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Incorporating the Use of Writing-to-Learn Strategy in Grade 10 Mathematics Lessons: The Students' Perspectives

Zuhairina Suhaimi
Sayyidina Ali Secondary
School, Ministry of Education,
Brunei Darussalam

Masitah Shahrill
Sultan Hassanal Bolkiah Institute
of Education, Universiti Brunei
Darussalam, Brunei Darussalam

Khairul Amilin Tengah
Sultan Hassanal Bolkiah Institute
of Education, Universiti Brunei
Darussalam, Brunei Darussalam

Nor'Arifahwati Haji Abbas
Sultan Hassanal Bolkiah Institute
of Education, Universiti Brunei
Darussalam, Brunei Darussalam

ABSTRACT This study incorporated the use of writing-to-learn strategy, particularly journal writing, in Grade 10 mathematics lessons. Although part of a study conducted to investigate the effects of journal writing on academically lower-achieving learners with English as their second language, this paper will focus only on the students' perceptions of writing journals in mathematics. The students' perceptions are based on their experience from a 2-cycle action research study. A total of 35 students, ranging from age 15 to 16 years old, from two Grade 10 classes were involved in the study. Data from the student journal entries and questionnaires revealed that the majority of students found journal writing beneficial for the development of their mathematical learning.

KEYWORDS *journal writing, mathematics, students' perceptions*

Introduction

Specifically in the area of mathematics, students are expected to be able to communicate mathematics, in writing or orally. This inspired us to find ways to enhance students' communication skills in mathematics class. Therefore, this study focuses on integrating writing, specifically writing-to-learn strategy, in a mathematics classroom. Emig (1977) stated that writing can contribute to the learning process through a combination of features such as engaging all learners actively in the deliberate structuring of meaning, allowing learners to learn at their own pace, and providing unique feedback through self-reflection, as learners can read the product of their own thinking on paper immediately. Most mathematics learners view learning of mathematics as simply memorizing working procedures in order to obtain the solutions to exercises given by the teacher (Yunus et al., 2016). These students seldom recognize the conceptual

knowledge or the purpose behind these procedures which, according to Borasi and Rose (1989), is not conducive to the success of the development of problem solving skills in the long run. However, before looking into the effectiveness of journal writing, it is essential to explore the students' perceptions and experiences in the use of journal writing in their learning process.

Purpose and Research Question

The purpose of this study is to investigate the low-achieving students' perceptions in the use of journal writing in mathematics lessons. This study aimed to benefit the participants and researchers in gaining insights of learners' integration of writing in the mathematics class, and help develop students' communication skills in mathematics in addition to supporting mathematics teachers in integrating writing as an alternative tool for students' learning. It is also envisaged that this study

would benefit future researchers in planning to explore the dynamics of writing in mathematics lessons. The research question “What are the students’ perceptions on writing journals in mathematics?” guided us in the study’s analysis.

Scope and Limitations

Since the views presented in this present study were from the students in Brunei Darussalam (hereafter, referred to as Brunei), this article was thus situated within the context of Brunei.

One of the main aims of the Bruneian new educational system reform called the National Education System for the 21st century, or commonly referred as *Sistem Pendidikan Negara Abad ke-21* (SPN21), is to raise the quality of education in line with the current and future needs by developing 21st century skills amongst learners. In particular, the system emphasized skills required beyond the academic curriculum such as communication, numeracy and Information Communication Technology (ICT) skills (Ministry of Education, 2013).

In Brunei, despite Malay being the first language for the majority of the students, almost all subjects in both primary and secondary levels are taught, written and assessed in English. Many students have difficulties in expressing their thoughts explicitly because English is a second language to them (Khalid & Tengah, 2007; Khoo et al., 2016). In this study, we allowed the participants to write in the Malay language when they were struggling to express their thoughts in the English language.

Review of the Literature

Writing has been recommended as a tool for concept learning by researchers and educators. Most of the time, writing is merely seen as an assessment tool for the students to answer structured questions. It is rarely used as a learning task, particularly for mathematics. For instance, when learners are required to write their observations, results, reasoning processes or attitudes, they pay more attention to details and are able to organize data more logically (Kober, 1993). Furthermore, learners are found to be able to structure their arguments in a more coherent way; thus, refining their communication skills.

Fulwiler and Young (1982) stated that the main function of writing-to-learn is not merely to communicate, but also as a tool to discover, shape meaning, and reach for fuller understanding. Some forms of writing-to-learn are journaling and the K-W-L charts (Know, what they

Want to know, and what they Learn). Observations, prediction writing and drawing conclusions (Gammill, 2006), as well as essay composition, research and project writing (Carter & Carter, 1994) are also within the framework of writing-to-learn.

