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Development and validation of self-learning kit in mathematics using bilingual instruction

Maridel Macol Dueňas [*] and Jennifer Medrano Montero [*]

Department of Graduate Studies, North Eastern Mindanao State University (NEMSU), Philippines.

Abstract

The objective of the study is to develop and validate a self-learning kit in Mathematics using bilingual instruction. It aims to explore the effectiveness of the developed and validated bilingual self-learning kit in improving the academic performance of the 35 Grade 7 students in Sto. Niňo National High School. The bilingual kit was designed using developmental research design utilizing the ADDIE Model, which comprises five stages: Analysis, Design, Development, Implementation, and Evaluation. There were 11 validators, consisting of four (4) Mathematics teachers, five (5) experts in Mathematics, and two (2) Master Teachers who evaluated and validated the material. The comments and suggestions of the validators helped refine and improve the material. The result of the content validation, as experienced by the 11 evaluators, shows a high rating across all indicators. The perceptions of the evaluators in content, language and style, presentation and organization, and accuracy and up-to-datedness have a grand mean of 4.776, which suggests that the bilingual self-learning kit in Mathematics developed is outstanding in quality and very valid. Also, the bilingual self-learning kit was field-tested on 35 Grade 7 students to test its effectiveness. At the significance level of 0.05, it has a computed t-value of 8.41. It has a p-value of 0.000, which signifies a significant difference between the pretest and posttest scores of the students during the field try-out of the bilingual self-learning kit. Utilizing the bilingual kit in mathematics helps students understand mathematics better, improving their academic performance.

Keywords: Self learning Kit; Mathematics; Development; Validation; Bilingual Instruction

1. Introduction

A self-learning kit is a tool where a learner can learn independently because it has an orderly set of instructions that facilitate the learner's mastery of a body of knowledge (Benito et al., 2022). The main goal of education is to ensure that all learners learn effectively and efficiently. According to Cabelin (2021), a Self-Learning Kit is one of the most effective tools made and improvised by teachers to cater to the needs of the learners in mastering the concepts of various subjects, especially mathematics. Also, the tool enhances learning, develops creativity and independence through manipulative processes, and develops higher-order thinking skills. Incorporating bilingual instruction in a self-learning kit in mathematics will help the learners succeed academically by utilizing their original language to improve learning outcomes while honoring their linguistic and cultural heritage (Leiva & Cespedes, 2020). Bilingual instruction in mathematics refers to teaching the students two languages. Aside from the English language, the primary instruction, a bilingual self-learning kit in mathematics, will also utilize the learners' original language. Thus, the researcher wants to study the development and validation of self-learning kit using bilingual instruction.

A study by Makdiani et al. (2020) showed the relevance of developing self-learning kits in mathematics, particularly by incorporating bilingual instruction. Results of the study revealed that it increases learners' understanding and improves their language and vocabulary, and there is improvement in the learning outcomes after utilizing the self-learning kit. A study conducted by Ajit (2020) compares the two groups of learners; the first group uses monolingual instruction, and

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* Corresponding authors: Maridel Macol Dueňas Jennifer Medrano Montero

the other group uses a bilingual medium of instruction in teaching and learning math. It was found that when bilingual instruction was applied to the first group of students, there was a difference in understanding the subject matter compared to a group that used monolingual instruction in learning math. Results of the study showed that bilingual mediums of instruction in teaching math positively affect the student's understanding and performance in mathematics compared to using English only. The study recommended that mathematics teachers should be encouraged by the administration to contribute their unique expertise to bilingual programs. In addition, according to Kesuma et al. (2023), there is an increase in students' higher-order thinking skills after using a self-learning kit and worksheets using bilingual instruction.

