**Development, Validation and Summative Evaluation of Code-Mixed Localized Instructional Materials (CMLIMs) in Mathematics I**

# Abstract

This study aimed to develop, validate, and conduct a summative evaluation of Code-Mixed and Localized Instructional Materials in Mathematics I to enhance comprehension and engagement among Grade 1 learners. In response to the linguistic and cultural diversity in early education settings, the materials integrated the local language (mother tongue) with English to support a gradual language transition while preserving contextual relevance. The development process followed the ADDIE model—Analysis, Design, Development, Implementation, and Evaluation.

Content and language experts validated the instructional materials using a researcher-developed tool assessing content accuracy, linguistic appropriateness, cultural relevance, and instructional design. The materials received a high overall mean rating, indicating strong validity. For the summative evaluation, a quasi-experimental design was employed involving two groups: the experimental group, which used the code-mixed and localized materials, and the control group, which used standard materials. Pre-tests and post-tests were administered to measure learning gains. The results demonstrate that the localized materials effectively support learner comprehension and engagement in bilingual settings.

Results revealed that the experimental group significantly outperformed the control group in terms of mathematics achievement, indicating that the use of code-mixed, localized materials had a positive impact on learners’ understanding and retention of mathematical concepts. Qualitative feedback from teachers and pupils further supported the effectiveness and cultural relevance of the materials.

The study concludes that code-mixed, localized instructional materials are effective tools for enhancing mathematics instruction in the early grades, particularly in multilingual settings. It is recommended that educators and curriculum developers integrate local languages and culturally relevant examples into instructional design to bridge linguistic gaps and promote deeper learning.

Keywords: Code-Mixing, Development, Validation, Summative Evaluation.

# Introduction

The field of education continues to evolve, consistently striving to enhance modern teaching and learning practices. Today, educators focus on applying well-established and research-based principles to stimulate learning and improve educational outcomes. To unify and deepen understanding, the development of new terminologies and frameworks has become essential. This ongoing process is continually refined, driven by emerging innovations and potential breakthroughs.

Numerous sociological and psychological insights have emerged from examining how diverse teaching contexts across different civilizations and cultures contribute to language development and educational programs. According to Churches, code-mixing refers to the integration of linguistic elements, such as words, phrases, or morphemes, from one language into an utterance of another, highlighting the dynamic nature of multilingual communication.

The acquisition of a second language must incorporate the active, integrated function of the local languages, as linguistic diversity leads to the acquisition of several languages and the mixing of codes in usage. The definition of code-mixing is "the mixing of two or more languages in discourse by bilinguals or multilinguals, often without a change in interlocutor or topic".

In a study titled Code-Mixing, Bilingualism, Biliteracy: A Case Study, Hudson et al. discovered that code-mixing, both verbally and in writing, facilitated efficient communication in a way that felt comfortable and natural for all parties. The code-mixing functions covered educational, linguistic, social, and psychological domains.

Instructional materials are learning assignments that are sufficiently structured, ordered, and articulated to give pupils enough direction and guidance even when the teacher is not physically present. It enables every student to learn at a speed and time that work best for them. He can set his own study speed based on how quickly he learns the material and achieves the goals.

One of the most popular and well-recognized teaching methods in the United States, Australia, and many other Western nations, including the Asian region, is the use of instructional materials. It is a relatively new discovery founded on the well acknowledged and well-established phenomenon of programmed learning. It takes into account the unique characteristics of each student, making it necessary to plan for the adoption of the best teaching strategies in order to support each person's growth and development at her or his own speed.

Experts attest that using educational resources to support learning is beneficial. This is due to the fact that learners receive prompt feedback on the outcomes of their efforts. As a component of the contemporary educational system, instructional materials serve to support and enhance current teaching methods as well as facilitate learning by making it engaging, exciting, accommodating to individual differences, eliminating verbalism, and assisting educators in keeping up with changes in the field of education.

The usage of instructional materials is important because it allows students to routinely assess their own progress and meets their unique requirements and learning rates. Additionally, this gives educational procedures more flexibility and permits various teaching methods such as self-pacing, independent study, individualization, and personalizing. For those who learn slowly, it provides remediation; for those who learn quickly, it provides enrichment.