From the educational perspective, mathematical journaling refers to a practice of recording thoughts, understanding, and explanations about mathematical ideas or concepts, where learners are expected to share their journal entries with the teacher (Journaling, n.d.). Journal writing in mathematics is also described as structured writing tasks with specific prompts or questions, for the purpose of triggering the students’ conceptual knowledge of a specific topic (Chai, 2004). The task can be done as often as every lesson, once in a week or even once for each topic.

Prompts are defined as mathematical questions or hints that stimulate deeper rather than superficial learning processes (King, 1992). They can be perceived as strategy activators (Reigeluth & Stein, 1983) since these prompts trigger learning strategies that the learners are capable of utilizing but are not able to demonstrate.

Fung (2010) discerns three genres of mathematical writing: personal, expository and expressive. Personal writing, or affective writing (Baxter et al., 2005) involves writing about one’s personal opinions or feelings. For example, “In your opinion, should calculators be used in mathematics class?” (Baxter et al., 2005). Meanwhile, expository writing involves applying and making the connections between mathematical ideas. For instance, “Explain in three different ways what it means when fractions are equivalent” (Carter & Carter, 1994). In expressive writing, learners are required to construct a new mathematical product from a particular mathematical concept, such as creating an exam question for a specific topic along with their own justifications for the answers (Fung, 2010). This type of writing may require the students to do some research beyond the classroom material.

Journal writing can benefit both the learners and the teachers reading it. Borasi and Rose (1989) claimed that journal writing has the potential to improve learners’ mathematical content knowledge because articulating and reflecting on their process of doing mathematics will enhance learners’ learning and problem-solving skills. Furthermore, the learners achieve a more appropriate view of mathematics when their perceptions of mathematics are made explicit and re-evaluated successively. The learners may also use journal writing to monitor aspects of the learning material they understood well or struggled in comprehending (Chi et al., 1989). The teachers, on the other hand, can use students’ journal writing

to diagnose students' errors, either due to guessing, careless mistakes or misunderstanding, in order to enhance their students' learning and understanding (Carter & Carter, 1994). Gammill (2006) asserted that classroom environment could be made more student-centered as a consequence of writing.

The literature contains numerous studies about journal writing in mathematics classes (Borasi & Rose, 1989; Nteza, 2006; Kostos & Shin, 2010; Tan & Garces-Bascal, 2013). The studies involved learners from primary schools to higher institutions. Kostos and Shin (2010) claimed that journal writing has a positive effect on the learners' mathematical communication and use of mathematical vocabulary, and that it operates as a communication medium between the learners and the teacher. Additionally, Tan and Garces-Bascal (2013) reported that journal-writing exercises enhanced gifted learners' mathematical achievement in algebra. Similar studies in other learning areas such as science and psychology have also been conducted (Hand et al., 2006; Papadopoulos et al., 2010; Nuckles et al., 2009; Teng et al., 2012).

Methods

Design of Research

The study is based on action research, which according to Mills (2003) is any systematic inquiry conducted by the teachers which aims to collect information about how well they teach and how well their students learn. Data collection comprised a mixture of qualitative and quantitative approaches. The study focused on how writing journals in a mathematics class could affect the students' mathematical perceptions on writing in mathematics. The data were collected from two different mathematics topics that were implemented in two consecutive cycles.

Sample

The study focused on Grade 10 students from a government secondary school located in a residential area in the Brunei-Muara district, which is the most populated district with the highest concentration of schools in the nation. A convenience sampling was selected and the first author was also the teacher conducting the lessons. The mathematics topics taught during the lesson interventions were 'Graphs of Functions' in the first cycle, followed by 'Geometrical Terms and Relationships' in the second cycle. *Graphs of Functions* from the first cycle covered the sub-topics *quadratic graphs* and *reciprocal graphs*, while the second cycle included sub-topics *measuring and drawing angles, bearings, nets of 3D solids, congruent shapes* and *similar shapes*.

Initially, 43 students from two Grade 10 classes (Class A and Class B), participated in the study. Class A comprised 13 male students and 11 female students, whereas Class B consisted of 14 male students and 5 female students. The students' ages ranged between 15 to 16 years old. However, due to absenteeism data from only 35 students were used.

In order to maintain the standard code of ethics in the study, the name of the school as well as that of the participants were coded for anonymity purposes, and pseudonyms were used for the students mentioned in this report. Consents, such as permission to conduct the study, were sought in advance from the principal of the school, the students' parents or guardians, and also the students themselves.

