible considerations for further research. The needs of those who suffer from mathematics anxiety, especially young women, must be addressed if this vital segment of our society is to reach its true potential in the increasingly

important areas of mathematics understanding and proficiency. The needs of world citizens in the twenty-first century will definitely include strong mathematics literacy. Alleviating the anxiety that impedes this literacy is most desirable.

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APPENDIX A

APPENDIX A

Parent/Guardian Information Letter

August 23, 1993

Dear Parent or Guardian:

Your daughter is a member of an Algebra I or Geometry class that has been selected to potentially participate in a research study. This study is being done in conjunction with a master's degree program at the University of Nebraska at Omaha. I am the principal investigator in the study and will work with Dr. Neal Grandgenett, assistant professor in the Department of Teacher Education at UNO. The study has the approval of our principal, Sr. Marie-Louise Flick.

The study concerns young women and mathematics anxiety. The Mathematics Anxiety Rating Scale - Adolescents and the Writing Apprehension Scale will be administered to each of the students in conjunction with this study. The study will involve the use of writing in the mathematics classroom. All instruction will focus on meeting regular curriculum goals and objectives. The instructional techniques used, and compared, in the study

are well accepted and respected in the educational community.

All tests and data collected will be anonymous and confidential. An analysis of the data collected will be available upon completion of all research.

If you have any questions or if you object to the participation of your daughter, please contact me at 558-3800.

Sincerely,

Carol M. Classe
Mathematics Department Chair

APPENDIX B

APPENDIX B

Verbal Instructions for MARS-A and WAS Surveys

The following instructions were written to supplement the instructions given on the Mathematics Anxiety Rating Scale and Daly-Miller Writing Apprehension Scale.

Today you will complete two questionnaires. The first, the Mathematics Anxiety Rating Scale, contains statements about things or experiences that may cause tension or apprehension in relation to mathematics. The second is a Writing Apprehension Scale and contains statements related to writing. There are no right or wrong answers. Work quickly, but try to be as honest as possible.

All answers will be recorded on a separate answer sheet by filling in the appropriate oval using a #2 pencil. If you do not have a #2 pencil or if your pencil breaks while you are working, please raise your hand and I will lend you a pencil.

You will begin with the mathematics scale for #1-98. When you complete this scale, raise your hand and I will give you the writing scale and show you where to record your answers for this second scale which will be recorded between #101-126.

Be sure to erase completely if you wish to change an

answer. Please do not mark on the questionnaires.

Please fill in the Answer Sheet information now. You need only record your name: last, first, middle initial and the date: 8/27/93. Leave the other information blank. You have each been provided with an identification number for the year. Record it in the first three spaces under identification number. If your random number is one or two digits only, record one or two zeros before your number.

Questionnaire results will be reported anonymously, but the above will aid organization of data. Do you have any questions? Answer quickly and honestly. Remember this is not a test.

APPENDIX C

APPENDIX C

Instructions to Students Regarding the Journaling Process.

Week of 8/29/93

1. Distribute spiral notebooks. Have students put name, class, and block clearly on front of notebook. (Algebra IB, Block 2 or Geometry A, Block 3)

2. I am asking each of you to write for about three to five minutes twice a week about some math related topic. Prompts, questions or statements, will be given on many days to guide the writing. After three to five minutes, I will go on with the lesson, but you may finish your comments as time allows during the class if you do not finish before the lesson is begun.

3. The notebooks will always in the classroom. All notebooks will be placed in a box before leaving the room. I will read what you have written and respond before the next class meeting. What you write and what I write will be considered private.

4. Prompts will be displayed on the overhead screen. When you see a question there, it is your cue to get your notebook and write a brief response.

APPENDIX D

APPENDIX D

Teacher Written Journaling Prompts

During most weeks the same prompts were given to both experimental groups. Prompts varied when specific subject matter warranted it. Prompts were written one week at a time to insure that they were significant to the current work.

Prompt #1

What teaching technique(s) help you learn? What happens in class, especially math classes that help you understand better?

Prompt #2

If math is not your favorite subject, compare your work in math to your work in your favorite area. If math is your favorite subject, tell why.