Advocates for the use of instructional materials in education contend that these resources are essential for instructors who are reduced to the role of learning facilitators. According to her, the educational resources have made classroom activities less teacher-dominated and more student-centered, giving them the necessary practice to become communicatively competent.

Lastly, the teacher will stay current with evolving paradigms in education through the usage of instructional materials approach. He said that for many centuries, instruction has been designed using the standard approach. These consist of the question-and-answer format, the lecture format, and the discussion format.

These insightful and well-reasoned ideas from respectable and legitimate sources highlight the need of individualized training in helping students acquire a positive attitude about the subject. According to Mercado, research has already shown that when using instructional materials, students feel successful because, at the conclusion of each session, they have completed a task on their own.

The researcher sought to develop and validate code-mixed instructional materials in this study based on this premise. This will allow for the testing of the variation in the student-respondents' performance before and after using the created and approved code-mixed instructional materials. Therefore, the study's important findings could aid in the formulation and enhancement of any issues pertaining to classroom instruction.

# Literature Review

In multilingual education settings, code-mixing has emerged as an effective strategy to enhance comprehension and engagement among early learners. Code-mixing, the practice of blending two or more languages within a conversation or sentence, is commonly observed in classrooms, particularly in areas where learners are transitioning from their mother tongue to a second language like English. Bautista (2004) emphasizes that this linguistic approach reduces learners’ anxiety and increases participation, especially in subjects like mathematics that often involve abstract concepts. Setati and Adler (2001) further highlight that code-mixed instruction enables learners to better grasp content by allowing them to relate new ideas to familiar language patterns.

Equally important is the localization of instructional materials, which ensures that lessons are contextually relevant to learners' cultural and social backgrounds. Localization adapts content to reflect local experiences, making learning more meaningful and relatable. According to United Nations Educational, Scientific and Cultural Organization UNESCO (2016), using culturally responsive materials enhances student motivation and promotes deeper learning. In the Philippines, the Department of Education’s Mother Tongue-Based Multilingual Education (MTB-MLE) policy supports this approach, encouraging the use of learners’ first language in early education. Nolasco (2008) notes that localized materials not only improve comprehension but also strengthen learners’ sense of identity and community.

Developing effective instructional materials requires a systematic and learner-centered process. The ADDIE model—Analysis, Design, Development, Implementation, and Evaluation—is widely used in the instructional design field to ensure that materials meet the needs of both learners and curriculum standards (Dick & Carey, 2009). In mathematics instruction, materials should include contextual examples, visual supports, and scaffolding strategies to aid in concept acquisition. Reys et al. (2012) assert that well-designed instructional resources are crucial in building foundational math skills, particularly in early grades.

Validation and summative evaluation play critical roles in assessing the quality and effectiveness of instructional materials. Validation involves the input of content experts to ensure accuracy, appropriateness, and alignment with learning outcomes (Taba, 1962). Meanwhile, summative evaluation measures the impact of the materials after implementation, often using pre- and post-tests, classroom observations, and stakeholder feedback. Tyler (1949) stresses that evaluation must be based on learning outcomes to determine whether educational goals have been achieved. Clements and Sarama (2009) also point out that early mathematical experiences shape a child's long-term success in mathematics, and instructional interventions must be carefully designed and evaluated to ensure effectiveness.

Overall, the integration of code-mixing and localization in instructional materials, supported by systematic development and rigorous evaluation, offers a promising approach to improving mathematics instruction in early grades. This review affirms that culturally and linguistically responsive materials can bridge learning gaps and enhance the educational experience of young learners in diverse classroom settings.

# Theoretical Framework

This study is anchored on three major educational theories: **Vygotsky’s Sociocultural Theory**, **Bruner’s Constructivist Theory**, and the **ADDIE Model of Instructional Design**. Together, these provide a solid foundation for the development, validation, and evaluation of code-mixed and localized instructional materials in Mathematics I.

**Vygotsky’s Sociocultural Theory** emphasizes the essential role of language and social interaction in learning. Vygotsky (1978) argued that learners construct knowledge more effectively when instruction is mediated through their cultural tools, especially language. In multilingual contexts, such as those in the Philippines, learners often think and express themselves best in their first language or mother tongue. The use of **code-mixed instruction**, blending English with the local language, aligns with Vygotsky’s idea of the **Zone of Proximal Development (ZPD)**—where learners achieve deeper understanding when supported by language and cultural cues they already understand. This theory validates the incorporation of both the native and second language in instructional materials, particularly in early mathematics, where abstract concepts require concrete linguistic bridges.

