Students’ Performance in Context – Based Lessons in Mathematics Classroom

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Abstract. This study aimed at developing contextualized lesson plans integrating writing in mathematics using the pupil’s mother tongue. It also aimed at determining pupil’s improvement in the writing math activities for a period of one month. A Grade 3 class with 31 pupils was purposively selected because of its heterogeneous composition. Using a comparative-descriptive design, this study utilized both quantitative and qualitative data from pupils’ weekly writing outputs, pretest, posttest and transcripts of classroom observations and interviews. Five lesson plans were developed using the backward curriculum design based on the K to 12 curriculum standard. The data revealed that the pupils made significant improvement in their writing math performance irrespective of ability group. However, the high-performing pupils made significant learning gains compared to the developing pupils. In-depth analysis of outputs showed improvements in pupils’ writing mathematics skills. Most pupils organized their ideas even after the question prompts have been removed on the last week of implementation. This study claimed that the use of scaffolding, contextualization, and mother tongue helped pupils in their writing and improved mathematical reasoning.

Keywords: Contextualization, Mother-Tongue-Based Education, Integration of Math and writing, Writing in Math

1. Introduction

The future problems students will face require them to draw solutions from an interdisciplinary point of view. Pupils need deeper understanding of issues rather than rote memorizing facts. These principles are embodied in the K-12 mathematics curriculum where emphasis is given to important skill sets such as problem solving and critical thinking [3]

The traditional conception about teaching is to teach mathematics consisting of memorizing facts, formulas, and procedures while reading and writing are part of languages and social science disciplines. However, two of the most pressing academic problems in the primary grades are reading together with writing and numeracy. Pupils who failed to attain fluency in these areas will have hard time learning in the succeeding year[6].

The integration of math with other subject helps pupils appreciate the importance of math in the real world [2]. However, mathematics is oftentimes integrated with sciences [7][10]but not with reading and writing. Finding better ways of successfully integrating both skills is crucial and beneficial to pupils’ academic success[11], citing the National Council of Teachers of Mathematics reports, strongly recommended that the process of writing in mathematics become an integral part of mathematics curriculum.
Another emerging issue is the use of pupils’ native language in classroom instruction to allow pupils to express ideas and develop in-depth understanding, confidence and self-efficacy in mathematics[5]. In the implementation of the mother-tongue-based education, the Department of Education (DepEd) recognized 19 regional languages which are the bases in the teaching of mother tongue in schools[3]. However, this poses problems to schools and teachers whose learners have a different home language, such as the Sinama speaking learners. In such a case, the schools and teachers should adapt strategies and develop their own contextualized instructional materials based on one of the recognized languages.

For these reasons, the researcher conducted this study with the aim of contributing contextualized lesson plans and activities in Sinama. This study also aimed at determining the effectiveness of integrating writing activities using the Sinama language in a Grade 3 mathematics class. Specifically, this study aimed to:

- Develop context-based math lesson plans
- Determine the improvement of the Grade 3 pupils’ performance on the writing math activities

Conceptual Framework. The DepEd’s mathematics framework states that the twin goals of mathematics education in basic education are problem solving and critical thinking[4]. Teaching pupils to write about mathematics promote in-depth understanding. Writing Mathematics Activities is grounded on the child-centered learning theories, notably, Vygotsky’s constructivism which underscores the importance for the learners to construct their own knowledge instead of being the passive recipient. The use of scaffolding is also anchored on Vygotsky’s concept of the Zone of Proximal Development[15]. Another emerging concept is the use of the Mother-Tongue-Based Multilingual Education as a subject and as a medium of instruction. This is also based on Vygotsky’s sociocultural theory which posited that conceptual development among children is influenced by cultural practices including pupil’s home language.

Figure 1 shows the conceptual framework of the study. The developed lesson plans integrating writing math activities contextualized in Sinama served as inputs which were used throughout the duration of the study. Prior knowledge in mathematics and writing are important variables which may influence the result of the study. The developed lesson plans and activities underwent validation and try-out before the actual implementation. Expected outputs include the developed lesson plans and improved pupils’ performance on the writing math activities.