Prompt #3

How do you plan to prepare for your chapter test next week? Be specific.

Prompt #4

Now that you have taken your first chapter test, what changes, if any, do you think you will make in your daily study and/or test preparation?

Prompt #5

Open - You may make any comments you would like to make.

Prompt #6

Finish the phrase - Math is like ...

Prompt #7

How do you feel about tests in math compared with tests in other subjects?

Prompt #8

What problem from last night's homework was the most challenging and why?

Prompt #9

How prepared are you for today's test? How much time did you spend in review altogether?

Prompt #10

Reflect and comment on your first quarter's work in math. What helped you the most in your learning process?

Prompt #11

Open - You may make any comments you wish.

Prompt #12

Geometry - Comment on the tessellation unit and your reaction to our work in this unit compared with other work.

Algebra - Comment on your concerns regarding word problems.

Prompt #13

Geometry - What have you heard about proof work from other people?

Algebra - Has the 5-step form and charting helped you with word problem solutions? Please comment.

Prompts #14 & #15

Algebra - Are you clear on your Formula Project requirements?

- What further information or help do you need in order to complete your Formula Project?

Geometry - What did you like best about the tessellation Unit?

- What Tessellation Unit activity or assignment was not helpful in understanding the unit? (Not necessarily due to difficulty.)

Prompt #16

Comment on what changes in class procedure or content would help you at this time.

Prompt #17

What about mathematics makes you nervous or upset, if anything?

Prompt #18

Algebra - What additions or changes would you suggest I make in the Formula Project sheets to make the instructions clearer (easier to understand)? (I value your input.)

Prompt #19

Open Comments

Prompt #20

Open Comment

Prompt #21

Algebra I - How is chapter 4 going? Any comments?
Geometry - What topic in geometry do you believe you understand best? Why?

Prompt #22

What are your thoughts about the commentary (journaling) you have been doing this semester?

Prompt #23

Are you worried about the semester examination? If yes, why? If not, why not?

Prompt #24

What are your plans (if any) for long range preparation for your semester examination?

Prompt #25 - Last Prompt of the First Semester - No further journaling due to examination review days and semester examinations. Extended Prompt.

Please scan your journal comments and the teacher comments for this semester.

1. What have you learned about yourself, your teacher, and this course through journaling this semester?

2. Should we continue journaling next semester? Why or why not?

3. Feel free to make any other comments you would like to make regarding this process.

APPENDIX E

APPENDIX E

Student Comparison of Algebra Groups

12/10/93

Student's Name,

In addition to the questions you answered in your journal, I would appreciate it if you would comment on the questions below. You may write on this sheet or attach another sheet. I am asking you to do this because you were the only student who was in Algebra IA first quarter and Algebra IB second quarter.

1. When you changed sections, did you find that the two classes were treated differently in any of the areas listed below? Please comment on each. If you would rather not comment on any area, that can be your comment.

   a. homework

"There is only one difference I see between the two classes regarding homework. We seem to do more examples of written problems on the board. In the 5th block class we didn't do as many examples and problems we didn't understand. Some times I think people don't ask as many questions in the 2nd block as 5th block. I think this is because people ask more questions in their journals. If

people would ask the questions they do in their journals in class I think it would not only help them but others in the class."

b. testing

"I think the testing is pretty much the same. Although I do think we need review days before the tests."

c. projects

"This is a little harder to comment on because we didn't really do any projects in the other class. Although, I can imagine there were more questions asked out loud in class than in ours because we asked questions in our journals while they didn't."

d. class lessons

"Again I feel people ask questions in their journals, rather then out loud. If people would ask questions out loud rather than in their journals it would help everyone. I know I am guilty of doing this, but I have been trying to ask questions in my journal and out loud."

e. class discipline

"I do not see any difference between the two classes."

f. treatment of class by teacher

" I do not see any difference between the two classes."

2. Did you find any differences between being in the two classes?

"There were definitely differences between the two classes. Obviously the students were different. The journaling was also different. I think the main differences were stated above. I really enjoy both classes. I am really glad I could help in your studies."

"Thanks,"

Signed

"P.S. I am sorry my handwriting is so bumpy but I'm on my way to Sioux City to see my cousins."