**Bruner’s Constructivist Theory** further supports the localization aspect of this study. According to Bruner (1966), learning is most effective when new concepts are built upon learners’ prior knowledge and experiences. Localization of instructional materials—by embedding local contexts, names, places, and culturally relevant situations—makes abstract mathematical concepts more relatable and understandable to young learners. Bruner’s idea of **scaffolding**, where learners are gradually led to independent understanding through contextually guided instruction, reinforces the importance of cultural familiarity in teaching materials.

Complementing these learning theories is the **ADDIE Model** (Analysis, Design, Development, Implementation, Evaluation), a widely used framework in instructional design (Dick & Carey, 2009). The ADDIE Model provides a systematic approach to creating high-quality instructional materials. In this study, the model guided each phase: identifying learners' needs (Analysis), structuring content and visual design (Design), creating and assembling the materials (Development), classroom use (Implementation), and expert review and impact assessment (Evaluation). The summative evaluation component of this study is also rooted in **Tyler’s (1949) Objectives Model**, which emphasizes evaluating instructional effectiveness based on defined learning outcomes.

By integrating Vygotsky’s sociocultural lens, Bruner’s constructivist principles, and the ADDIE Model’s instructional structure, this study ensures that the code-mixed, localized instructional materials developed are pedagogically sound, culturally appropriate, and effective in enhancing learners' understanding of Mathematics I. These theoretical foundations not only justify the methodology but also underscore the relevance of language and context in early-grade mathematics education.

# Methodology

This study aimed to develop, validate, and conduct a summative evaluation of code-mixed and localized instructional materials in Mathematics I to enhance comprehension and engagement among Grade 1 learners. Addressing the linguistic and cultural diversity present in early education settings, the instructional materials incorporated both the local language (mother tongue) and English. This integration was designed to support a gradual transition to English instruction while preserving contextual and cultural relevance.

The development of the materials followed the ADDIE Model, which includes five phases: Analysis, Design, Development, Implementation, and Evaluation. In the Analysis phase, the learning needs and linguistic background of the learners were assessed. During the Design and Development phases, the materials were crafted with culturally relevant content and code-mixed language to improve accessibility and learner engagement. These materials were then validated by a panel of experts using a researcher-developed evaluation tool. The tool assessed the content accuracy, linguistic appropriateness, cultural relevance, and instructional design of the materials. The results of the validation process yielded a high overall mean rating, indicating strong validity and appropriateness for classroom use.

To determine the effectiveness of the instructional materials, the study utilized a quasi-experimental design involving two intact Grade 1 classes. The experimental group was taught using the developed code-mixed and localized materials, while the control group used standard instructional materials. Both groups were given pre-tests and post-tests to assess their performance in mathematics. The test results were analyzed to compare the learning gains between the two groups. Findings revealed that the experimental group significantly outperformed the control group, suggesting that the code-mixed and localized materials positively impacted learners’ understanding and retention of mathematical concepts.

In addition to quantitative analysis, qualitative feedback was gathered from teachers and pupils to gain deeper insights into the usability, relevance, and effectiveness of the materials. Feedback indicated strong support for the approach, highlighting improvements in learner engagement and comprehension. Overall, the methodology affirmed the value of integrating local languages and cultural contexts into instructional material design to support effective teaching and learning in multilingual classroom settings.

# Results and Discussions

This part presents the evaluation conducted by experts to assess the instructional materials before using them in teaching mathematics. The ratings focus on six key areas: alignment with the Most Essential Learning Competencies (MELC), the Effectiveness of the instructional design and organization, the instructional quality of texts and visuals, the appropriateness of assessment tools, the readability of the materials, and the accuracy of referencing and source citation.

