

**The Effect of Journal Writing on Secondary One Students' Ability to Explain
Mathematical Concepts and their Perceptions of Journal Writing**

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Abstract

This study explored the effects of journal writing on students' ability to explain mathematical concepts and their perceptions of journal writing in the learning of mathematics. Journal writing was used in this Mathematics classroom to provide students with further opportunity to explain concepts and apply knowledge. Additional journal prompts were designed to provide the teacher with information on the students' attitudes in the learning Mathematics. In this study, a Secondary One Express (Grade 7) class (N = 37) completed six journal writing tasks over a period of ten weeks. Data on students' ability to explain concepts was gathered through their responses to the journal prompts. A comparison of pre- and post-journal writing was made. Students' perceptions on journal writing were gathered through a survey. Results suggested that journal writing had a positive impact on students' ability to explain mathematical concepts among the average ability students. Students' responses to the survey indicated that journal writing was a useful form of communication between the teacher and the students. The results of the study suggested that journal writing would be a plausible alternative assessment mode for the average ability students in enhancing their ability to explain mathematical concepts.

Introduction

One of the aims of the Singapore Mathematics Education is to be able to communicate mathematical ideas and arguments precisely, concisely and logically. Students demonstrate their ability to communicate mathematically when they are able to illustrate, interpret, explain and discuss mathematical ideas and their experiences in doing mathematics. Mathematical communication could be enhanced through the provision of opportunities for students to engage in activities which involve explanation, interpretation and presentation (Ministry of Education, 2000).

The Singapore Mathematics Syllabus suggests that schools provide students with multiple opportunities and a range of contexts in the learning of Mathematics (Ministry of Education, 2004). A variety of assessment types could be used by students to demonstrate the different outcomes stated in the syllabus. The assessment tools used by the school teachers are similar to the assessment requirements in the national examinations like the GCE-N and GCE-O Level Examinations.

In recent years, there is a higher proportion of questions in the national examinations requiring students to communicate and apply their mathematical knowledge. An example of this is when students are asked to explain why a certain triangle is a right-angled triangle. As a result, schools could be seen increasing their use of alternative modes to assess students' learning processes, metacognition and attitudes, complementing the conventional pen-and-paper tests (Ministry of Education, 2007).

In 2004, journal writing was introduced in East View Secondary School by the Mathematics (Math) Head-of-Department as an alternative assessment in Mathematics, starting with the Secondary One classes. From 2004 to 2007, the implementation of Math journal writing in the school went through several changes and the implementation was extended to other grade levels. The journal prompts and the rubrics for grading the journals entries were refined. The school continued with the programme, encouraged by the positive feedback from the questionnaires administered to students and teachers at the end of every year. Although the school has noted that journal writing in the teaching of

English Language has been beneficial, benefits using Math journal writing would need to be documented.

Literature Review

The interest in journal writing in the Mathematics classroom started in 1980s (Borasi & Rose, 1989; Jurdak & Zein, 1998, Vukovich, 1985). Similarly, in Singapore, there was also an increased interest in using journal writing as a tool to assess students' learning (Yazilah & Fan, 2002 and Yeo, 2001). As a result of the potential benefits surfaced by researchers and classroom practitioners, more schools were seen to introduce journal writing.

The study by Borasi and Rose (1989) suggested that journal writing helped both the teacher and the students in the teaching and learning process. Journal writing was said to have a therapeutic effect on feelings and attitudes of students, as well as positive effect on their learning of mathematical concepts and problem-solving skills. Guided by students' journal entries, the teachers were better positioned to evaluate student's learning and plan remediation.

Drake and Amspaugh (1994) concluded that perhaps one of the most important benefits of using journal writing was in its use as a diagnostic tool as well as a way for teachers to gain insights into their own practices. Students' regular journaling helped teachers to better understand their students' thinking. Relevant information gleaned from students' journals when carefully analysed, accurately interpreted and applied, could help teachers become more reflective in their practice.

Liebars (1997) shared that journal writing was a valuable means of student assessment. She noted that writing encouraged one to be more thoughtful in reflecting and clarifying one's own thinking, a mental habit which enabled students who were not mathematically inclined to be more confident. Burns and Silbey (2001) also asserted that Math journaling was one of the ways to introduce writing into the Math class. When children wrote journals, they examined, expressed, and kept track of their reasoning, which was especially useful when ideas became too complex. By reading their journals, teachers could evaluate the students' progress and recognised their strengths and learning needs.

