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Towards the Acquisition of Cognitive Academic Language Proficiency (CALP) in Mathematics Using the Cognitive Academic Language Learning Approach (CALLA): An Action Research

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TOWARDS THE ACQUISITION OF COGNITIVE ACADEMIC LANGUAGE PROFICIENCY (CALP) IN MATHEMATICS USING THE COGNITIVE ACADEMIC LANGUAGE LEARNING APPROACH (CALLA): AN ACTION RESEARCH

A Thesis
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Rachel D. Balansay-Agcaoili

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APPROVAL SHEET

This thesis entitled "TOWARDS THE ACQUISITION OF COGNITIVE ACADEMIC LANGUAGE PROFICIENCY (CALP) IN MATHEMATICS USING THE COGNITIVE ACADEMIC LANGUAGE LEARNING APPROACH (CALLA): AN ACTION RESEARCH" prepared and submitted by RACHEL D. BALANSAY-AGCAOILI in partial fulfillment of the requirements for the degree of Master of Arts in Education with specialization in English Language Teaching, is hereby recommended for approval and acceptance.
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Title: **"Towards the Acquisition of Cognitive Academic Language Proficiency (CALP) in Mathematics Using the Cognitive Academic Language Learning Approach (CALLA): An Action Research"**

Key Concepts: Academic Language

Basic Interpersonal Communication Skills (BICS)

Cognitive Academic Language Proficiency (CALP)

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<u>Statement of the Problem</u>

General Objective:

This study aimed to determine the applicability of Cognitive Academic Language Learning Approach (CALLA) towards the acquisition of Cognitive Academic Language Proficiency (CALP) in Mathematics.

Specific Objective:

This study determined the language performance, mathematics performance, academic language use and learning strategy use of the research participants before and after using CALLA.

Methodology

The four phases of an action research and an added phase by the researcher was utilized as the methodology: Phase I – Topic Identification; Phase II – Data Gathering; Phase III – Decision Making; Phase IV – Resulting Action; and Phase V – Analysis and Reporting of Results.

The instruments used to determine language performance of the research participants were School Readiness Tests Result and Language Grades while the Mathematics Grades were used to determine mathematics performance. Eight mathematical word-problems given as pre-test and post-test determined the academic language use. The CALLA Learning Strategies Questionnaire in Mathematics was accomplished and results determined the learning strategy use.

The participants were thirty-eight (38) grade one students who are heterogeneously grouped.

The statistical treatment in this study included mean, frequencies and percentages.

Results

1. The language performance of the students was determined using the two instruments:

   a) School Readiness Tests Result – the students' performance falls on the average category with a large number of the group falling under Below Average. This was considered before the use of CALLA.

   b) Language Grades – the students' performance before CALLA was based on the first and second quarter grades. Performance largely falls on the satisfactory category with a large number of the group under Highly Satisfactory or a numeric equivalent of 90-94. The students' performance after CALLA was determined using the third and fourth quarter grades. The students maintained their performance as Satisfactory with a large number of the group under Highly Satisfactory or a numeric equivalent of 90-94.

2. The mathematics performance of the students before and after CALLA was determined using the Mathematics grade. The students' performance falls under the Satisfactory category with a large number of the group either under Satisfactory or numeric equivalent of 85-89 before CALLA and Moderately Satisfactory or numeric grade equivalent of 80-84 after CALLA.

3. The academic language use by the students based on the pre-test and the post-test indicated a positive result. The students highly improved in articulating and explaining the process used to solve mathematical word-problems. They also improved in their mathematical computation thus, minimizing computation error.

Students' protocols which were substantiated by interview and think-aloud schedules manifested that academic language competence is not only measured by numeric grades but also other contributing factors like positive attitude and environment support. Students' openness to corrections led to mastery of content as they were able to construct longer sentences using adjectives and prepositional phrases, and compose short stories in the form of word-problems. Daily interactions in school and at home also helped the students practice and develop language proficiency.

4. The learning strategies aided students in understanding content lessons. The following strategies, which are arranged according to rank, guided the students in their mathematical word-problem solving: 1) Self-Evaluation, 2) Planning, 3) Selective Attention, 4) Imagery, 5) Elaboration and 6) Cooperation.

