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**AUTHOR** Wason-Ellam, Linda  
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**ABSTRACT**

Based on the idea that journal writing can help students discover gaps in their knowledge and explore relationships by allowing them to reflect on what they have learned, a study examined the usefulness of expressive journal writing in a first grade mathematics program. Subjects, members of a first grade classroom involved in a "hands-on" mathematics program, were asked to record in journals their impressions of what they were learning over an 18-week period. They were often asked motivating questions such as "What did I learn or discover this week at Math Centers?" Results showed that students used writing for four distinct purposes: (1) self-questioning, (2) organizing information, (3) assimilating and accommodating information, and (4) making guesses. As students became more comfortable with writing to learn rather than writing to display knowledge, they began to ask questions in their journals, order their experiences chronologically, connect new experiences with old, reflect on wrong answers as well as correct ones, and make guesses. The findings suggest that expressive writing makes learning active and personal, and does not relegate students to learning only by memorizing, transcribing, and recalling. (JC)

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WRITING AS A TOOL FOR LEARNING: MATH JOURNALS IN GRADE ONE

Linda Wason-Ellam  
University of Saskatchewan

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Writing is primarily a process and only secondarily a product. As a process writing can be used to reflect, to clarify information, to discover one's knowledge and opinions, to learn information specifically and to explore the self and the world. Writing can be used as an aid to one's own thinking. Writing has two functions:

1. **Writing for informing** which connects writers for an audience.
2. **Writing for learning** which gets writers in touch with themselves.

The former is Britton's (1970) idea of **transactional** and **poetic** writing which conveys ideas, feelings and understandings to others and the latter is **expressive** writing, an exploratory close-to-the-self language which gives insights into self.

Expressive writing is best used for exploration and discovery; it has a feeling-thinking aspect to it which may or may not be present in other writing modes. Students can use expressive writing to record or react to what they are learning. The writing they produce mirrors personal knowledge. Graves (1978) states that by encouraging students to write expressively they are given an implicit message; the message that they have something worthwhile to say. More important, the experience of expressive writing is a freeing one for most young writers as they begin the composing process. They are freed from the fear of writing, the lack of confidence in their writing, and the lack of fluency with written language.

### WRITING FOR LEARNING

Writing for learning is different from writing or informing. This exploratory reflective language is important to foster in classroom contexts as it is one of the primary means students have of personalizing their knowledge. This view supports Polanyi's (1962) idea that all knowledge if it is to be genuine, must be somehow made

personal; students must construct their own meanings for experiences. Vygotsky (1978) believes that language is the outward expression of thinking, the way one makes meaning out of one's thoughts (p. 72). Likewise, Emig (1977) and Thais (1986) write that students need to be active participants in their own learning, sorting ideas first for themselves then later communicating these ideas with others. Frank Smith (1982) explains "writing separates our ideas from ourselves in a way that is easiest for us to examine, explore and develop" (p. 15).

One of the most versatile and productive writing to learn strategies is the use of a journal or learning log (Vacca and Vacca 1986). Journals add an alternate dimension to the learning process in content areas by allowing students to record their personal thoughts as they explore new concepts. The journal becomes a natural format for both self-inquiry and examination. Based on this premise, a study was developed to investigate the contributions expressive writing could make to students learning in mathematics. Once a week, beginning writers in a grade one classroom were asked to pictorialize (draw first) and then to write in a mathematics journal reflecting on concepts explored while working in a mathematics centre. Students responded to the process question: "What did I learn or discover this week at Math Centres"?

In conducting the study, the following premises were made:

1. that writing promotes learning,
2. writing is a developmental process,
3. the universe of discourse includes a broad range of writing functions and audiences.

In this study, journal writing was not a think/write model that reduced the process to simply transcribing fully formed concepts; instead, it represented a unique mode of learning. Writing was not used to test or solicit information nor was it something students did after they learn. Writing was used as a tool for discovery, an aid to learning; not merely as an instrument for reporting someone else's information. Writing was used to promote metacognitive awareness, a time for young students to reflect upon knowledge. Writing was regarded

as critical to idea formation. a chance for beginning writers to work out emerging ideas.

### THE CLASSROOM

The classroom teacher in this study used an activity-centred approach to the teaching of mathematics. The program's goal was to develop mathematical concepts from the actual manipulation of the environment. Activities were designed to help the students see mathematical relationships and interconnections. This process enabled them to deal flexibly with mathematical ideas and concepts. Students moved gradually from a "hands on" experience to increasing levels of abstraction and symbolism. Since the students were involved in groups at "learning centres", the program emphasis was on developing language as well as math learning. Talk was fostered as students discovered and shared their ideas within the math centres.