In Sto. Niño National High School, it was found out that there is no available self-learning kit in mathematics using bilingual instruction. The students also have difficulty understanding and learning the concepts in mathematics. It was revealed in the mean percentage score (MPS) during the third quarter of SY 2024-205 that the students did not meet the 75% passing score. The third quarter topics are statistics and integers. The researcher noticed that the students have had difficulty understanding these topics for the past few years. So, the researcher wants to make a bilingual kit so the students can study independently and understand the lessons easily. Also, by developing a bilingual self-learning kit, the students can continue exploring the lessons since this kind of kit will help them study anywhere at their own pace. Aside from English as the primary instruction, there is also a translation in Bisaya for the students to understand math even in the absence of the teacher. In addition, this school experiences heavy flooding during rainy days, and extra-curricular activities disrupt class hours, leading to a shift in modular distance learning. So, developing a bilingual learning kit will be a great help for the students to continue learning even outside the school premises. From the scenarios mentioned above, the researcher wishes to develop instructional material, a self-learning kit in mathematics using bilingual instruction, to help increase the achievement scores of the Grade 7 Newton students in Mathematics with an average of 66.35 MPS, develop higher-order thinking skills, increase mathematical abilities in solving problems, develop their study habits and gain independence in answering and learning mathematics at their own time.

Developing and validating a self-learning kit in Mathematics 7 using bilingual instruction contributes to the body of knowledge in mathematics education, self-directed learning, and bilingual instruction. This innovative approach will support mathematics teachers in teaching and help learners enhance their learning process and outcomes, especially for linguistically diverse learners. Also, the learning kit will enhance the learner's self-directed skills since it will allow them to personalize their learning experience and offer flexibility in pacing and learning style. Because mathematics subject is considered one of the most difficult subjects, integrating bilingual instruction will allow them to understand the lesson in their language and make them understand the lesson better, increasing their academic performance in the subject matter. Finally, this study will promote equity and inclusion in mathematics education, celebrate cultural diversity, provide flexibility and accessibility, and promote lifelong learning.

2. Methods

The researcher employed a Developmental Research Design (Richey & Klein, 2007) utilizing the ADDIE Model by Dick and Carey 1978 (Analysis, Design, Development, Implementation, Evaluation) to develop and validate the bilingual self-learning kit in Mathematics. The process involved the analysis stage, where the identification of learning standards and bilingual instruction requirements done. Then, it is followed by the design of the learning kit's content. The parts of the learning kit were learning competencies, pretest, discussions, illustrative examples, posttest, and answers key.

After developing the self-learning kit, the Mathematics teachers and master teachers in Mathematics were provided a hard copy of the developed self-learning kit for validation. They were also offered rubrics and questionnaires adapted from the Department of Education's "A Tool to Assess the Quality of Self-Learning Modules (SLMs) for Mathematics" to evaluate its parts, content, and their perception about the bilingual self-learning kit. The ratings, as well as the comments and suggestions from the evaluators, were consolidated. All of the information gathered from the mathematics teachers, validators, and master teachers, as well as their ratings, comments, and suggestions, were consolidated for revision. If the material was found to comply with all the factors with no corrections, the material is subject to field validation. On the other hand, the researcher also developed an achievement test on the least learned topics, which was checked and validated by the mathematics teachers.

The study focused on the development and validation of a self-learning kit in Mathematics 7 using bilingual instruction. Specifically, it explores the effectiveness of the developed and validated self-learning kit in Mathematics 7 using bilingual instruction. The developed and validated kit was tested for the 35 Grade 7 Newton students. It served as an intervention for the third quarter's least learned topics in Mathematics. On the first day of the implementation, a pretest was given to the learners, and it served as a test for their prior knowledge of the topics before the learning kit was

implemented. Then, the self-learning kit was implemented and tried out to the learners for two weeks. After implementing the kit, the learners were given a posttest to assess their knowledge gained

3. Results and discussion

The following section presents the findings of research conducted on the development and validation of self-learning kit in mathematics using bilingual instruction. The research used the ADDIE Model with the following stages: Analysis, design, developmental, implementation and evaluation.

3.1. Analysis Stage

The analysis stage involved identifying the learning standards and instructional strategies. It is where the topics will be identified. The researcher conducted the item analysis for the third quarter of the SY 2024-2025 to find the least-learned competencies in Mathematics that will be the basis for developing the bilingual self-learning kit in mathematics. The table below shows the least -learned competencies for the third quarter in Mathematics.

