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# Contextualized Schema-Based Instruction in Improving Numeracy Skills of Learners

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**Abstract:**

This research study explored the effect of Contextualized Schema-based Instruction on the numeracy skills of Grade 5 learners. The subject of the study is composed of 15 Grade 5 learners enrolled in Buenaventura Mahilum Elementary School in A.Y 2023 – 2024. This research study used one group pretest-posttest design. The respondents were subjected to an intervention, and data were collected before and after using the contextualized schema-based instruction using the researcher made test on numeracy skills. The researcher used Mean, Standard Deviations, and analysis of paired t test to analyze the data. The study's findings revealed a significant difference in the level of numeracy skills of grade 5 learners before and after using the contextualized schema-based instruction. The increase in the performance is attributed to the use of contextualized schema-based instruction but other factors could have contributed to the improvement. The contextualized schema-based instruction as an intervention is an effective resource to the learning process and is proven effective improving the numeracy skills. As evidence were found that the intervention helps improve the numeracy skills, the researcher suggests that the use schema-based instruction embedded on the materials may be considered and teachers may adopt it as teaching strategy and supplementary material in learning mathematics.

**Keywords:** Contextualized, Schema-based, Intervention

## Introduction:

Mathematics is essential to a better quality of life for each individual, it has a special and relevant role in the educational curriculum. However, it is well known that the majority of students find mathematics challenging (Dagdag, et. Al, 2023). According to Education Scotland (2019), Mathematics, out of all the learning areas in basic education, presents students with problems that arise from within or from without, which consequently affects numeracy skills.

The poor mathematical skills are prevalent in the Philippines. In the "Trends in Mathematics and Science Study" (TIMSS), Philippines rank last and second to the last in the "Program in International Student Assessment" (PISA). In the PISA result, Filipino students achieved an average score of 353 points in Mathematical Literacy, which was significantly lower than the OECD average of 489 points. Also, the Philippines scored 297 in math according to the TIMSS 2019, which is a lower score than how the country fared in 2003 which is 358 and is lower than the lowest scale in the TIMSS interpretation of scores which is the Low International Benchmark (400). Both international tests showed how worrisome is the performance of the students in the field.

In the Regional Memorandum No. 256, s. 2019, the 2019 Regional Unified Numeracy Test (RUNT) shows that 816 (24%) students of the division of Sagay City were categorized as non-numerates.

The record of pupils with poor numeracy skills is also present in our school. This is supported with a low MPS on mathematics in the 4th quarter in the last school year of Buenaventura Mahilum Elementary School grade 5 pupils of 69.19 which is lower than the standard of 75. Moreover, In the conduct of enhanced regional unified numeracy test or the E-RUNT, the 20 grade 5 pupils were tested and the result showed a 15% non-numerates.

Teachers perceived lack of sufficient effort and previous knowledge as the prime reasons that make students mathematics learning difficult (Agustyaningrum, et. Al 2021). The reason why mathematics is difficult is that students find it challenging when they don't have prior information. In the absence of pertinent prior knowledge or schema, it might be challenging to learn higher mathematical skills.

Researchers claimed that certain schools have had success using schema-based learning. Results revealed from the study of Fuchs et al. (2021) that schema-based word problem interventions do improve students' understanding of word problems, and schema-based instruction was more effective when it's embedded language instruction about word problems. In similar manner, Hughes and Cuevas (2020) conducted research which investigate the frequency at which students use strategies to solve word problems in a second- grade resource

class with students which have individualized programs and found out that students were better in solving problems using the schema strategy in solving it.

In research of Root et al., 2019, states that Traditional SBI has been modified to support students with extensive support needs who are likely to need more intensive supports to overcome additional barriers to problem solving, such as limited procedural and conceptual knowledge and weaknesses in executive functioning and metacognition. Thus, the researcher taught of contextualizing schema-based instruction by incorporating curriculum content and instructional strategies relevant to learners.