Number concepts were taught on three levels.

First, students confronted number and all its various relationships as represented by different concrete materials. Secondly, attempts were made to link the concept of number as represented concretely in the familiar materials with the traditional mathematical symbols.

Thirdly, students were given the opportunity to express their mathematical thinking in their own written work as they grew to feel at ease with abstraction

The classroom program was structured so that students worked at Math Centres on activities designed to teach meaningful concepts rather than numerical symbols. The program focused on an inductive, problem-solving model which called for problems to be identified and quantitative solutions suggested. This practice built in the learner a "math sense", which became the basis for further analytic reasoning.

The students had an opportunity to put mathematical language into their own words and to speculate on mathematical solutions in their journals. Students were asked to interpret—that is, to relate what they saw and heard to other parts of their experience—or to use writing in a personal meaningful way. This related to Britton's idea that the most important function of writing is "commentary", that is making sense for oneself. One must write about an experience in order to understand one's perception (1970). This practice differed from more traditional instructional models which have students participate in a mathematical/language learning environment by first listening, "paying attention" and "taking it all in", and then responding, "giving it back", when called upon to recite or write an answer.

Traditionally, the great problem for beginning writers is knowing what to say and how to say it. In this particular classroom context, the students were operating in a world of real experiences totally understandable to them. The students were thinking with pencil in hand as evidenced by these journal entries.

Mark, 6:

I learned how to do rithmintics. I learned it by counting my fingers. Then I did it with my pencil.

Kirsti, 6:

I like dominoes. We put them together. What ones that match.

Personal experiences with mathematical manipulatives provided the source for these emerging writers and these experiences enabled them to write in their own voice. Writing in math journals centred around things the students thought to be interesting and important as in the case of Michael's entry who commented about how dinosaur shapes can be grouped and subtracted on a felt board. Michael even constructed his own word for the process

Students were given the task: "Match sets (e.g. counting blocks, dinosaur shapes) to number words."

Michael, 6:

I learned in centers today you can match the same blocks together. At the other centers, I noticed that you can **minus up** dinosaurs.

Mayer and Lester (1983) advocate letting students find their own words to represent what they are learning. Responding to Britton's (1980) statement "we ask students to limp around in someone else's language in hopes that eventually it will fit," the expectation was that the language students used in their journals was their own. This writing mode required students, to interpret, to synthesize or to actively think about the investigation of the mathematical materials, and to become aware of how they considered their answers. Observation revealed that students went beyond the information of the mathematics curriculum; they acted on it, made connections to previous experiences and transformed it into a useful personal structure of knowledge.

Writing was functional, it was a tool for learning as well as communication. Writing gave the students an awareness and control of their thoughts. It allowed students to hold onto ideas long enough to scrutinize them. The math journals invited students to respond in personal terms to what they are learning. Entries into the journals influenced learning by revealing problems, clarifying thinking and generating ideas and questions. Students wrote about their puzzlements, frustrations, amazements and interesting facts. Observations became inquiry. Responding to the question "What did you learn," helped students reflect on their own thinking. This research suggests that students used writing to learn for four distinct purposes: self-questioning, organizing information, assimilating and accomodating information and making guesses.

## SELF-QUESTIONING

A crucial aspect of comprehension is the ability to ask appropriate and probing self-questions. In most instructional activities, students are taught to answer questions rather than to ask them or even to pose self-questions. One of the compositional features of the students' writing was the use of a rhetorical question at the beginning of their journal entries. Students began with statements such as: "Do you know what I learned today at centres?" Inquiry-centred writing helped students to understand and synthesize what they were learning. This was evident in Tyler's entry which reflected on the adding process.

Tyler, 6:

Do you know how I learned how to add? I used junk to learn to add. I took one group of things of junk and then another group of things and I put them together and I counted them and the numbers made a higher number than it was before. I like doing it that way.

As the students developed as writers, compositional features changed. Although there are no linguistic features which serve to identify expressive writing (Perera 1984), an analysis of the students' writing demonstrated the growth of certain structural components that emerge in all beginning writers; beginnings, patterns of organization, and closures. Table 1 shows the development of journal beginnings from primarily a personal text to one that began either as impersonal or as a rhetorical question. As the students developed an awareness of a self-audience, they often began their journals with inquiry.