Table 1 Least-Learned Competencies for the Third Quarter SY 2024-2025

Total No. of Correct Responses	% of Correct Responses	Competency/Topic	Remarks
101	47.64	Add/Subtract Integers	Least-Learned
112	52.83		
115	54.25		
121	57.08		
134	63.21		
137	64.62	Multiply/Divide Integers	Least-Learned
145	68.40		
143	67.45		
124	58.90		
112	52.83		
101	47.64	Simplify numerical expressions involving integers using (GEMDAS)	Least-Learned
137	64.62		
109	51.42		
118	55.66		
121	57.08		
132	62.26		
121	57.08	Construct a sample from the given population using systematic random and stratified random sampling	Least-Learned
103	48.53		
108	50.94		
112	52.83	Organize statistical data in a frequency distribution table	Least-Learned
123	58.02		
132	62.26		
139	65.57		

Table 1 presents the least-learned competencies for the third quarter of SY 2024-2025 with the total number of correct responses and the corresponding percentage of competency/topic. The basis for the least-learned competencies were the scores of 212 Grade 7 students during the third quarter examination. Many of the 212 Grade 7 students who took the examination struggled to meet the 75% passing score. Upon analyzing the examination results, it became evident

that the least-learned competencies for the third quarter SY 2024-2025 are add/subtract integers, multiply/divide integers, simplify numerical expressions involving integers using GEMDAS, construct a sample from the given population using systematic random and stratified random sampling and organize statistical data in a frequency distribution table.

3.2. Design Stage

These findings suggest that educators need to develop learning materials such as bilingual self-learning kits in mathematics to improve and enhance the student's learning experience and mathematical abilities (Pecson 2020). Based on the identified least-learned competencies, a bilingual self-learning kit can be developed where the students can easily understand the lesson since it will utilize their original language. Also, they will be able to review the lesson since it will provide activities, discussions, and answer keys, which can help the students check their understanding of a certain topic and help them improve their mathematical skills. By providing students with enough resources and learning support, they will be able to cope with the learning loss in mathematics.

3.3. Developmental Stage

The researcher developed a self-learning kit in mathematics using bilingual instruction. The topics were the identified least-learned competencies. The parts of the learning kit were learning competencies, pretest, discussions, illustrative examples, posttest, and answers key. The researcher based the study on Reigeluth's theory wherein the self-learning kit will have discussions, explanations, activities, and examples with step-by-step processes on solving mathematics, which will guide the learners to develop higher-order thinking skills and gain independence in studying.

The validation phase followed in terms of content, language and style, presentation and organization, and accuracy and up-to-datedness of information. Below is the table of the ratings of the three groups of respondents on the developed bilingual self-learning kit.

Table 2 Ratings of the Three Groups of Respondents on the Developed Bilingual Self-Learning Kit

Indicators	Teachers		Experts		Master Teachers		Grand Mean	Over-all Adj. Rating
	Mean	Adj. Rating	Mean	Adj.Rating	Mean	Adj.Rating	Mean	Adj.Rating
Content	4.800	Outstanding	4.670	Outstanding	4.800	Outstanding	4.757	Outstanding
Language & Style	4.850	Outstanding	4.800	Outstanding	4.700	Outstanding	4.783	Outstanding
Presentation and Organization	4.708	Outstanding	4.800	Outstanding	4.750	Outstanding	4.753	Outstanding
Accuracy and Up-to-datedness	4.750	Outstanding	4.800	Outstanding	4.875	Outstanding	4.808	Outstanding
Over-all Mean	4.780	Outstanding	4.767	Outstanding	4.781	Outstanding	4.776	Outstanding

Table 2 presents the ratings of the three groups of respondents on the developed bilingual self-learning kit based on the following indicators: content, language and style, presentation and organization, and accuracy and up-to-date. The result of the evaluation shows high ratings across all indicators. The overall grand mean is 4.776, which suggests that the developed bilingual self-learning kit in mathematics is outstanding in quality and very valid.