Furthermore, this study aims to improve numeracy skills of the grade 5 learners using contextualized schema-based instruction.

**Objectives**

The primary purpose of this research was to find out the effectiveness of contextualized schema-based instruction as s an intervention in improving numeracy skills of the learners for the S.Y. 2023-2024 in problem-solving. Specifically, the study sought to answers the following questions: What is the level of numeracy skills of the Grade 5 Learners in their pre-test? What is the level of numeracy skills of the Grade 5 Learners in their post-test? Is there a significant difference in the level of numeracy skills of the Grade 5 Learners between their pre-test and post-test?

**Literature Review:**

This section presents the different related literature that has been organized according to the concepts relevant to the research problems.

**Schema-Based Instruction**

Schema-based instruction combines the key components identified by Hughes, S. (2020) of explicit instruction, problem type identification, multiple exemplars, and visual representation models. This strategy has received considerable attention from researchers. In schema-based instruction, students receive direction instruction during which they learn to categorize math word problems based on the structure of the problem. After students have identified the problem type, they then use visual representations or number sentences to represent schemas (Powell, et. Al, 2020). Learning to learn has been viewed as one of the primary goals of education in the 21st century. It aims to achieve through activities and practices where students are actively involved.

As mention in the study of Hughes & Cuevas (2020), identified schema-based instruction which combine the following components: the explicit instruction, problem type identification, multiple exemplars, and visual representation models. On the other hand, Powell & Fuchs (2018) discussed how schemas were determined based on the problem's structure. The learners receive direction instruction during which they learn to categorize math word problems based on the structure of the problem. After learners have identified the problem type, they then used visual representations or number sentences to represent schemas (Powell, 2022).

In the same manner, Peltier et al (2018) mentioned that schema-based instruction (SBI) was identified as a promising practice for students with special learning disabilities. It was an evidence-based practice used in mathematics that supports the underlying structure of any given word problem to find solutions to mathematical problems and apply that knowledge to future problems. As a result of this intervention, learners learned to recognize important problem structures and record the problem onto a diagram and review information in the problem on a finished diagram.

There were studies revealed that the use of schema-based instruction in traditional classroom was effective in learning mathematics word problems. As mentioned in the study conducted by Hott et al (2021, schema-based instruction has proven to be an effective strategy in enhancing Mathematics teaching and learning. Students were able to experience a hands-on method of learning which had a positive effect in enabling them to understand the concepts better rather than just being passive learners. Indeed, Hughes & Cuevas (2020) study's affirmed that when schema-based intervention was implemented, students showed an increase in attempted and correct strategy use during instruction.

**Schema-based Instruction in learning**

Mathematics Difficulties

Word problem-solving was an ongoing challenge for students with learning disabilities. Rather than setting up the problem for computation, word-problems embed the mathematical concepts in a literary context (Fuchs et al., 2021). This made solving word problems a challenge for students with both reading and math difficulties.

There were number of factors that impact student difficulties in math such as comprehension, number sense, and working memory (Daniels, 2022). Being able to solve word problems requires a student to retrieve information from their long-term memory and hold information in their active working memory.

According to Scherer et al (2017), students with difficulties in learning math, share a set of general characteristics. This list includes memory deficits as well as "inadequate use of strategies for solving math tasks, caused by problems with the acquisition and the application of both cognitive and metacognitive strategies".

If literacy difficulties, personalization of word problems, and working memory were not sufficient to solve the deficit in mathematics, further methods must be examined to support not only students with disabilities but also those without (Daniels, 2022).

During early childhood years, children develop several mathematical skills that form the foundation for later mathematics learning at school (for a detailed description of learning trajectories, see Clements, D. H., & Sarama, J. (2020). Counting skills, basic arithmetical skills, magnitude comparison, and numeracy-related logical abilities, measured before the onset of formal schooling have been shown to be good predictors of later mathematics learning in school (Chavez & Maguate, 2023).