![Figure 1. The Conceptual Framework of the Study.](image-url)
2. Methodology

2.1 Sample of the Study.
One Grade 3 class in the district of Tawi – Tawi during the school-year 2018-2019 was purposively selected as the subjects of the study because of its heterogeneous composition in terms of academic ability and the pupils’ use of single mother tongue, i.e., Sinama. The class was composed of 31 Grade 3 pupils who were then classified as high-performing, average-performing, and developing based on their first quarter grades in mathematics.

2.2 Data Collection.
After having done the development process and followed the experts’ suggestions, the researcher, with the consent of the thesis adviser asked the permission of the Schools Division Superintendent of the Department of Education (DepEd), Division of Tawi-Tawi for the pilot testing, try-out, and finally the implementation of the lessons to the selected Grade 3 pupils. Similar letters were sent to the district supervisor, school head, and cooperating teachers explaining the purpose of the study. The researcher implemented the developed lessons and activities in the Grade 3 class with the help of the Grade 3 mathematics teacher and a research assistant for the duration of one month for 50 minutes per day. The pretest and posttest were administered before and after the implementation of the study, respectively. Actual classroom observations were done by three trained teachers using the STAR observation tool during the first and the last week of the implementation. Individual interviews were conducted twice involving all pupil respondents. The interviews were done during the first and the last week of the implementation to determine pupils’ perceptions and experiences on the writing math activities.

3. Results and Discussions

3.1 Process in the Development of Lesson Plans
The development of lesson plans follows the backward approach to curriculum design. The basic rationale of choosing backward curriculum design is that it ensures the development of the desired output, i.e., the development and integration of writing activities. According to Grant Wiggins and Jay McTighe [17], backward design follows three stages, these are 1.) Identify the desired result 2.) Determine assessment evidence and 3.) Plan learning experiences and instruction.

![Figure 2. Process of Development of Lesson Plans and Activities](image)

The development started with the researcher's interest in the integration of writing in math class using the pupils' mother tongue and determination of the pupils' progress. The researcher determined how these objectives can be best integrated into the curriculum by mapping of topics based on the K to 12 Curriculum Guide in mathematics. This was followed by the selection of appropriate writing math activities among the many strategies and assessment tools to be used. Then the writing of the lesson plans was based on the above objectives and tools. Afterward, the lesson plans underwent try-outs and revisions. Making reflection is part of every phase of the development.
3.2 Development of Writing Math Activities.
The selection of the appropriate writing math activities was important in this study because these were used to achieve the general objective, i.e., the development of mathematical thinking and problem solving through writing. The developed writing activities were then embedded in the lessons and used to measure pupils’ improvement.

The researchers started with researching literature on different writing math activities that can be applied in the context of the study. Considering the grade level of the pupils and their experiences with the writing math activities, the researcher, upon the recommendation of the research adviser, decided to focus on Write-to-Explain math activities.

The researcher recognized the importance of guiding the pupils using prompts during the first few weeks of implementation. It was also decided that the prompts would eventually be removed from the activity as soon as the pupils had developed their writing math skill. This is based on Vygotsky’s ideas of Zone of Proximal Development (ZPD) and scaffolding where the quality and quantity of assistance need to change over time with learner assuming more responsibility [15]. Finally, there were five question-prompts developed and translated into Sinama. Aside from the use of the pupil’s mother tongue, i.e., Sinama, the story problems used in the developed lesson plans were contextualized by relating these to the local setting. This is based on the idea that pupils learn better mathematical concepts by working with things of his culture and the language he is familiar with[9].

3.3 Writing of Lessons Plans.
Five lesson plans were developed by the researcher covering addition and subtraction of three to four digit numbers. These topics were selected from Grade 3 curriculum guides for mathematics and based on the researcher’s expected time frame of the actual implementation. The unique features of the developed lesson plans are the utilization of Sinama language and the integration of writing math activities. Each lesson plan has three write-to-explain math activities where pupils are asked not only to compute but to explain and justify their answers in writing. Each lesson plan is expected to be taught in three days. The lesson plan model is based on the DepEd Teacher’s Guide (TG) for Grade 3 mathematics consisting of the preliminary activities, developmental activities and assessment.

