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ABSTRACT

This paper discusses the use of process writing to assist middle and junior high school students in becoming competent, confident mathematical problem solvers and communicators. The process writing technique involves students in four recursive, overlapping stages in writing: rehearsing, drafting, responding, and revising. Students utilize this technique in daily writers' workshops to produce a class book of creative, meaningful math problems. This method of instruction not only helps students to better understand mathematical concepts, but also encourages them to express and think about their problem-solving skills. It also follows the guidelines outlined by the National Council of Teachers of Mathematics (NCTM) in their curriculum standards. A typical classroom scenario involving the four-step process writing technique and examples of student work are presented. (MDM)

Using Process Writing to Teach Problem Solving to Middle School and Junior High Students

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Using Process Writing to Teach Problem Solving to Middle School and Junior High Students

This paper deals with using process writing to assist middle school and junior high students in becoming competent, confident mathematical problem solvers and communicators. It will discuss how process writing may be integrated with mathematics to have students make a class book of creative, meaningful math problems. Although the scope of this paper will be limited to fourth through eighth graders, the techniques presented may be modified to encourage writing across the curriculum with students of all ages. The paper will be divided into three parts: a) Process writing background, b) Overview of the National Council of Teachers of Mathematics' (NCTM) guidelines for mathematical problem solving and communication, and c) Steps for the integration of process writing with problem solving to encourage children to use process writing to create original math problems straight from their own lives.

Process Writing Background

Before one can appreciate the benefits of writing about mathematics, it is important to understand the writing process. Process writing involves cooperative learning, an equal role for student and teacher, and a specific timeframe and structure for writing which may be referred to as Writer's Workshop (Calkins, 1986; Graves, 1983; Butler, 1984).

Writing begins with the will to say something to someone else. Before a child can be taught a set of strategies to guide the writing process, the desire to say something to someone else must be present and encouraged (Temple, et al, 1988). Therefore the middle school and junior high teacher must first create a safe, risk-free environment in which students feel comfortable expressing themselves and then provide activities that allow students to discover topics about which they want to write. If students are forced to write about subjects that inspire no emotions, writing is pointless. It is imperative that students have a desire to write about a topic and that every effort should be made to make writing meaningful.

Process writing values the journey that the writer travels more than the finished written product that is eventually produced. Process writing activities develop from four recursive, overlapping stages: rehearsing, drafting, responding, and revising. Murray (1990) states that writing is a process of continuous thinking, experimenting, and reviewing which encompasses all four stages.

A. **Stages**

1. Rehearsing: Rehearsal is the stage in which writers discover what they have to say. Graves (1983) called this being an observant liver of life. In the beginning, teachers can encourage rehearsing through the use of brainstorming sessions in which students free associate and verbalize disconnected ideas about their proposed topics. Free writing is another technique that may be used during this stage. Free writing is timed writing (5 to 10 minutes) in which students write down anything that occurs to them about a subject. The purpose of brainstorming and free writing is to discover a wide range of ideas and details that the student can include in a later written piece.

Knowing that they are encouraged to write each day will encourage students to see each day's experiences through the eyes of an author. Keeping an idea folder with titles or subjects listed for quick referrals may help students generate other pieces.

2. Drafting: "Writing, I remind myself, is an experimental art. I have to commit and stand back to see what I have been taught by the words on the page. I am instructed by my writing (Murray, 1990). The second stage, writing the rough draft, occurs when writers tentatively write their ideas. Drafting implies that a work is undergoing change and that more drafts may follow. It is during the drafting stage that writers experience clearly what they have to say. Reading the rough draft allows writers to move outside themselves and consider their thoughts as if they belonged to someone else. Writers can appraise their works with detachment in this stage and consider them from the standpoint of the teacher or another reader. Getting the meaning of the text across to the reader is the focus and writers are not concerned about the conventions of language at this point.

3. Responding: The responding stage involves receiving feedback from peers and the teacher. The author reads the piece while the listeners give suggestions, ask questions, and seek clarification. The first response begins with praising of ideas and involves only the meaning of the piece. The author seeks to answer questions such as, "Does my piece make sense to the reader?" and "How can the readers' questions about meaning be clarified?".

4. Revising: During the first step of revision, writers examine their pieces and make changes in order to speak more clearly to the reader. This may include patching up phrases or sentences in order to make them clearer or more precise. Writers often discover whole new possibilities that may be developed in their works. In this event, revision can mean changes to larger parts of the piece or the entire piece. Any changes resulting from the peer or teacher conferencing in the previous stage will be the decision of the author. It should be remembered that process writing is recursive: revision often leads to further rehearsal and drafting.