Therefore, it is important that early mathematics instruction emphasizes these skills. According to Rajagopal (2022), the five most trained mathematics skills with preschoolers and kindergartners were counting, conservation, computation, enumeration, and comparison. Measurement, estimation, writing numerals, and fractions were less emphasized (Sotto et al., 2023).

**Research Methodology:**

**Research Design**

This study sought to assess the effectiveness of contextualized schema-based instruction on the numeracy skills of Grade 5 learners; hence the experimental research design was used. Specifically, this research study makes use of one group pretest-posttest design. One group is monitored twice, once before the intervention and once after the intervention, in a research design known as a one group pretest-posttest. In this study, one group was subjected to an intervention, the contextualized schema-based instruction, to test whether the applied intervention has the potential to cause changes on the numeracy skills of Grade 5 learners, thus pre-experimental pre-/posttest research design was used.

**Participants of the Study**

To assess the effectiveness of the contextualized schema-based instruction on the numeracy skills of Grade 5 learners, Grade 5 learners who are officially enrolled in the SY 2023-2024 handled by the researcher were chosen as the respondents of the study. In relation to this, the participants of this research would be the 15 Grade 5 learners officially enrolled and is under the researcher's handled section. Total enumeration was used

**Research Instrument**

To determine the level of numeracy skills of Grade 5 learners, the researcher used a teacher-made test instrument. The instrument was composed of 20-item multiple choice test and 20-item supply test representing the competencies taken from the second quarter of solving problem involving the four fundamental operations of mathematics, the addition, subtraction, multiplication, and division. The TOS was created before the questions to establish validity and ensure that all the concerned areas are covered, and content domains are well represented. Item analysis was done, and two questions were revised as its difficulty index is 0.80 and another 3 items were non-discriminating with an index of 0.35 and necessitated the need for revision. The final established questionnaire was used as pretest and post-test and no randomization was used in the posttest.

On the other hand, the intervention, the contextualized schema-based instruction imbedded materials made by the researcher and quality assured by the school principal was administered to the learners after the conduct of the pretest. The contextualized schema-based instruction materials focused on second quarter competencies which are; solving routine or non-routine problems involving addition and subtraction, of decimal numbers including money using appropriate problem-solving strategies, solves routine and non-routine problems involving multiplication without or with addition or subtraction of decimals and whole numbers including money using appropriate problem-solving strategies and tools, and solves routine and non-routine problems involving division

without or with any of the other operations of decimals and whole numbers including money using appropriate problem solving strategies and tools. The activities in the intervention materials are contextualized schema based with examples based on their prior knowledge and situations happened in the locale of the study, the Buenaventura Mahilum Elementary School which are relevant to the respondents.

The intervention materials undergone validation on acceptability of the printed materials and was referred to five validators and with a computed mean of 4.64 which means that its validity is very high.

**Validity**

According to Frey (2018), the extent to which an instrument measures what it is intended to measure is known as validity. It must produce the desired outcome. A test is considered valid if the results help achieve the goals it was designed to. The degree to which the measurement instrument's items accurately reflect the full content domain is known as content validity (CV). The validity of the items is assessed by experts familiar with the instrument's content domain. A CV ratio (CVR) is a numerical value that represents the instrument's level of validity as assessed by the CV expert evaluations. The research instrument used in this study was subjected to validation following the criteria set forth by Lawshe's content validity ratio (CVR). The validity of the data gathering instrument was referred to five expert math teachers. All 40 items of the questionnaire were marked essential by five experts and are valid according to CVR, with the content validity ratio of 1.0 for all items. The applicability of the questions was evaluated by the experts as they went through the instrument item by item. Improvement ideas and recommendations were taken into account.

**Reliability**

KR-20 was used in establishing the reliability of the questionnaire on the numeracy skills of grade 5 students. A test, questionnaire, or inventory's internal consistency reliability is measured by the KR-20 (Kuder-Richardson Formula 20) index. It can be used for any test question with a single right response (Allen, 2017).