Table 1

Mathematics Experts’ Evaluation of the Code-Mixed Instructional Materials Along the Most Essential Learning Competencies

|  |  |  |
| --- | --- | --- |
| Standard/Criterion Items | Mean | Descriptive Value |
| 1. The INSTRUCTIONAL MATERIAL covered the targeted Most Essential Learning Competencies (MELCs) intended for the quarter. | 4.40 | Strongly Agree |
| 1. The INSTRUCTIONAL MATERIAL sufficiently developed the targeted Most Essential Learning Competencies (MELCs) intended for the quarter. | 5.00 | Strongly Agree |
| Overall Mean | 4.70 | Strongly Agree |

Table 1 shows that before implementation, the Code-Mixed Instructional Materials received an overall weighted mean of 4.70 ("Strongly Agree"), indicating strong alignment with the Most Essential Learning Competencies (MELCs). The first criterion, covering MELC alignment, scored 4.40, suggesting good coverage with minor room for improvement. The second criterion, on developing MELCs, achieved a score of 5.00, reflecting unanimous expert agreement on the materials' effectiveness. Overall, the results confirm that the materials are well-designed and capable of supporting learning, though slight refinement could enhance their comprehensiveness.

Table 2

Mathematics Experts’ Evaluation of the Code-Mixed Instructional Materials Along with Instructional Design and Organization

|  |  |  |
| --- | --- | --- |
| Standard/Criterion Items | Mean | Descriptive Value |
| 1. INSTRUCTIONAL MATERIAL has learning objectives that are anchored on the MELCs. | 4.00 | Agree |
| 1. INSTRUCTIONAL MATERIAL uses a variety (at least 3) of self-directed techniques, learning tasks, and formative assessments. | 4.60 | Strongly Agree |
| 1. INSTRUCTIONAL MATERIAL has content that is logically developed and organized, i.e., lessons/activities are arranged from simple to complex, from observable to abstract. | 4.40 | Strongly Agree |
| 1. INSTRUCTIONAL MATERIAL contains essential instructional design elements that contribute to the achievement of learning objectives. | 4.40 | Strongly Agree |
| 1. INSTRUCTIONAL MATERIAL allows for review, comparison, and integration with previous lessons (if applicable). | 4.40 | Strongly Agree |
| 1. INSTRUCTIONAL MATERIAL uses various motivational strategies (i.e., advance organizers, puzzles, games) to hook the target user’s interest and engagement. | 4.80 | Strongly Agree |
| 1. INSTRUCTIONAL MATERIAL uses process questions and activities which require different levels of cognitive domain to achieve desired learning outcomes. | 4.60 | Strongly Agree |
| 1. INSTRUCTIONAL MATERIAL has written and performance tasks that are differentiated based on target user’s multiple intelligences, learning styles, and readiness levels. | 4.60 | Strongly Agree |
| 1. INSTRUCTIONAL MATERIAL develops 21st century skills and higher order cognition (i.e., critical thinking, creativity, learning by doing, problem solving). | 4.60 | Strongly Agree |
| 1. INSTRUCTIONAL MATERIAL integrates desirable values and traits. | 4.60 | Strongly Agree |
| Overall Mean | 4.50 | Strongly Agree |

Table 2 shows an overall mean rating of 4.50 ("Strongly Agree"), indicating that the instructional materials are well-designed and effectively organized for learner needs. The highest rating, 4.80, was for motivational strategies like puzzles and games, highlighting their strong potential to engage learners. Scores of 4.60 were given for self-directed learning, varied activities, differentiated tasks, and 21st-century skills, showing strong alignment with modern teaching approaches. Criteria such as logical content flow, review opportunities, and values integration scored 4.40, reflecting solid organization. The lowest score, 4.00 ("Agree"), was for objectives aligned with MELCs, suggesting some room for improvement. Overall, the results affirm the materials' strength in promoting effective learning, with minor areas to refine.

Table 3

Mathematics Experts’ Evaluation of the Code-Mixed Instructional Materials Along with Instructional Quality of Text and Visuals

|  |  |  |
| --- | --- | --- |
| Standard/Criterion Items | Mean | Descriptive Value |
| 1. All contents in the INSTRUCTIONAL MATERIAL are accurate. | 4.40 | Strongly Agree |
| 1. The INSTRUCTIONAL MATERIAL is free from any social content violations. | 4.60 | Strongly Agree |
| 1. The INSTRUCTIONAL MATERIAL has free from factual errors. | 4.20 | Strongly Agree |
| 1. The INSTRUCTIONAL MATERIAL is free from computational errors (if applicable). | 4.40 | Strongly Agree |
| Overall Mean | 4.40 | Strongly Agree |

Table 3 shows an overall mean rating of 4.40 ("Strongly Agree"), indicating that the instructional materials are of high quality in both text and visuals. The highest score, 4.60, was for the absence of social content violations, reflecting cultural sensitivity and inclusivity. Content accuracy and lack of computational errors both scored 4.40, while freedom from factual errors received 4.20—still strong but suggesting a small area for improvement. Overall, the results confirm the materials’ reliability and effectiveness, with minor revisions needed to enhance factual precision.