Instruments

The instruments used to collect data were journal entries and questionnaires.

Journals

Each participant was provided with a small exercise book in which to write the journal entries for both cycles. In each cycle, the participants were provided with prompts (refer to the prompts provided in Appendix 1) that were modified from the ones given in Carter and Carter (1994) and Fung (2010). In the first cycle, the participants were required to write at the end of each lesson in order to maximize their experience in writing within the limited period of time. The instructions for journal writing were provided to the students (refer to Appendix 2). Since four lessons were conducted for the topic *Graphs of Functions*, four journal entries were thus written. However, for the second cycle, the participants were required to write once for each of the five sub-topics on *Geometrical Terms and Relationships*.

Questionnaire

The questionnaire was adapted and modified from the online questionnaire conducted by Tan and Garces-Bascal (2013). The questionnaire had a total of 14 questions; 8 questions were designed using the 4-point Likert scale format while an additional 5 items were open-ended questions (refer to Appendix 3). However, in Cycle 2, some items were modified to suit the topic taught. The questions can be classified into three sub-categories: the classification of benefits of journal writing, recommendation of journal writing, and suggestions or comments on journal exercises.

Data Analysis

Journal entries

Each of the participants' journal entries was checked for patterns before the next journal-writing task. The teacher spent approximately one hour to perform such a task for every class.

Questionnaire responses

The participants' responses were first re-recorded in a Microsoft Excel spreadsheet. Since the first eight items of the questionnaire were in the Likert scale format, the frequency of each response (strongly agree, agree, disagree and strongly disagree) was then tallied for each item. Subsequently, the percentage count was calculated. For the remaining five open-ended questions, patterns were identified and analyzed.

Results

Journal

The participants were given prompts before writing the journal entry. However, in the first cycle of the study, the students seemed to be struggling in expressing themselves, as it was their first experience writing a journal in mathematics. Figure 1 and 2 respectively are samples of work from Yasmin and Hamzah. Both entries were responses to the second prompt in Cycle 1.

"One of your friends is absent from school today. Write a letter to your friend to describe/teach him about today's lesson. Explain carefully step-by-step on how you achieve the objective of today's lesson."

Figure 1 illustrates an example of a relatively good response. Not only was the subtopic to be described

mentioned, Yasmin also compared the topic with the previous lesson on *Quadratic Equations*. Although the word 'constant' had been introduced in the lesson, Yasmin chose to define the constant 'a' as 'any given number'. However, she seemed to have misunderstood the mirror conception. Instead of the point (0,0), the correct concept would be that the line $y = -x$ that passes through the point (0,0) acts like a mirror.

Hamzah's response in Figure 2 was not sufficiently explicit, with some parts missing or left unexplained. Most importantly, Hamzah did not mention the topic he was describing. Hamzah's entry is more reflective than Yasmin's of the instruction to teach an absent friend about today's lesson.

In order for the participants to know how well they had done in their writing, the journal entries were again assessed in the second cycle. Each entry was assessed using a guided rubric. Figures 3 and 4 show journal entries with different scores, written by Yasmin and Hamzah respectively. Both entries were responses to the second prompt of Cycle 2.

"What are the differences (in terms of procedures) between the previous topic that you have learnt (measuring and drawing angles) with the topic bearing?"

Yasmin's response shown in Figure 3 was inadequate. She stated the property of a bearing, but failed to relate these properties to the previous topic. Hence, Yasmin obtained a score of 3 out of 4 marks for this particular exercise. Meanwhile, Hamzah stated only one property of a bearing. He also did not express the actual difference from the previous topic. Hence, Hamzah obtained 1 mark only.