3.4. Implementation Stage

The developed and validated self-learning kit in Mathematics was field-tested on 35 Grade 7 students to test its effectiveness. After the bilingual self-learning kit was implemented, the students' post-test scores increased from their pre-test scores.

Table 3 Pretest-Posttest Scores results based on the Field Try-out

Group	Pretest		Posttest	
	Mean	Sd	Mean	Sd
Field Try-out	27.6	5.807	33.314	5.016

The table above presents the pretest-posttest scores of the students during the field try-out. Before implementing the bilingual self-learning kit in mathematics, the mean pretest score is 27.6 with a standard deviation of 5.807. After implementing the kit, the mean pretest score increases to 33.314 with a standard deviation of 5.016. This means that the utilization of a bilingual self-learning kit in Mathematics helps the students understand the concepts of Mathematics.

Table 4 Significant difference between the Pretest-Posttest Scores of the Students

Sources of Variation	Computed t	P-value	Decision	Conclusion
Pretest & Posttest Score	8.41	0.000	Reject the Null hypothesis	Highly Significant

Table 4 shows the significant difference between the pretest-posttest scores of the students during the field try-out. At the significance level of 0.05, the table above has a computed value t of 8.41 and has a p-value of 0.000, which is less than 0.05 and the decision is to reject the null hypothesis. It shows a significant difference between the pretest and posttest scores of the students during the field try-out of the bilingual self-learning kit in Mathematics.
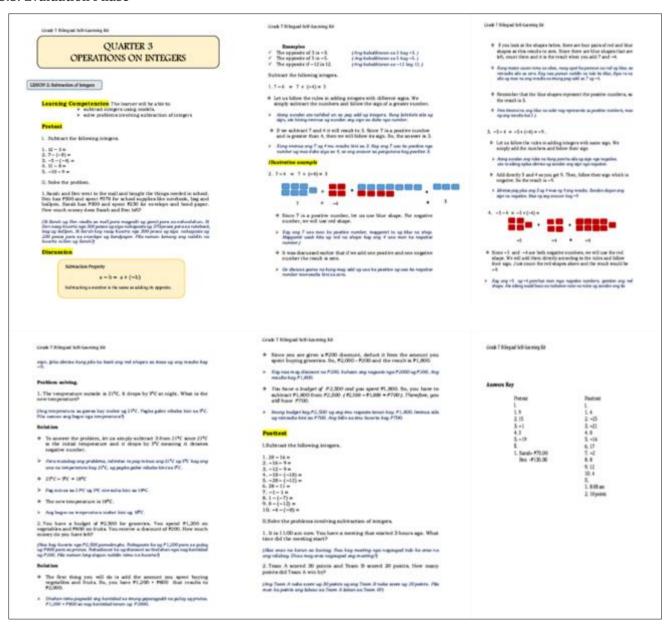
3.5. Evaluation Phase

Figure 1 Lay-out of Bilingual Self-learning Kit

Incorporating the comments and suggestions of the validators to improve the material, the study's findings suggest several enhancements to the output. First, the material can be improved by making additional interactive exercises, quizzes, and feedback mechanisms to guide the students especially those who need support, and to increase their motivation. Another is, that the material can be designed to cater to the students' different learning styles and abilities, providing other supplementary activities and resources and activities for students who need more support or challenge. The developed, validated and enhanced self-learning kit in mathematics are depicted in figure 1 below.

4. Conclusion

The following conclusions can be drawn from the study's findings:

- The Self-learning Kit in Mathematics using bilingual instruction was created using the ADDIE Model that went through stages: Analysis, design, development, implementation and evaluation.
- The kit contents were identified using the item analysis which the least-learned competencies were also identified.
- After the design and development stage, the kit was evaluated by 11 validators: 4 Mathematics teachers, 5 experts in mathematics and 2 master teachers. The over-all result of the content validation by the three groups of respondents revealed a grand mean of 4.776 which suggests that the developed bilingual self-learning kit in mathematics is outstanding in quality and very much valid.
- The kit was field-tested to 35 Grade 7 students, and it was found out that after utilizing the kit, the students' post-test scores increased from their pre-test scores. It means that the bilingual kit increased their academic performance in solving mathematics

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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