<u>Conclusion</u>

The following conclusions were drawn based on the significant results gathered:

1. The CALLA is helpful in the initial acquisition of target language competence.
2. Students' performance in mathematical word-problem solving improved side by side with academic language and learning strategy use.
3. The academic language instruction helped students achieve better understanding of content lessons. The students became spontaneous in explaining their thoughts particularly the process used in solving mathematical word-problems.
4. The learning strategies made students autonomous learners, as they were able to do their tasks even without teacher's supervision. Learning was also made easy as they were guided with steps and procedures that led them to correct mathematical computations.

5. Think aloud activities honed students' cognitive thinking and developed language skills as they were provided with venues to express their thoughts.
6. Other strategies like ***code switching, self-correction, asking questions for clarification, note taking and making illustrations*** were considered effective strategies in comprehending a problem. This implies that strategy use also relied on the students' prior knowledge and experience.
7. The teacher has a significant role in providing second language learners with opportunities to facilitate their own learning, which they can apply in different content areas.

8. The teacher's varied teaching techniques and learning activities motivated students to experiment with a wide variety of learning strategies.

Recommendations

The following recommendations are presented based on the conclusions mentioned:

On Research

To pave the way for future researchers who wish to conduct studies on academic language and the use of CALLA, the following are recommended:

1. Longitudinal study on the development of cognitive academic language proficiency using CALLA.
2. The effectiveness of CALLA in the general performance of students in mathematics and other disciplines.
3. Comprehensive study on academic language and learning strategy use in different disciplines.

4. Comparative study on the acquisition of cognitive academic language proficiency of students from exclusive girls' school and boys' school.
5. The effect of the use of ***code switching*** as a strategy in comprehending mathematical word-problem.
6. The feasibility of CALLA as a curriculum approach in the primary and secondary level.
7. The use of CALLA in the higher grade level.
8. The use of CALLA in a self-content classroom where the Mathematics teacher is also the Language teacher.
9. The methodology be replicated at different levels, different pupil characteristics, and different school context.

On Pedagogy

This study has several implications for the improvement of teaching practices particularly in English and Mathematics:

1. Teachers' training in the execution of CALLA as an instructional model.
2. Teachers to incorporate academic language and learning strategy use in the syllabus design.
3. Language specialists to play an active role in helping content teachers use language appropriately and to maximize students' learning thus, should be aware of the role of language in different content areas.
4. Mathematics teachers to start asking insightful and probing questions to help students develop academic language and critical thinking rather than giving restricted and formulaic responses.

5. Mathematics teachers to provide varied teaching and learning techniques where students can articulate their thoughts and apply appropriate learning strategies.

TABLE OF CONTENTS

CHAPTER		PAGE

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

THE PROBLEM AND ITS BACKGROUND

1.1 Introduction

> *"Two of the essential ingredients of mathematics are people and communication…Mathematics education begins and proceeds in language, it advances and stumbles because of language, and its outcomes are often assessed in language. Such observations could be made of most school curricula, but the interweaving of mathematics and language is particularly intricate and intriguing…"*
>
> *Durkin (1991)*

The significant role of language challenges teachers of any content area to understand, speak and use the language of instruction appropriately with a high level of proficiency. Students, on the other hand, succeed in their learning if they understand the uniqueness of the language, symbolism, and context of a particular content area.

In a formal education setting, the English language plays a significant role to gain full knowledge in any academic lessons. Mohan, as cited by Sorani and Tamponi (1992), explained that helping students use language to learn requires us to look beyond the language domain to all subject areas and beyond language learning to education in general. In order to ensure this proficiency, teachers must have a thorough knowledge of the English language – the way it works, how it grows and changes, and the ways it affects lives of all of us (Petty et. al., 1989). The classroom then becomes a vehicle for helping students deal with language development.

Mathematics, in Assumption Antipolo, is one of the content areas taught using the English language as the medium of instruction. However, not discounting the fact that most students of this school are fluent English speakers, some of them encounter difficulty in their mathematics lessons particularly with word-problem solving. This concern of the researcher is related to what Li (1990) mentioned that the level of difficulty of a word-problem is related not only to its mathematical content but also to its linguistic form and semantic structure. It is a given fact that mathematics teaching is confronted with a dilemma that most students encounter difficulty in word-problem solving.

The objective of most schools to produce good mathematicians carries with it the development of higher level of thinking skills. In this regard, success may be attained if learners are given the opportunity to acquire and develop ***cognitive academic language proficiency (CALP)*** with the help of a content-area teacher who provides instruction in the special language of the subject matter, while focusing attention as much or more on the subject matter itself. In content-based instruction, students become proficient in the language because the focus is on the exchange of important messages, and language use is purposeful. A student pursuing advanced academic studies through the medium of a second language is always of advantage with CALP.