Likewise, findings from two local studies on the implementation of journal writing at a primary school and a junior college, have been equally positive. Yazilah and Fan (2002), in their study involving primary school students, recognised the value of journal writing in being a good avenue for primary students to provide feedback on school programmes and express their needs in terms of learning mathematics. As for the teachers, students' journal responses allow them to gather information on their students, monitor their understanding of the topic and most importantly, it brings them closer to their students. In the other local study, Yeo (2001) found journal writing to be an effective tool to increase teachers' understanding of students' learning in Math and students' attitude towards Math learning and teaching. Moreover, student journals supported teachers' reflection and improved their instructional programmes.

For this study, journal writing was defined as a structured piece of writing in Math classroom which required students to explain concepts, apply knowledge as well as to provide the teacher with information on students' attitudes in learning Math. The students' ability to explain Math is characterised by their: (a) correct use of mathematical terminology and symbols; (b) choice of suitable examples and/or counter examples; and (c) application of mathematical knowledge in reasoning. In relation to assessing mathematical communication, the journal writing tasks also functioned as learning tasks for the students, developing in them the desired learning outcomes (Careless, 2007).

Building on the earlier studies, this preliminary effort examined the benefits of journal writing when implemented in a neighbourhood secondary school. The study also contributed to the knowledge base on the use of math journal writing among secondary schools. The study's research questions were: (a) Does the use of journal writing increase students' ability to explain mathematical concepts? and (b) What are the students' perceptions of journal writing in the learning of mathematics?

Method

Participants

This study involved a class of 37 Secondary One students. Among them were 18 girls and 19 boys. The students were of average Math ability as indicated by the Math T-

scores obtained at the Primary School Leaving Examinations (Grade 6 national examinations). Their Math lessons were conducted by a Math teacher with more than 10 years of teaching experience. As the students were randomly assigned to their respective classes, the participating class might not comprise the high ability students. Nevertheless, it was noted that the students in this class were motivated and responsive during lessons.

Measures

The researcher crafted the journal prompts based on the topics to be covered for the term. The prompts were adapted from *Journal Writing in the Mathematics Classroom* (Kaur, 2004) and a related article (Dougherty, 1996). The prompts were of two types – affective and content. Figure 1 displays two such prompts.

Example 1 (Content)

Dorothy wrote the following:

$$3a + b = 3ab$$
$$2s \times 4t = 6st$$

Do you agree with her? Explain to Dorothy what you think of her algebraic manipulation.

Example 2 (Affective)

Write a letter to your Mathematics teacher, telling him about your feelings towards Mathematics and his Mathematics lessons.

Figure 1. Examples of Journal Prompts

The researcher collaborated with the teacher who conducted the writing tasks to design a survey to find out students' perceptions towards the use of journal writing in the learning of Math. The survey findings would help the teachers make refinement in future rounds of implementation.

Procedure

The students responded to six journal prompts over a period of ten weeks. The first journal was labelled Journal No. 1 and the sixth journal was labelled No. 6. Two of the journals (affective) were given as assignments to be completed at home. For the other four journals (content), students were given 20 minutes to write their responses in class.

For the first two journals, the teacher spent time explaining the prompts before the students started writing. This was done to clarify any doubts and to help the students get started on journal writing. Subsequently, the students attempted the remaining journals on their own with minimal guidance from the teacher. The content journals were submitted to the teacher on the same day of the writing task while the affective journals were submitted at the beginning of the following week after the task was given.

While the teacher gave feedback on both types of journals, only the content journals were scored using the rubrics. A teacher-designed rubric was used to assess the students' ability to explain mathematical concepts. The rubric served as a scoring guide to evaluate the quality of the students' journal entries. The criteria used in the rubric were: the use of mathematical terminology, connections to mathematical knowledge and the application of mathematical processes. For each criteria, students' performance were marked against four levels of achievement: Level 0 through Level 3 with Level 0 representing a level of achievement which was below expectations and Level 3 representing the highest level of achievement which exceeded expectations. For each criteria and level of achievement, a numerical score was assigned.

Before marking the content journals, the teacher team and the researcher went through a standardisation exercise. In each standardisation exercise, the teachers first agreed on the mark allocation for each of the components of the rubrics before marking three selected students' journal samples. The teachers deliberated and made the necessary adjustment to their marking before they concurred on the marks to be awarded to the three samples. The standardisation served as a guide for the teachers in awarding marks to the rest of the journals.