Table 1

Compositional Features Beginnings		
Personal I, This is me	Impersonal this, it	Rhetorical Question Do you know?
Week 1	13	2
Week 2	12	7
Week 3	12	4
Week 4	6	8
Week 5	7	6
Week 6	4	7
Week 7	6	5
Week 8	9	5
Week 9	6	4
Week 10	4	7
Week 11	5	6
Week 12	4	10
Week 13	3	11
Week 14	6	6
Week 15	5	5
Week 16	5	10
Week 17	6	9
Week 18	4	9

N=19

## ORGANIZING INFORMATION

Through journal writing students shaped and refined their thoughts. As beginning writers, they were wrestling with the information gathered in the math activities to find patterns in their facts and to build an idea out of their data. In contrast, students in traditional classrooms are given little opportunity to organize information on their own although this is a crucial part of writing. The idea that writing brings order, understanding and meaning to one's thoughts and experiences is another way of saying that writing processes internalize information, makes it external and holds it in graphic relief for reflection and learning. Students who responded in these journals were thinking on paper. Hopefully, they were beginning to see relationships, connections and ideas which were previously elusive and abstract as demonstrated in Amy's entry.

Students were given the task: " How many Halloween shapes at the flannelboard? Graph the number of shapes."

Amy commented about her work at the graphing centre. She wrote in a chronological sequence about the linearity of graphs .

Amy, 6:

This is me playing at the graphing center. I put pumkins on the board. We put them in lines, otherwise, they would be all mixed up and it wouldn't look right.

To be a cohesive text, writing should have both an overall discourse theme and connections between adjacent sentences (Perera 1984). Amy's writing demonstrated text coherence as she recorded her thoughts about the graphing centre. The order of sentences reflects the order of recalled events. Amy's chronological sequence is similar to a **focus chain** (Applebee 1978); a writing style in which beginning writers attempt to link text together.

As writers developed, connectors were often used to order the sequence of activities. Tyler's entry was ordered chronologically and joined by the temporal connectives **then** and **after that**.

Tyler, 6:

I learned how to play dice roll. And it is fun. You have to get a book. Then you get a piece of paper. And you get one dice with numbers and a dice with dots. And you take turns. Two people play in group and the other 2 people play in another. One person rolls the dice and sees how much they get. After that they write it down in the column. If you already know it you write it down in the column. It goes  $5+5=10$ . If you don't know you count them up.

Later, students were given another graphing task: "Take a handful of jelly beans. Graph your jelly beans by color. What did you learn from your graph?" Heather explained her results expressing her ideas using her own language. She organized her information non-chronologically by comparing results: same and different.

Heather, 6:

The pink is winning and the purple is the same as the yellow. The orange is at three. And the pink is at four  
And I like the pink best

Table 2 shows the development of how students organized their entries; chronological and non-chronological. In a chronologically ordered text, time structures the sequence of events. In a non-chronologically ordered text, the relationships between the parts are logical rather than temporal.

Table 2

Pattern of Organization		
	Chronological	Non-Chronological
Week 1	1	17
Week 2	6	17
Week 3	6	11
Week 4	8	10
Week 5	8	9
Week 6	12	5
Week 7	14	3
Week 8	14	3
Week 9	16	2
Week 10	17	1
Week 11	15	2
Week 12	17	1
Week 13	18	0
Week 14	17	0
Week 15	16	0
Week 16	17	0
Week 17	18	0
Week 18	16	1

## ASSIMILATION AND ACCOMODATION

Journal writing played a vital role; it allowed students to reflect and generalize about experiences and to recode that experience in a written form so that it could be assimilated into the student's prior knowledge. Learning did not involve taking in and processing chunks of information. In a Piagetian sense, new information was stored in the student's existing mental files or the file was restructured to make it compatible with new ideas. Journals helped students "activate prior knowledge" which was an appropriate way to begin any form of learning. Expressive writing was loosely structured and was closer to everyday speech. Students speculated on their learning, engaging processes that reflected independent thinking. Existing ideas were connected to new experiences. It focused on experiences or point of view that was a concern to the writer and may not be shared by the audience as in Heather's entry.

Students were given the task: "Estimate how many seeds are in the pumpkin?"

Heather:

I discovered that the one that had the most wasn't right. It was hard to guess because you couldn't see inside the pumpkin.