Among various models which further academic language development in English through content-area instruction is the Cognitive Academic Language Learning Approach (CALLA) by O'Malley and Chamot (1986, 1994). Language modalities (e.g., listening, speaking, reading, writing) are developed for content area activities as they are needed, rather than being taught sequentially. With CALLA, at least four reasons are considered for incorporating content into the English as a Second Language class. First, content provides students with an opportunity to develop important knowledge in different subject areas. This knowledge provides the foundation for learning grade level information and processes in science, mathematics, social studies, and other academic areas of the curriculum. Second, students are able to practice the language functions and skills needed to understand, discuss, read about, and write about the concepts developed. A third reason for introducing content is that many students exhibit greater motivation when they are learning content than when they are learning language only. Finally, content provides a context for teaching students learning strategies that can be applied in the grade-level classroom.

The above objectives, as a matter of course, place into context the continued learning and use of the English language in any content area specifically mathematics. Gibbs and Orton (1994) explained that language consists of much more than mere vocabulary. The language used by a mathematics teacher, a textbook writer and an examiner involves the use of particular structures on grammatical patterns associated with the mathematical register. The growing body of work on the analysis of the semantic structure of mathematical word-problems has alerted educationists to the need to be more sensitive to the problems that language can create due to its structure.

Anstrom (1997), summarizing the U.S. National Council of Teachers of Mathematics guidelines, states that:

> Command of mathematical language plays an important role in the development of mathematical ability. The importance of language in mathematics instruction is often overlooked in the mistaken belief that mathematics is somehow independent of language proficiency. However, particularly with the increased emphasis placed on problem solving, command of mathematical language plays an ability in academic language. Mathematics vocabulary, special syntactic structures, inferring mathematical meaning, and discourse patterns typical of written text all contribute to the difficulties many [L2] students have when learning mathematics in English.

It must, however, be acknowledged that the research in the past has been more adept at identifying the problem issues than at providing guidance for effective intervention in the classroom (Orton, 1996).

This study, then, is brought to the ultimate goal of promoting the teaching and learning of *cognitive academic language* so that students can better assess what it is they need to learn and do when dealing with mathematics lessons particularly word-problem solving.

1.2 Theoretical Framework

O'Malley and Chamot (1994) developed the Cognitive Academic Language Learning Approach (CALLA), an instructional model to meet the academic needs of students learning English as a second language. It helps students in the transition from an ESL program into the mainstream curriculum by teaching them the learning strategies needed to successfully handle content area material. These strategies assist students to understand and retain content area material while they are increasing their language skills. The model includes three components namely: a) topics from the major content subjects, b) development of academic language skills and c) explicit instruction in learning strategies for both content and language acquisition.

This study is based on the said instructional model and is best presented through the paradigm on the next page.