Editing is the second step in the revision stage. After the meaning has been established, the author, peers, and teacher read the piece underlining misspelled words, incorrect grammar, or incomplete sentences. Many times, a common problem (e.g., a misspelling, a misplaced comma, or lack of quotation marks) is found that occurs throughout the piece and may be directly taught using the first example from the writing. Then the author is able to proof the piece and correct similar problems.

5. Sharing: In a classroom practicing Writers Workshop, a sharing time at the end of each writing session is critical to its success. Calkins (1986) calls this Author's Chair. This sharing time should be held after each writing session, not just when someone publishes an entire piece. A good title or first sentence may be shared and valued as much as an entire piece. Sharing their works with others helps students become aware of the significance of their writings and encourages them to value their written pieces. Otherwise, students may believe that their own writing only fulfills a teacher's assignment

and does not have an important message. However, students should never be forced to share.

B. **Flowers Technique**

Flowers (1981) suggests a figurative way to make writing stages meaningful to writers. Students are presented with four role models: the madman, the architect, the carpenter, and the judge. The presenters like to add a fifth role, the social worker. Writers take on these roles one at a time, as they work through the writing process.

The madman is in charge during the rehearsing stage. He has scores of ideas writes crazily and messily, and gets carried away with emotions. The architect then comes in during the drafting stage, reads over what the madman wrote, and selects large sections of material and arranges them into a basic structure. Next, the carpenter comes in to revise and build the piece as he nails the ideas together, making sure the writing is clear and sequential. The social worker listens as the author reads the piece, praises the author, and asks questions to clarify and extend the piece. The judge then considers the piece. He reads it carefully, considers it reflectively, and compares it with what the author intended to communicate. The judge may send the piece back to the madman, architect, or carpenter for more revisions or may declare the work finished.

C. **Timeframe for Writer's Workshop**

Graves (1983) recommends planning Writers Workshop in the school schedule three to five times a week. If it is integrated with mathematics (or other subject matter), the teacher will find it easier to find the time. The writing period begins with a five minute, teacher-directed mini-lesson. The lesson may cover a specific skill, writing technique, or a conferencing technique.. Hopefully, examples used on the overhead or board will be from the students' writing making instruction more meaningful and relevant.

The majority of the writing period, 35-40 minutes, is spent actually writing and conferencing with peers and teacher. Rehearsal, drafting, responding, and revising occur as students progress through these stages at their own rates.

The last 15 minutes of each writing session, Author's Chair, is crucial to improving the written work and the author's as well as the classes' confidence as writers. During this time, the student reads part or all of the piece as classmates reflect and make suggestions or ask questions.

NCTM Standards

The National Council of Teachers of Mathematics (NCTM) has developed curriculum standards for teaching mathematics to students in grades K-12 (NCTM, 1989). This paper will only be concerned with the Standards for grades 5-8. In the past, mathematics has often been taught in a dull, boring, and routine way to middle school students. Many times, schools have emphasized computation at the expense of a broad, integrated view of mathematics. Luckily, this is changing and the NCTM Standards have a lot to do with the changes.

According to NCTM, the major focus of the middle school curriculum should be on Standard 1: Problem Solving. Problem solving does not refer to the word problems in most math textbooks. Most of the time, if a student can remember how to do the skill he has been studying in the chapter, he can solve the word problems in the text. Most of the time, these exercises simply drill on what has just been taught.

Real problem solving is the process by which students experience the power of the usefulness of mathematics in the world around them. It occurs when students integrate mathematical concepts and skills from many areas (geometry, measurement, calculations, etc.) in order to solve interesting problems that demand extended effort to solve. Often, problem solving integrates mathematics with other subject areas, too. NCTM recommends that students learn to apply mathematics to solve real world problems (i.e., How much more money do I need to buy a CD?) and problems that arise from the investigation of mathematical ideas (i.e., How many multiples of three occur between one and 100?).

Standard 2: Communication is, also, very important. Middle school students should have many opportunities to use language to communicate their mathematical ideas. Students should have opportunities to speak, read, listen, and write about mathematics. In the past, writing about mathematics has often been limited to solving problems on textbook pages and talking about mathematics has been limited to giving answers. However, TM advocates that writing and talking about mathematics helps students develop mathematical skills and concepts and observing their communications assists the teacher in planning instruction. Emphasizing communication in mathematics class helps shift the classroom from an environment in which students are dependent upon the teacher to one in which students assume more responsibility for their own learning.