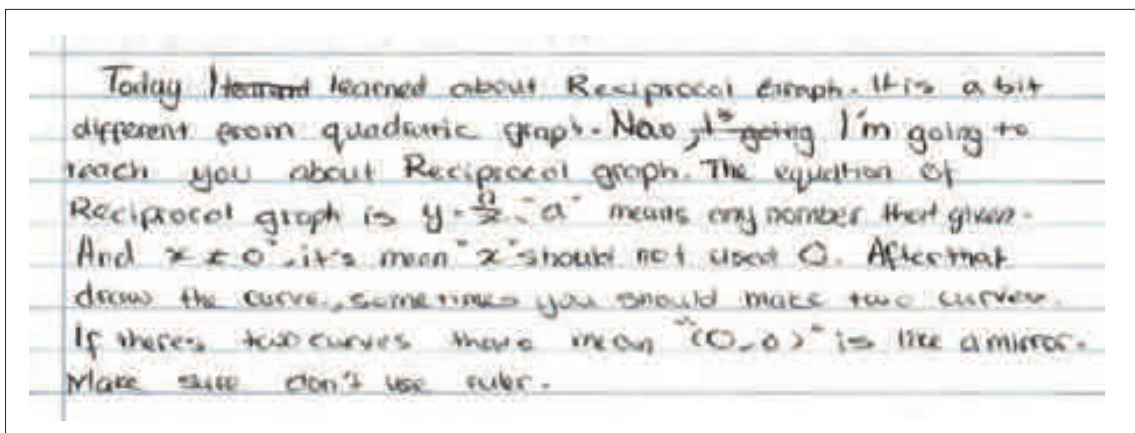


Figure 1. Yasmin's response to the second prompt in Cycle 1.

First step: you must complete the missing values of y in the table.
2 step: If draw graph you should draw the graph first.
3 step: Point the number of y .
4 step: draw a curved line according to the point or (x) .

Figure 2. Hamzah's response to the second prompt in Cycle 1.

The difference between measuring and drawing angle and bearing is bearing always in three-digits, measure clockwise from the north and measuring and drawing angles.

Figure 3. Journal entry written by Yasmin for Cycle 2.

*The differences is bearings is always use 3 digits number but different angle.

Figure 4. Journal entry written by Hamzah for Cycle 2.

Questionnaires

From Cycle 1, 86% of the participants agreed or strongly agreed that the journals helped them to improve their understanding in the topic *Graphs of Functions*, 86% concurred that journal writing helped them to effectively reflect on their mistakes, 88% improved their rapport with the teacher through journal writing, 66% believed that the feedback given to them was useful for their learning, and 69% responded that they could monitor their own thinking through journal writing.

For the recommendation section, 60% would like to continue to write in their journals, 54% recommended journal writing for the topic *Graphs of Functions*, and 71% would like to recommend journal writing to their fellow peers.

Cycle 2 saw only a slight decrease in the percentages of agree or strongly agree for the topics of interest. Only 72% of the participants agreed or strongly agreed that the journals were useful for them to improve their understanding for this topic, 66% concurred that journal writing helped them to effectively reflect on their mistakes, 63% improved their rapport with the teacher through journal writing, 62% believed that the feedback given to them was useful for their learning, and 65% responded that they could monitor their own thinking through journal writing.

For the recommendation section, 62% would like to continue to write in their journals, 63% recommended journal writing for the topic *Geometrical Terms and Relationships*, and 60% would like to recommend journal writing to their fellow peers.

Open-ended Questions

In the questionnaire, the open-ended questions in both cycles revealed that most participants had difficulty expressing themselves in English. Although the teacher had allowed the use of the Malay language in writing the journal, the participants still utilized English in their journal entries. One possible influence may be that the mathematical terms introduced in the lesson were in English. Other common struggles include difficulties in deciding on the precise choice of words to express and not fully understanding the prompts themselves. On the other hand, it should be noted that poor English language competency does not affect the students' mathematical achievement (Pungut & Shahrill, 2014). Some of the participants also noted that the lesson had to be well understood before they could respond to the prompts.

The open-ended questions also elicited the participants' views on the journal writing task. One participant men-

tioned how much she liked the idea of thinking and writing that the task demanded, while another complained that his dizziness was attributed to excessive thinking about the task given. In spite of the seemingly negative responses from some respondents, participants were evidently actively involved in thinking rather than simply employing formulae to solve mathematical problems.

Some other participants also mentioned how journal writing had enabled them to monitor their own learning, as they would not have been able to respond to the prompts if they had not understood the lesson. Journal writing was also said to encourage participants to communicate with their teacher about parts of the lesson they had not understood, allow them to improve on both mathematics and English, as well as enable them to reflect on what they had learnt in the lesson. All of these responses reflected on the benefits of journal writing as mentioned by Borasi and Rose (1989) and Kostos and Shin (2010). One of the participants remarked how easy learning mathematics could be, and she also discovered the joy of learning mathematics through journal writing. However, two participants did not find journal writing to be useful and wrote that it was a waste of their time. Some participants also expressed their dislike for writing in mathematics and found it difficult.

Conclusion and Recommendation

Despite the participants' mixed reactions towards journal writing, their responses were generally positive. However, the second cycle saw a decline in the percentage of participants who agreed or strongly agreed on the task. This may be due to the fact that the participants felt discouraged about writing, after seeing their scores in the test given between the first and second cycles. The difference between the two topics may also be the cause. Through the responses from the questionnaire, most of the students agreed or strongly agreed that writing a journal was beneficial for their development in learning mathematics. As claimed by 60% or more students, the journal writing exercises benefitted them in improving their understanding in the mathematical concepts through the teacher's feedback. It also enabled the students to recall what they had learnt in the lesson, thus allowing them to monitor their own learning. Not only did journal writing help students academically, it also improved the teacher-student rapport.