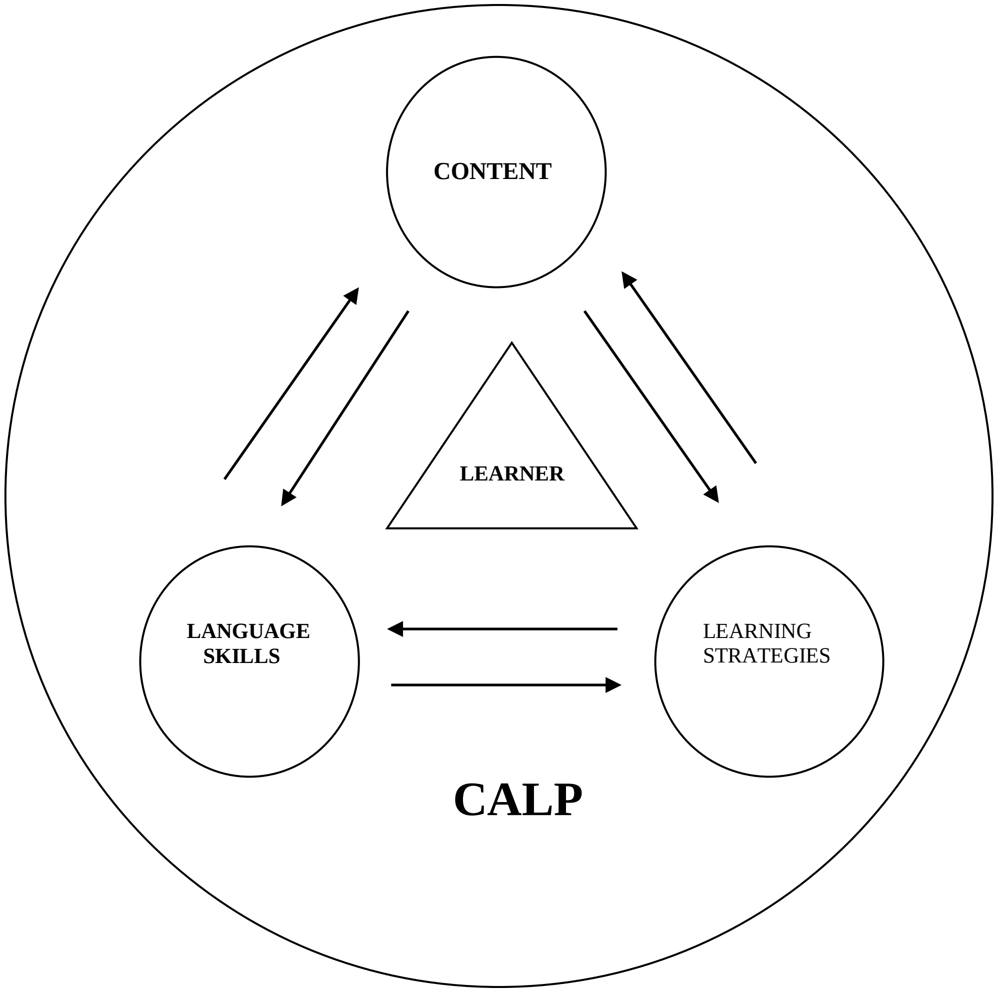

Figure 1

Paradigm on CALP Acquisition

Adapted from: CALLA Model of O'Malley and Chamot (1994)

The three components – Content, Language Skills, and Learning Strategies are enclosed in a circle suggesting that they constitute the totality of the learning instruction. The circle is also indicative of the continuous process of cognitive academic language learning.

The two-way arrows indicate the dynamic interaction and relationship that should exist among the components if the model is to be properly implemented. The outer circle encloses the whole process of CALP acquisition. Finally, the all-important process of the model is the formation of the "Learner." This becomes the ultimate measure of the success or failure of teaching and learning the academic subject.

1.3 Conceptual Framework

The dynamic role of language, whether first language or second language, poses a challenge to many researchers, educators and learners. Studies on proper discourse in both spoken and written forms are conducted. Communicative skills and cognitive language proficiency are also brought into the picture as one of the concerns of second language learners.

A person's proficiency in language refers to the extent to which that person is able to utilize the language. In the early sixties, Lado and Carroll proposed a framework for describing the measurement of language proficiency that was incorporated in the skills and components models. These models indicated the difference of skills (listening, speaking, reading, and writing) from components of knowledge (grammar, vocabulary, phonology/graphology), but did not explain how skills and knowledge are related. Another limitation is the failure to acknowledge the full contexts of language use which are discourse and situation. Bachman (1990) mentioned that Halliday's description of language functions, both textual and illocutionary, and van Dijk's delineation of the relationship between text and context, clearly recognize the context of discourse. Hymes (1972) further identifies the sociocultural factors in the speech situation.

What surfaced from these ideas is an expanded conception of language proficiency whose distinguishing characteristic is its recognition of the importance of context beyond the sentence to the appropriate use of the language. Together with the recognition of the context in which language use takes place is the recognition of the dynamic interaction between that context and the discourse itself, and an expanded view of communication as something more than the simple transfer of information.

Recent developments in communicative competence, however, provides a much more detailed description of the knowledge required to use language than did the earlier skills and components models. In addition to the knowledge of grammatical rules, it is also significant to have a knowledge of how language is used to achieve particular communicative goals and the recognition of language use as a dynamic process.