NCTM advocates that no aspect of the Standards should be taught in isolation. Problem solving and communication should be integrated not only with each other but with all of the other Standards (i.e., reasoning, geometry, algebra, etc.) as well. Keeping this background in mind, the remaining portion of this paper will consider the integration of mathematical communication with real world problem solving through encouraging adolescents to use process writing to write their own word problems.

Classroom Scenario

An eighth grade class in the New Orleans area which had been using Writers Workshop with fiction pieces decided to take the experience they had with the steps of process writing into the mathematical arena. The teacher explained the assignment: The students were to each write three math problems found in their daily lives. They were to consider how they encountered the applications of math in their personal worlds.

Rehearsing: The class began to generate ideas of how numbers were used in their daily lives while the teacher wrote on a stationary class chart. Suggestions such as babysitting, dry wash 'n guard (a business venture), mowing lawns, the slant of a mountain while skiing, bank robbery, food at McDonald's, baseball (acceleration and velocity), monthly insurance costs for a car, monthly car payments, insurance savings resulting from taking drivers' education, percentage of state tax on items they purchased, and the amount of money spent on dates came from all corners of the room.

For several days at the end of class the teacher challenged the students to notice how math was necessary for them to make sense of their world. The list of ideas grew adding the cost of public transportation per week to get to a parttime job, the amount of money saved on a dress that was 20% off, the bank charges for a checking account, and other personal pursuits.

Rough drafts: After a week of brainstorming math problems from their daily lives, the students were asked to write rough drafts of three original math problems. Despite the advanced brainstorming, most of the students lapsed into workbook sounding, impersonal types of text. The explanation was given that it was important for the problem to "sound right." The assignment was repeated with the **personal** part of the writing stressed along with a reference to the class chart of mathematical ideas. This time, the class got original.

The ideas began to flow freely on the paper as spelling, punctuation, and other conventions of the language were not considerations at this stage of writing. Most of the students chose at least one of the math ideas from the class brainstorming chart that was still displayed in the room. The writers were told to work the problems before asking a friend to attempt to do the same. Formulas and scribbled computations were found in the margins of the papers. An example of a draft of a problem about baseball may be found in Figure 1.

Insert Figure 1 about here.

Meaning conferences: As the authors read their problems to a classmate, it was obvious that ownership had already occurred even at this early stage of its development. The authors often changed wording after problems were heard read aloud. Talents, interests, and hobbies were shared. Additional questions about the problems were asked by the listeners. The mathematics involved was attempted by the peer conferencees. If answers differed from the writers' answers, more comparison, discussion, and co-teaching took place. Changes were made.

Next, the writers read the problems to the teacher. Names were written on the board as students were ready for the teacher conferences. A student sat on either side of the teacher to save time between readings. This also ensured that the teacher as well as another student heard each piece.

From the problem in Figure 1, the teacher/writer dialogue went something like this:

T: (Starting with praise). "I didn't know that you were a baseball player. How long have you been playing? Where do you play? How many games a week do you play? You really seem knowledgeable about the terms and procedures of this All-American game."

S: Answers.

T: "Do you feel that your audience will know as much as you do about baseball? For example, will all the readers know what the 'count' is or should you clarify this?"

S: "I feel that just about everybody knows that count means score."

T. "OK. I know what fastballs and curved balls are, but what are breaking balls? Also, should fastballs be two words?"

S: "Oh, a breaking ball is when a ball drops suddenly just before getting to the plate. They are much trickier to hit."

T: "That would be interesting for your readers to know "

T: "Read the last sentence again aloud and make sure your reader understands exactly what math is involved."

S: " 'What was the speed of the pitch and then tell me what the acceleration of the ball.' Oh. I need to add **was** at the end."

T: "Now read it again to make sure the sentence will be clear to the reader."

S: Reads.

T: "Will that make sense to the reader? Now you are ready to look at the conventions of the language."

Editing conferences: Referring to an editing checklist, students read their problems again looking now for the correct use of capitals, spellings, whole sentences, punctuation marks, and other conventions of the language. Peers did the same steps checking off the appropriate areas. A box was put in the area if a weakness was noted. (See Figure 2.)