In this entry, the text was not self-sufficient. In linguistic terms, a self-sufficient text is one in which the writer uses the reference system appropriately; referents must be specific to the reader as well as to the writer (Perera 1984). Heather's writing was much like a monologue; writing for oneself that does not require a response from the reader. Heather was working in a world of real experiences totally understandable to her but unaware that the reader did not have the same knowledge. From an interview with Heather, one learned that she discovered the largest estimate made by one of her classmates, which she calls the "most", was not the right answer.

When examining the compositional features of the journal writing, it demonstrated that students move from closing their entry with a personal statement (I like it), toward an impersonal statement (That was what happened) or an adverbial clause of reason (because I couldn't figure it out). This is shown in Table 3.

Table 3

Compositional Features Closure		
Personal I Like	Impersonal It was	Explanation because, then, otherwise, I found if
Week 1	11	2
Week 2	8	4
Week 3	4	6
Week 4	6	5
Week 5	5	6
Week 6	2	8
Week 7	3	9
Week 8	5	7
Week 9	4	7
Week 10	1	7
Week 11	0	11
Week 12	3	5
Week 13	1	7
Week 14	1	7
Week 15	0	7
Week 16	0	6
Week 17	1	8
Week 18	2	8

## MAKING GUESSES

Guessing is called forming hypotheses. Like questioning, guessing is an important part of learning in mathematics. The activity based program encouraged students to take risks and to speculate on answers. Journal writing became the time for students to reflect on their guesses. Mark explained why his guess was not right.

Students were given the task: "Estimate the circumference of a pumpkin. Cut a piece of string to match your estimate; then measure your string around the pumpkin and finally, place the string on hooks labelled: Too Short, Just Right, Too Long

Mark, 6:

I learned how to do the yarn putting it on the jack-o-lantern. Mine was too long cause I didn't know. But it was really close.

Since the classroom environment is one of mutual trust between students and the teacher, students felt confident in reflecting on wrong answers. Students knew that the purpose of the journal was writing for oneself; not writing to please the teacher. In a like manner, Michael and Billy explained their guesses for the same task.

Michael, 6:

The pumpkin was big and then I noticed it shrunk. I cut my string too short because I thought it was the right size. But I was wrong.

Billy stated why his guess was accurate.

Billy, 6:

I made my string so it would just fit around the pumpkin because I am a good guesser.

The discovery function of writing can help students become aware of the processes they used to solve problems. Britton supported this notion by stating that an essential part of the writing process was explaining the matter to oneself. This was very much akin to Donald Murray's idea of "teaching the other self" (1982). Murray described writing as a conversation between two workers at a workbench. "The self speaks, the other self listens and considers." This was demonstrated by Sarah's entry which validated her response to a task.

When writing about playing a game of dominoes, Sarah gave a reason for her answer.

Sarah, 6:

I learned how to play the dominoes. Heather was playing. We were putting them in the same place. We put one in the wrong place because we could not figure out.

Amy explained why counting buttons are not as easy as counting fingers.

Amy, 6:

We divide diamonds into groups then we add. Then we use paper for doing our equations. Equations are adding anything. I like to add the most was my fingers because buttons make me get mixed up.

Jarvis summed up how he learned how to count using counting cubes.

Jarvis, 6:

We learned how to count 1,2,3,4,5,6,7,8,9,10. And that's how we want to. And we are learning how to do this with cubes and with a place value board. And sometimes it gets confusing. And sometimes I get confused because sometimes I can't put all the cups into tens. And we numbered them funny names. And we did this because we are supposed to learn how to count numbers together.

## Conclusion

In summary, results of the investigation suggested that writing to learn demanded a view of learning which was active and personal. Students engaged the material on the basis of their previous experience and made it their own. This required an interactive conception of learning as hypothesis testing. The students created their own language through interaction with mathematical experiences around them. Knowledge was not something that existed "out there" in the teacher's mind or in a book independent of a knower. Knowledge was a personal possession and it was based on the knower's own experience. The process of developing ownership of knowledge was facilitated and enhanced when students wrote in their own terms about the concept being learned. This was different from memorizing, transcribing or regurgitating. Writing as a tool for learning looked at students as "apprentices" who made their own construction of meaning from the content of the mathematics curriculum. Students used math journals to reflect on their learning, to discover gaps in their knowledge and to explore relationships between what they were learning and their prior experiences.

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