Table 4

Mathematics Experts’ Evaluation of the Code-Mixed Instructional Materials Along with Assessment

|  |  |  |
| --- | --- | --- |
| Standard/Criterion Items | Mean | Descriptive Value |
| 1. The INSTRUCTIONAL MATERIAL provides sufficient assessment activities that will help the learner track his/her progress and mastery of the target competencies | 4.40 | Strongly Agree |
| 1. INSTRUCTIONAL MATERIAL has assessments that are aligned with the specific objectives and contents (i.e., lesson/topic). | 4.60 | Strongly Agree |
| 1. The INSTRUCTIONAL MATERIAL provides variety of assessment types. Note: There should at least 3 assessment types in a module. | 4.40 | Strongly Agree |
| 1. The INSTRUCTIONAL MATERIAL contains assessments that have clear demonstrations / examples, instructions, and/or rubrics to serve as guide on how these will be used. | 4.40 | Strongly Agree |
| 1. The INSTRUCTIONAL MATERIAL has assessment activities that ensure active engagement of the learners. | 4.00 | Strongly Agree |
| 1. The INSTRUCTIONAL MATERIAL has answer keys that provide exact answers for objective-type assessments and discussion points for non-objective types. | 4.60 | Strongly Agree |
| 1. The INSTRUCTIONAL MATERIAL has pre- and post- assessment items that are constructed differently. | 4.80 | Strongly Agree |
| Overall Mean | 4.46 | Strongly Agree |

Table 4 shows an overall mean rating of 4.46 ("Strongly Agree"), indicating high assessment quality in the instructional materials. The highest score, 4.80, was for well-constructed pre- and post-assessments, reflecting their effectiveness in measuring learning progress. Ratings of 4.60 were given for alignment with objectives and the inclusion of answer keys with explanations. Scores of 4.40 for variety, clarity of rubrics, and learner engagement highlight a solid assessment structure. The lowest rating, 4.00, for promoting active engagement, suggests minor improvement is needed. Overall, the assessments are reliable, aligned, and supportive of student learning.

Table 5

Mathematics Experts’ Evaluation of the Code-Mixed Instructional Materials Along Readability

|  |  |  |
| --- | --- | --- |
| Standard/Criterion Items | Mean | Descriptive Value |
| 1. Vocabulary used in the INSTRUCTIONAL MATERIAL is appropriate to the target user’s level of comprehension and experience. | 4.20 | Strongly Agree |
| 1. Length and structures of sentences in the INSTRUCTIONAL MATERIAL are suited to the comprehension level of the target users, | 4.60 | Strongly Agree |
| 1. Paragraph structures in the INSTRUCTIONAL MATERIAL facilitate smooth flow of ideas and concepts. | 4.60 | Strongly Agree |
| 1. Topics and ideas presented from one lesson to the next are coherent and integrated with each other. | 4.20 | Strongly Agree |
| 1. Instructions, discussion points, questions, and activities are clear to the target users. | 4.20 | Strongly Agree |
| Overall Mean | 4.36 | Strongly Agree |

Table 5 shows an overall mean rating of 4.36 ("Strongly Agree"), indicating that the instructional materials are highly readable and appropriate for the target learners. The highest score, 4.60, was for sentence and paragraph structure, reflecting clear and logical presentation. Vocabulary, coherence of ideas, and clarity of instructions each scored 4.20, suggesting they are effective but with room for slight improvement. Overall, the materials are accessible and well-structured, with minor refinements needed to further enhance readability.

**Comparison of the performance of the students before and after the use of the code-mixed instructional materials**

This part examines the differences in students' academic performance prior to and following the introduction of code-mixed instructional materials in mathematics. This comparison aims to assess if there is progress in their performance in mathematics after integrating code-mixed approaches in enhancing students' learning outcomes, particularly in terms of their comprehension, engagement, and ability to retain key concepts and skills.