Insert Figure 2 about here

In the baseball problem, the peer conferencee found a capital letter in the middle of a sentence that should have been lower case, a misplaced comma between two nouns, and a

comma needed between the two thoughts in the last compound sentence. This was a good start. The writer corrected these mistakes. (See Figure 3)

Insert Figure 3 about here

Next, the authors signed up on the board for a teacher conference for the second time. This time as the students read the problems, the teacher looked at the written work. If editing problems were repeated several times, the teacher went over the first example with the student, allowing the student to find the others independently.

In the baseball problem , the teacher pointed out the first run-on sentence, "The ball was pitched I realized that it was a breaking ball," while explaining the use of a semi-colon between two short sentences. The semicolon was placed after "pitched." The student was then asked to find a second example of two sentences running together. "I hit the ball, but I grounded out we lost the game" was read and corrected by placing a period after "out." The paper was rewritten and typed in preparation for publication.

Author's Chair: Sharing through Author's Chair was accomplished during the last five minutes of each class period. At every stage of the writing process, students voluntarily shared math problems orally with the class for encouragement, questions of clarification, and examples for other classmates.

On the last day of the project, when all the students had finished conferencing, typing, and working the math problems involved, the coil bound booklet was handed out with each author having a page of his own to share. An answer key was supplied in the back, as well as a dedication page, Table of Contents, and an alphabetical listing of the authors.

Adhering to the rules of Author's Chair, students volunteered to read, and only positive comments were made. Time was allowed for the audience to work the problem, then the author explained its computation on the board. Questions again were posed to the writers.

Amazing things happened during Author's Chair! The shy child who had not responded orally in class suddenly was the authority explaining a mathematical process on the board that had been very well- rehearsed from the written experience. The student was truly in charge of the class and became well-known as being an expert on his particular type of problem. The books were passed around and autographed by authors on their pages. The principal, counselor, and special education teachers were invited to also share in this exciting day.

Conclusion

Using the steps of process writing to create original math problems has many benefits for children. The roles of the teacher and students become one as they conference, listen, and offer suggestions to each other. The social element of verbal interaction becomes well-developed and constructive. Students' self-concepts are improved as their self-esteem rockets. Mathematics and its applications are viewed as valuable as students use math to solve their own personal problems. Students' literacy skills improve. Concise meaning and correct language forms become important as students conference with others. The fact that the book is going to be published with their names in it encourages students to write meaningful and correctly. In conclusion, writing original mathematical problems using process writing steps benefits middle school and junior high students in far more ways than just helping them learn the basics in math and language.

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DW

3-5-94

Rough Draft

Last year the g baseball game was all up to me. The count was ~~tde~~ three and two with two outs. All that night ~~the~~ I was ~~beeng~~ pitched fastballs and curver balls. ~~I was~~ The ball was ~~pitched~~, I realized that it was a breaking ball. I hit the ball but I grounded out, we lost the game. The next day I figured out that the ball was pitched from 52 feet away and it took the ball ~~.86~~ .88 s. to get there. What was the speed of the pitch and then ~~what was the avg~~ tell me what ~~average velocity~~ acceleration of the ball.

Figure 1

Name _____ Date _____

EDITING CHECKLIST

	1st Draft			2nd Draft			3rd Draft		
CONTENT:	A	P	T	A	P	T	A	P	T
Is the meaning clear?	✓	✓	✓						
What is confusing?	✓	✓	✓						
Ways to be more descriptive	✓	✓	✓						
General content additions	✓	✓	✓						
FORM:									
capitals	✓	✓	✓						
spelling	✓	✓	✓						
whole sentences	✓	✓	✓						
commas	✓	✓	✓						
periods	✓	✓	✓						
quotation marks	✓	✓	—						
paragraphing	✓	✓	✓						
(mathematically correct)	✓	✓	✓						

A= Author P= Peer T= Teacher

Comments (and date): Author's Chair: _____ (Date)

3-5 Will nonbaseball players understand? KH

Figure 2

$A = \frac{V_f - V_i}{t}$

speed $D = \frac{D}{t}$

The Baseball Game

3.13.94

4

Last year the ~~g~~ baseball game was all up to me. The count was ~~the~~ three and two with two outs. All that night ~~the~~ I was ~~being~~ pitched fastballs and curves balls. ~~I was~~ The ball was pitched; I realized that it was a breaking ball. I hit the ball, but I grounded out. We lost the game. The next day I figured out that the ball was pitched from 52 feet away, and ~~it~~ it took the ball ~~.86~~ .88 s. to get there. What was the speed of the pitch, and then ~~what was~~ tell me what the ~~avg~~ ~~average velocity~~ acceleration of the ball [illegible]!

Figure 3