A dry-run of the instrument was conducted involving the 30 grade 5 students who were not participants in the study. The test was administered on September 11, 2023. The results of the dry-run administration of the research instrument were computed using the KR-20 in SPSS. The reliability computed was 0.90. According to Ornstein (1983) as cited by Figueroa (2008), if the coefficient is 0.80 or greater, the reliability is good. This indicates that the research tool the researcher employed was highly reliable.

**Data Gathering Procedure**

***Preliminary Procedure (Research Permission)***

The researcher sent a request letter to the principal of Buenaventura Mahilum Elementary School asking permission to conduct the study to the Grade 5 learners. Prior to this, consent letter was sent to the parents and students who will be the participants of the study.

***Actual Data Gathering Procedure***

After establishing the validity and reliability of the data gathering collection tool, the researcher conducted a pre-test on the level of numeracy skills on the students who are identified as target participants. After administering the pre-test, the intervention was conducted for 3 weeks by the researcher, the sole instruction used as to not influence the result by other strategies other than the contextualized schema-based instruction.

The result of the pretest was not discussed with the participants and was keep only for the data analysis in the study as not to decrease the validity of the research instrument. After that, the students then take the post-test after the period of intervention for 3 weeks administered and checked by the researcher to control other variables that might affect the result.

The significant difference was determined out of the comparative results of student test results from both the pre- and post-tests. The scores of the students were the data analyzed to ascertain the effectiveness of contextualized schema-based instruction as intervention.

**Data Analysis**

The descriptive and inferential analyses were utilized in the data analysis using the appropriate statistical tool.
For problems 1 and 2, the mean scores of the Pretest and Posttest of the students were used to determine the level of numeracy skills of Grade 5 learners before and after the intervention.

**The obtained mean scores for the level of numeracy skills were interpreted as follows:**

| Mean | Description | Verbal Interpretation |
|---|---|---|
| 29.78– 40.00 | Advanced (A) | At this level, the learner iscapable of applying knowledgeof problem solving related tonumbers and number sense automatically and flexibly, surpassing the standards required. |
| 19.52– 29.77 | Proficient (P) | At this level, learner is capable of applying knowledgeof problem solving related tonumbers and number sense automatically andindependently. |
| 9.26 – 19.51 | Developing (D) | At this level, the learner has a basic understanding of problem solving in numbers and number sense, but needs assistance using them in practical situations. |
| 0.00 – 9.25 | Beginning (B) | At this level, the learner struggles with comprehension, prerequisite knowledge, and basic knowledge of problem solving related to numbers and number sense. |

For problem 3, Paired T test was utilized to determine the significant difference between the pre-test and post-test scores of Grade 5 learners when taken as whole.
All of the tests will be subject to the 5% level of significance for the acceptance or rejection of the null hypothesis.

**Ethical Consideration**

The researcher shall address the general ethical principles of respect for persons, beneficence, and justice to ensure the ethical soundness of the study.

**Results and Discussion:**

**Table 1. The Numeracy Skills of Grade 5 Learners before the intervention**

| | | Mean | SD | Interpretation |
|---|---|---|---|---|
| Numeracy Skills | Pretest | 18.47 | 3.50 | Developing |

Table 1 reflects the numeracy skills of grade 5 learners before using the contextualized schema-based instruction as an intervention. As shown in the table, the obtain mean for the pretest is 18.47 (SD=3.50) which indicates that the level of numeracy skills before the intervention is still developing. One of major objective of this study is to determine the level of developing learners. This implies that the learners still have some problems in performing in four fundamentals basic operation in Mathematics.

The results of this study were similar with Vorholter, Greefrath and Schukajlow (2019) results. It showed that the numeracy skills of elementary school learners do not have enough numeracy skills to perform mathematical problem.