Journal writing in mathematics is different from the traditional classwork and homework exercises, as it requires the students to recall the lessons and apply their

knowledge in their writing, using their own words. Worksheet exercises, on the other hand, allow students to obtain the correct answer simply by using the formulae, the significance of which may not be fully fathomable. The thinking process was confirmed by the students' response in the open-ended questions from the questionnaire. Although journal writing was well received by most, some participants did express their dislike as they found writing in mathematics difficult.

The feedback from the questionnaire confirmed that the students were able to keep track of their own learning and be responsible for it through journal writing. Some students concluded that understanding was crucial in responding to the journal prompts and that they need to reflect before writing.

Journal writing can encourage learners to become more independent. Moreover, the students who had difficulty communicating the mathematics lesson that they had learnt suggested that writing or oral presentations should be incorporated in mathematics lessons so as to improve students' communication skills. This would not only enhance the learning of mathematics, but it would also improve the students' language skills.

Future research into this area should consider extending the time given to students for writing a journal so that they could familiarize themselves with the procedure. In addition, using students with diverse abilities and at different educational levels could shed more light on the effective use of journal writing in the learning of mathematics. Apart from that, the types of prompts and writing activities used can be varied. Also, correlating students' writing in mathematics with their oral communication in presentations can prove beneficial. Finally, the use of journal writing can be extended to disciplines other than mathematics.

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Appendix 1

The prompts provided in Cycle 1 and Cycle 2

Cycle 1: Graphs of Functions

- Prompt 1: Do you think that the topic Quadratic Graph is related to any of the topic that you have learnt before? Which topic and how?
- Prompt 2: One of your friends is absent from school today. Write a letter to your friend to describe/ teach about today's lesson. Explain carefully step-by-step on how you achieve the objective of today's lesson.
- Prompt 3: Why do you think there is a need for the curves to be smooth?
- Prompt 4: If you were to give advice or directions to someone new to this topic, what helpful hints would you offer?

Cycle 2: Geometrical Terms and Relationships

- Prompt 1: Describe a real world situation that involves angle measures.
- Prompt 2: What are the differences between the previous topic that you have learnt (measuring and drawing angles) with the topic bearing?
- Prompt 3: Give two examples of objects that you may encounter daily and name their respective shapes.
- Prompt 4: Explain how would you check if two shapes are congruent.
- Prompt 5: Explain the differences between congruent and similar figures.

Appendix 2

The instructions for journal writing that were given to the students.

1. You will be given something to write about. Think about it and write on!
2. You will be given 10-15 minutes to write.
3. Write in full sentences.
4. Do not worry too much about your grammar.
5. Please write on your own. The journal is about your own honest thinking.
6. Please DO NOT copy from your friends.
7. Write as much as you can!
8. This will not be assessed.

Example:

Question: Miss Lee has 23 dogs. She decides that she's going to give 17 to Mrs. Watsons. How many will she have left?

Answer: So we can't do $3-7$ so we have to borrow from the 2 and make the 3 a 13. And $13-7$ equals 6 so then you put down your 6. Now $1-1$ equals 0 so she will have 6 remaining dogs.

Appendix 3

The questionnaire (adapted and modified from Tan and Garces-Bascal (2013))

No.	Questions	Strongly Disagree	Disagree	Agree	Strongly Agree
		1	2	3	4
1.	The journal writing is useful in improving my understanding of the topic <i>Graphs of Functions</i> .				
2.	The journal writing has allowed me to reflect on my mistakes effectively.				
3.	The journal writing has improved my rapport with my teacher.				
4.	The feedback given to me through journal writing has been useful for my learning.				
5.	Journal writing has helped me monitor my own thinking such as the selection and use of problem-solving strategies.				
6.	I would like to continue journal writing for other topics in mathematics.				
7.	I would like to recommend journal writing in the teaching of <i>Graphs of Functions</i> .				
8.	I would like to recommend journal writing for other topics in mathematics.				
9.	What I like about journal writing exercises:				
10.	What I think can be improved about the journal writing exercises:				
11.	On reflection, journal writing helped me to discover that:				
12.	The difficulties I faced in writing the journal entries:				
13.	What I did to overcome my difficulties in writing the journal entries:				
14.	Comments or suggestions on journal writing:				