Table 6

Comparison of the performance of the students before and after the use of the code-mixed instructional materials

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Tests | Mean | N | SD | DF | T | P-Value | Decision |
| Pretest | 4.75 | 20 | 2.43 | 19 | 10.97\* | 0.00 | Reject Ho |
| Posttest | 15.7 | 20 | 2.89 |

\*Significant at 0.01

Table 6 compares students’ scores before and after using code-mixed instructional materials in Mathematics. The pretest mean was 4.75 (SD = 2.43), and the posttest mean was 15.7 (SD = 2.89), showing a significant mean gain of 10.95. A paired sample t-test revealed a statistically significant improvement, t(19) = 10.97, p < 0.01, indicating that the materials had a strong positive impact on learning.

This supports prior research (e.g., Shrestha, Zarei, Smith & Lynch, 2020) showing that contextually relevant, bilingual materials enhance comprehension and engagement. However, studies like Alavi and Khatib (2017) caution that effectiveness may vary depending on language proficiency and how the code-mixing is structured. Thus, while results are promising, further research is needed to refine code-mixed materials for broader applicability.

# Conclusion and Recommendations

This section summarizes the study's key findings and their implications. The analysis reveals that code-mixed instructional materials significantly improved students' learning outcomes, particularly in comprehension, engagement, and performance.

1. The Code-Mixed Localized Instructional Materials (CMLIMs) in Mathematics I was rated by the Mathematics experts as Strongly Agree. The materials were well-aligned with the Most Essential Learning Competencies and demonstrated strong instructional design, readability, and accuracy in content and referencing.
2. There is a significant difference in the performance of the pupils before and after the used o Code-Mixed Localized Instructional Materials (CMLIMs) in Mathematics I with P value of <0.01.
3. The experiences encounter by the pupils in using Code-Mixed Localized Instructional Materials (CMLIMs) in Mathematics I are increase enthusiasm, reduced confusion and they become more confident in dealing with mathematics activities.

Based on the findings of this study, several recommendations are put forward to enhance the use of code-mixed instructional materials for improved student learning.

1. Instructional Materials developed should be continuously aligned with the existing DepEd MELCs.
2. Varied types of formative assessments should be based on the diverse learning styles of the pupils.
3. Teachers should attend trainings and seminars in the construction of Instructional Materials and Formative Assessment Tools.

4. Ongoing assessments of code-mixed instructional materials are essential to maintain their effectiveness. It is important to consistently gather and incorporate feedback from both students and teachers to improve and update the materials for future implementation.

These recommendations aim to further improve the quality and impact of code-mixed instructional materials, ultimately enhancing student engagement and performance.

**Ethical Approval:**

As per international standards or university standards written ethical approval has been collected and preserved by the author(s).

**Disclaimer (Artificial intelligence)**

Option 2:

I hereby declare that generative AI technologies such as Chat GPT have been used during the writing or editing of manuscripts.

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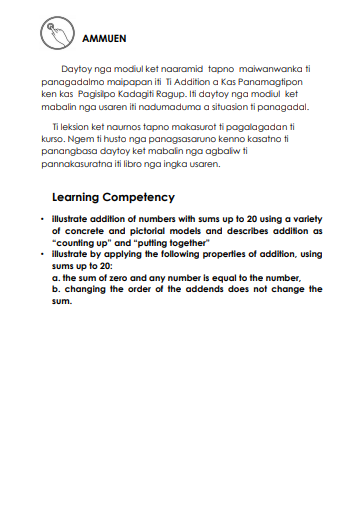
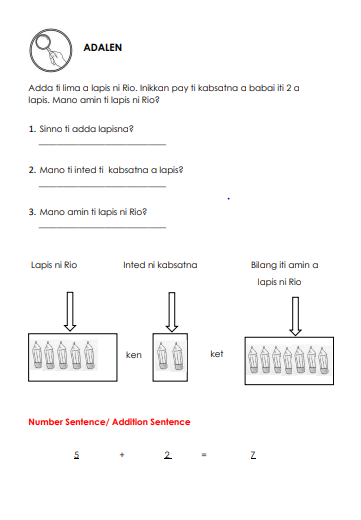
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**Appendix:**

**Developed Instructional Material**