3.4 Try-out of Lesson Plans and Writing Activities.
The try-out aimed to determine the appropriateness of the developed lesson and writing math activities for possible improvement and the length of time of implementation of each lesson plan was based on the capacity of the pupils faced with the writing math activities. It also looked into difficulties experienced by the pupils with the writing math activities. It was also during this try-out where the pretest was also pilot-tested in the actual classroom.

3.5 Improvement in Pupils’ Performance.
To determine the improvement in pupils’ performance in the writing math activities, pupils’ outputs were rated on a weekly interval. Figure 4.5 shows the pupils’ performance in the writing math activities during the four-week implementation. The pretest scores of developing (M=2.73, SD=1.11) and average performing (M=3.96, SD=2.75) were on the ‘Beginning level’, while those of the high-performing pupils (M=6.58, SD=3.28) were on the ‘Developing level.’ After a week, pupils’ performance improved irrespective of ability groups compared to their pretest. The high-performing group made the largest learning gains (M=8.61, SD=3.42). Significant improvement was also achieved by the average-performing group (M=6.99, SD=3.85) and developing group (M=5.58, SD=2.33).

All groups also improved in their writing math performance in terms of overall mean gains during the second (M = 2.50, SD= 3.56) and the third week (M = .23, SD = 3.07). On the fourth week of implementation, there was a decrease in the pupils’ performance in writing math compared to their third-week performance. This decrease in the pupils’ scores was probably due to the kind of activity given. It was at this period when the pupils were given Write-to-Explain math activities without the question prompts. However, compared to their pretest scores, the developing and average-performing
group are now improving to ‘Developing level’ (M=7.78, SD=2.15) and ‘Proficient level’ (M=12.56, SD=2.59), respectively. Similarly, the high-performing group is now in the ‘Advanced level’ (M=16.29, SD=2.81).

These findings show that pupils’ outputs in writing math improved when pupils were exposed to this strategy which is similar to the findings of Petersen, McAuliffe & Vermeulen (2017) who found improvements in the strategies and explanations learners used after having been taught math writing and to the study of [8]on the use of question prompts that improved pupils’ performance in math problem solving. We can also infer that the use of the mother tongue helps pupils in organizing their answers to the math problems. This supports those studies favoring the use of mother tongue in class instruction [13]; [9] [1]. Some pupils made frequent spelling and grammatical mistakes showing that their level of ability in the language used in math classes affects their performance in the writing math activity.

3.6 Pupils’ Performance in Pretest and Posttest.

The result of the pretest and posttest shows a highly significant difference in the pupils’ performance after one month irrespective of their ability group. The finding is supported by [14] and[12] who found significant improvements in pupils’ writing strategies and skills after having been taught writing in mathematics.

| Group            | Pretest | Posttest | Standard Deviation | t-value | p-value |
|------------------|---------|----------|--------------------|---------|---------|
| High-Performing  | 6.582   | 15.519   | 3.78               | 6.25    | < 0.001*|
| Average -Performing | 3.962  | 11.294   | 2.67               | 8.77    | < 0.001*|
| Developing       | 2.73    | 7.356    | 2.87               | 6.25    | < 0.001*|

*Highly Significant at α<0.05
3.7 Comparison of the Pupils’ Gain Scores by Group.

Table 3 shows the comparison of the mean gain scores by ability groups. The gain scores were computed by subtracting the pupils’ pretest scores from their posttest scores. The result shows significant difference in the average gain scores, $F(2, 27), p = 0.025$ at $\alpha = 0.05$ level among the three groups of pupils. This indicates that there was an improvement in the pupil’s writing math skills after the one-month study.

Table 2: The Result of the One-way Analysis of Variance (ANOVA) on the Mean Gain Scores Among the Three Groups

|                | Sum of Squares | df | Mean Square | F    | Sig. |
|----------------|----------------|----|-------------|------|------|
| Gain Between Groups | 77.44          | 2  | 38.72       | 4.22 | 0.025* |
| Gain Within Groups     | 247.83         | 27 | 9.18        |      |      |
| Total                   | 325.26         | 29 | 4.22        |      |      |