In education, Cummins (1981) classified the use of language into two dimensions: the social dimension called Basic Interpersonal Communication Skills (BICS) and the academic dimension called Cognitive Academic Language Proficiency (CALP). This latter type of proficiency is related to cognitive skills and conceptual knowledge, and can be transferred from native language to English. To use a language in academic work, the speaker must have an extensive foundation related to the language and this foundation is acquired though using the language over an extensive period of time. Conversational fluency (social dimension) is acquired to a functional level within two years of initial exposure to the second language whereas at least five years is usually required to catch up to native speakers in academic aspects of the second language (Collier, 1987; Klesmer, 1994; Cummins, 1981a). This was further elaborated into two intersecting continua (Cummins 1981b) which highlighted the range of cognitive demands and contextual support involved in a particular language task as activities. Cummins expanded this concept to include two distinct types of communication, depending on the context in which it occurs:

- Context-embedded communication provides several communicative supports to the listener or reader, such as objects, gestures, or vocal inflections, which help make the information comprehensible. Examples are a one-to-one social conversation with physical gestures, or storytelling activities that include visual props.
- Context-reduced communication provides fewer communicative clues to support understanding. Examples are a phone conversation, which provides no visual clues, or a note left on a refrigerator.

Similarly, Cummins distinguished between the different cognitive demands that communication can place on the learner:

- Cognitively undemanding communication requires a minimal amount of abstract or critical thinking. Examples are yes/no questions in the classroom.
- Cognitively demanding communication requires a learner to analyze and synthesize information quickly and contains abstract or specialized concepts. Examples are academic content lessons, such as a social studies lecture, a math lesson, or a multiple-choice test.

Figure 2 below exhibits Cummins's framework to classify language activities:

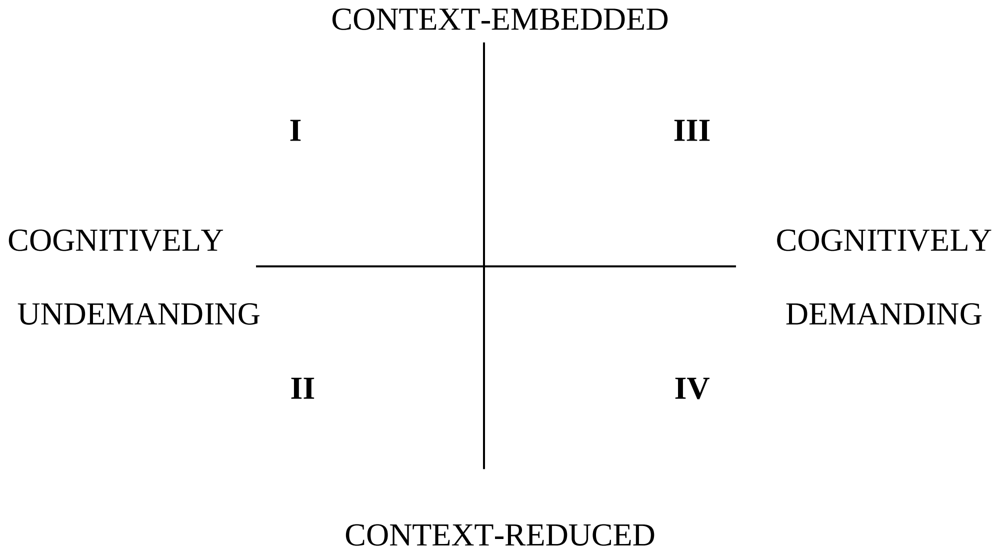

Figure 2

The Cummin's Framework

Source: O'Malley and Chamot, The CALLA Handbook: Implementing the Cognitive Academic Language Proficiency Approach. USA: Addison-Wesley Publishing Co., 1994, p.24.

The scheme shows the complex relationship between language proficiency and content learning. In content area, the students use a second language to acquire subject matter knowledge. Learning in a second language is often considered as a source of problems, because there can be discrepancies between the proficiency in the second language and the demands placed on students by academic language use. The importance of this scheme in mathematics learning calls for context-reduced situations or tasks where learners have to rely on linguistic cues. These tasks can be very difficult because learners get little support from the situation in understanding the task. Mathematics learning also involves cognitively demanding situations or tasks because it requires active cognitive involvement of the learner for appropriate performance.

The BICS/CALP distinction was maintained within this elaboration and related to the theoretical distinctions of several other theorists like Bruner’s (1975) communicative and analytic competence, Donaldsons’s (1978) embedded and disembedded language, and Olson’s (1977) utterance and text. The terms used by different investigators are varied, but the essential distinction refers to the extent to which the meaning being communicated is supported by contextual or interpersonal cues (such as gestures, facial expressions, and intonation present in face-to-face interaction) or dependent on linguistic cues that are largely independent of the immediate communicative context.