Findings and Discussion

Journal No. 1 mean score was compared with that of Journal No. 6 to examine for discernable progress in the students' ability to explain Math concepts. Descriptive statistics was used in the analysis of the survey responses.

he students' capacity to explain mathematical conceptFrom the scores of the content journals, it was observed that 51% of the Journal No. 1's scores were higher than Journal No. 6's scores. Table 1 shows the mean scores for Journal No. 1 and Journal No. 6, across the different PSLE Math grades. The effect sizes ranged from 0 to 1.35, suggesting that there was some level of improvement in the quality of the students' journal entries. The results also indicated that journal writing has the largest effect on the group of students who scored Bs in their PSLE Math examination. For the lower ability group of students who scored Ds in their PSLE Math examination, journal writing seemed to have no impact. This group of students were unable to maximise the benefits of journal writing as they were limited by their language capability. As such, a differentiated provision of scaffolding could have been provided across the different Math ability groups to support their journal writing.

Table 1: Comparison of Journal Writing Scores

PSLE Math Grade	Journal Writing Task ¹	Mean (SD)	Effect size
A	Journal No. 1	4.1 (2.13)	0.28 (small effect)
	Journal No. 6	4.7 (1.16)	
B	Journal No. 1	3.7 (1.49)	1.34 (very large effect)
	Journal No. 6	5.7 (1.03)	
C	Journal No. 1	4.8 (1.28)	0.55 (moderate effect)
	Journal No. 6	5.5 (0.53)	

D	Journal No. 1	2.0 (2.83)	0.00 (negligible effect)
	Journal No. 6	2.0 (2.83)	
All students	Journal No. 1	3.9 (1.75)	0.57 (moderate effect)
	Journal No. 6	4.9 (1.79)	

Examining their survey item responses found in Table 2 could provide a more in-depth understanding of the students' journal writing experience. It was noted that 68% of the students agreed that the use of Mathematics journals encouraged them to think and 65% indicated that journal writing helped them with their Math learning. 59% of the students agreed that journal writing helped them to communicate with their Math teacher and they appreciated their teacher's efforts to respond to their comments. 59% of the students indicated that they did not like writing in the Math journal as they felt that they were required to write a considerable length in order to score high marks in their journal writing tasks. In addition, the students commented that journal writing took up the curriculum time during their Math lessons which they preferred to be used for completing the syllabus. The students saw this as an add-on though they agreed that journal writing was beneficial. It would be therefore useful if the teacher took time to explain the intention of journal writing in learning Math. Teachers could emphasise how journal writing would allow students to express their Math understanding as well as to provide feedback to the teachers in the planning and adjusting to students' learning needs.

Table 2. Students' Perception of Journal Writing

No.	Statements	SD	D	A	SA
1.	Journal writing helps me with my Math.	5 (35%)	9	22 (65%)	2
2.	I am encouraged to think when I write my Math journals.	1 (32%)	11	16 (68%)	9
3.	I can express my feelings and thoughts through Math journals.	7 (49%)	11	13 (51%)	6
4.	I face difficulty in writing my Math journals.	6 (57%)	15	10 (43%)	6
5.	Journal writing has helped me to communicate with my Math teacher.	7	8	17	5

		(41%)	(59%)
6.	I can complete my Math journal on time.	2 10	16 9
		(32%)	(68%)
7.	Math journal writing is easy.	3 13	15 6
		(43%)	(57%)
8.	I am comfortable with doing three Math journals in one term.	6 5	20 6
		(30%)	(70%)
9.	I like doing Math journals.	15 7	13 2
		(59%)	(41%)

SD- Strongly Agree, D - Disagree, A- Agree, SA- Strongly Agree

Conclusion

This study was a single school's preliminary effort to investigate the effect of journal writing on students' ability to explain mathematical concepts and their perceptions of journal writing in the learning of Math. While the findings have been encouraging with most of the students showing an increase in the scores obtained for the journal tasks over time, the school was aware of the inherent limitations of the study which included the use of a single group research design and the collection of data using a teacher-constructed survey questionnaire which has yet to be validated. Further research involving the use of a comparison group and a validated instrument would be needed to establish more conclusive results. Going forward, the school team could use the findings to: (a) understand their students' progress in Math learning; (b) explore suitable pedagogies to move students forward in their learning of Math; and (c) provide exemplars to enable students to communicate clearly their Math ideas, thinking and understanding.

As the use of journal writing in the secondary school mathematics classrooms began to be more accepted by teachers, the effective implementation of journal writing lies in the teachers' perceptions of the value-addedness of journal writing. Teachers could be provided with opportunities to carry out journal writing as part of their professional development journey for them to understand the relevant issues so as to better support their students in these writing activities.

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