* Significant at $\alpha = 0.05$

Table 4 shows the result of the post hoc analysis of the average gain scores among the three groups using the Least Significant Difference (LSD) Test. The result shows no significant difference in the learning gains between the high-performing group ($M = 7.33, SD = 2.64$) and the average-performing group ($M = 8.94, SD = 3.78$), $p = .292$. No significant difference was also found in the mean gain score of the high-performing ($M = 7.33, SD = 2.64$), and developing group ($M = 4.98, SD = 2.87$), $p = .076$ indicating that both groups compared made similar improvements in terms of gain scores. However, comparison in the learning gains between the high-performing group ($M = 8.94, SD = 3.78$), and the developing group ($M = 4.98, SD = 2.87$) yields a significant result, $p = .010$ indicating that high-performing pupils benefited more in the writing math activities compared to the developing group in terms of learning gains. This finding is similar to that of [8] who found that the high-performing pupils benefited more in activities using prompts in mathematical problem-solving.

Table 3: Comparison of Mean Gain Scores Among Groups.

|                | Ave. Gain Score | Mean Difference | Std. Error | p-value |
|----------------|-----------------|-----------------|------------|---------|
| High Average   | 8.936           | 1.60            | 1.49       | .292    |
| Developing     | 4.980           | 3.96            | 1.27       | .010*   |
| Average Developing | 4.980         | 3.96            | 1.42       | .076    |

*Significant at $\alpha = 0.05$

3.8 Pupils’ Perceptions on the Writing Math Activities.

The researcher conducted a one-on-one interview to understand pupils’ perception about the writing math activities during the first week and after the implementation. During the first week, only 14 or 45% of the pupils said they found the writing math activity easy while 17 or 55% of the pupils found the writing math activity difficult. However, after the one-month implementation, majority or 27 out of 31 pupils described the writing math activity as easy compared to only four or 13% of the pupils who still found writing math activities difficult. Among the top three reasons the pupils found the writing activities easy were: (1) doing the computation, (2) use of question prompts helped them in writing, and (3) looking for what are known and what is asked in the problem.
Among the top three reasons mentioned by the pupils as to why they found writing activity hard were: (1) difficulty in identifying the given and questions in the story problems, (2) some pupils had difficulty in making a conclusion or final answer that answers the questions being asked, and (3) difficulty in reading and understanding the story problems. This finding supports [16] which implies that a better understanding of the language subjects used in math class contributes to pupils’ performance in the writing math activity.

3.9 Result of Teachers’ Observations.

During the first observation, teacher-observers noted that pupils are still new to the activity and many have difficulties. However, marked improvements were noted during the last week observation. The teacher-observers noted that the pupils are finishing the tasks on time and were asking question to clarify doubts about the story problem. On the other hand teachers gave lesser scaffoldings. However, one teacher-observer noted that pupils seemed getting bored after doing the same activity for a long time. This indicates that pupils should be exposed to different writing math activities. Overall, it can be inferred that integrating writing in math class can be a good strategy to be adopted although some pupils will find it challenging at first when they are new at writing in math. Teacher’s role and amount of scaffoldings shifted to mostly pupils doing the task when integrating writing in math class.

4. Conclusion and recommendations

The development of lessons integrating writing activities followed a backward curriculum design. Pupils’ performance in writing math improved significantly with the high-performing group benefiting more from the lessons compared to the developing group. The use of scaffoldings, mother tongue and the local context helped the pupils in understanding mathematics problems and in writing math. Pupils’ perception on the writing activities in using the Sinama language improves over time as they became familiar with the activities. Similarly, teacher-observers noted changes in the teacher’s and the pupils’ actions in terms of teacher’s scaffoldings, more pupil activity and lesser time in completion of tasks.

This study recommends that: (1) Teachers integrate writing activities into their math lessons; (2) The use of mother tongue helped the pupils in their understanding of math problems and in writing their ideas; therefore, teachers may contextualize math problems and activities to make these more interesting to pupils; (3) The DepEd Tawi-Tawi conduct teachers’ trainings on the integration of writing into math lessons and on contextualization using Sinama language; (4) Math teachers use question prompts as scaffolds when introducing the writing in math for the first time; (5) Developing
learners be given individualized or special sessions; (6) The write-to-explain math activity be used in combination with other writing activities when integrating writing in math classrooms.

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