**Table 2. The Numeracy Skills of Grade 5 Learners after the intervention**

| | | Mean | SD | Interpretation |
|---|---|---|---|---|
| Numeracy Skills | Posttest | 27.93 | 3.92 | Proficient |

Table 2 reflects the numeracy skills of grade 5 learners after using the contextualized schema-based instruction as an intervention. As shown in the table, the obtain mean for the posttest is 27.93 (SD=3.92) which indicates that the respondents, the grade 5 learners have proficient skills in numeracy after the introducing the schema-based instruction in mathematics. One major objective of this study is to determine the level of Proficient learners. This implies that the learners have had improved their numeracy skills through the use of contextualized schema-based instruction.

The results of this study were similar with Hott et al (2021) results which showed that before the schema-based instruction, students are having problem in dealing with mathematics problem and after introducing the SBI, learners were able to develop their mathematical skills up to independent level. Furthermore, it is supported with the findings of Skinner & Cuevas (2023) which documented the efficacy of schema-based instruction in enhancing the numeracy skills of elementary learners. It further suggests that SBI may be an effective instructional option in elementary classrooms to improve students' mathematical understanding and computational accuracy. This implies that schema-based instruction aids in the development of the numeracy skills of learners.

**Table 3. Significant Difference on the Numeracy Skills of Grade 5 Learners before and after the intervention**

| | Mean | t-value | p-value | Decision | Interpretation |
|---|---|---|---|---|---|
| Pretest | 18.47 | | | | |
| Posttest | 27.93 | -16.92 | 0.000 | Reject Ho | Significant |

*Level of Significance at alpha 0.05

Table 3 shows the significant difference on numeracy skills of grade 5 learners before and after using the contextualized schema-based instruction. As shown in the table, the difference is statistically significant between the pretest and the posttest, t-value=-16.92 and p-value=0.000, statistically significant at alpha=0.05. Therefore, it showed that the Grade 5 learners has performed better after receiving the schema-based instruction as the intervention compared to their performance before the implementation of the intervention, a statistically significant difference of -9.47.

The outcomes of this investigation were in agreement with those of Fuchs et al. (2021) which claimed that schema-based instruction as an intervention do improve students' mathematical skills, and schema-based instruction was more effective when it's embedded language instruction about wordproblems. In similar manner, it is in accordance with Hughes and Cuevas (2023) result of research which investigate the frequency at which students use strategies to solve word problems in a second- grade resource class with students which have individualized programs and found out that students were better in solving problems using the schema strategy in solving it.

The use of contextualized schema-based instruction is one way to improve the numeracy skills of learners.

**Conclusions:**

Based on the findings of the study the contextualized schema-based instruction is effective in developing the numeracy skills of the learners. Therefore, the following conclusions were derived:

It was determined in the result of the study that the numeracy skills of the grade 5 learners of Buenaventura Mahilum Elementary School were still developing. It supports further the reason why the researcher conducted the study which aims to improve the numeracy skills of the learners. The result of the posttest provides evidence that participants appeared to have improved in their numeracy skills as supported with their increased in the mean. This difference in performance may be an indication of the effectiveness of the contextualized schema-based instruction. Furthermore, it was found out in the result of the study that contextualized schema-based instruction improved the numeracy skills of the learners as the result show statistically significant result. The contextualized schema-based instruction as an intervention is an effective resource to the learning process and is proven effective improving the numeracy skills. As the use of the intervention can stimulate active learning among students it is a highly effective approach.

As evidence were found that the intervention helps improve the numeracy skills, the researcher suggests that the use schema-based instruction embedded on the materials may be considered and teachers may adopt it as teaching strategy and supplementary material in learning mathematics.

**Recommendations**

Based on the summary of findings and conclusions the following recommendations are advanced:

1. Developing learners may use the CSBI to improve more their numeracy skills.
2. Proficient learners may continue to use the CSBI enrich their learning and become advance when it comes to numeracy skills.
3. The CSBI is a significant intervention, therefore it is recommended to be used as part of classroom instruction and for other mathematics teachers for future purposes.
4. Other researchers may conduct similar research studies of similar nature, but on much wider coverage, more grouping variables than that in the present research.

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