If it is through language forms adopted in mathematics classrooms that mismatches between the goals and views of teachers and students are created, then, it is also the case that, by coming to understand these language forms, the mismatches can be identified, observed, and ultimately resolved in ways which facilitate richer modes of communication between all involved in the creation of mathematical meaning (Orton and Wain, 1994).

Figure 3 on the next page is a detailed presentation of the conceptual framework of CALP acquisition as based on O’Malley and Chamot’s (1994) Calla Model.

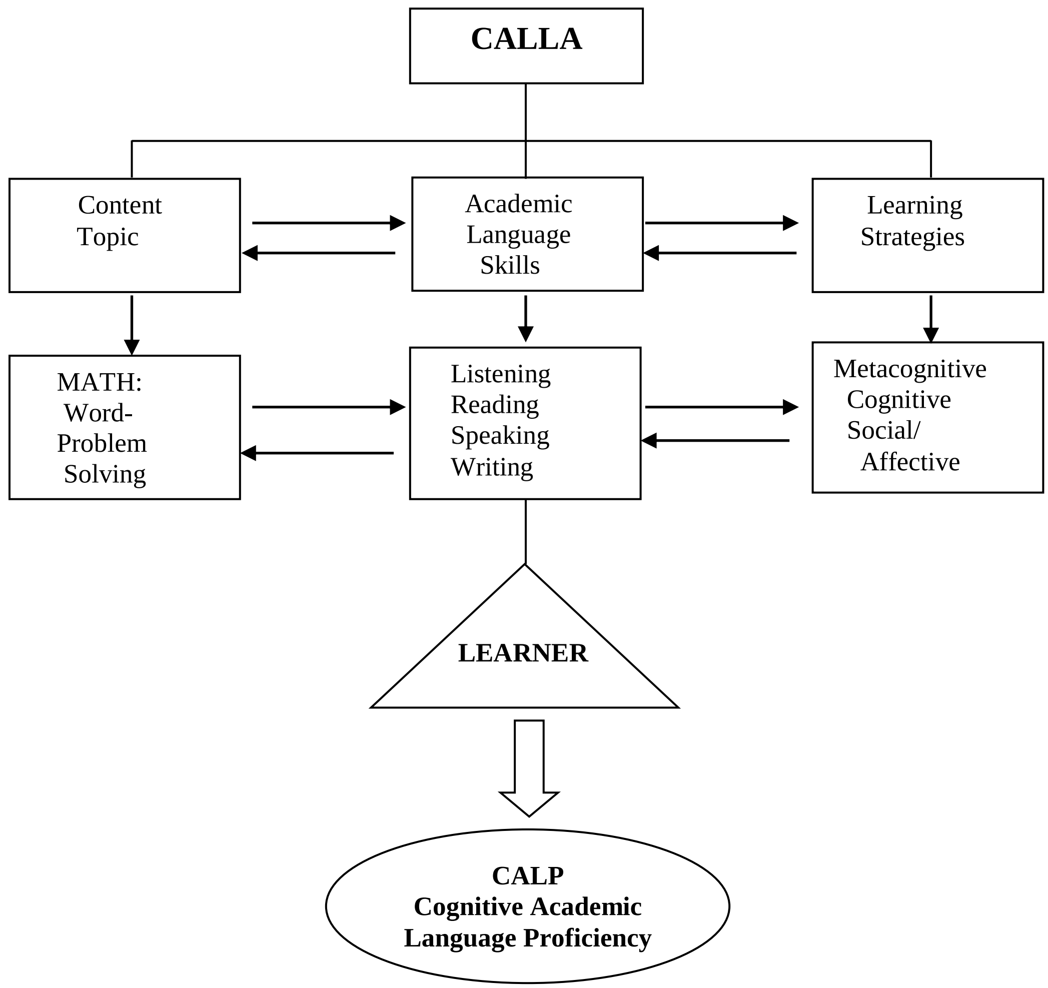

Figure 3

Conceptual Framework of CALP Acquisition

Source: CALLA Model of O'Malley and Chamot (1994) with some dimensions added by the researcher.

The above figure shows Mathematics as the chosen content area focusing on word-problem solving. The four language skills – listening, reading, speaking, and writing are developed as the students learn the academic language while engaging in activities of the content topic. Learning strategies are likewise taught for the students to be equipped with strategies that will assist them in their process of solving word-problems. These three components are directly related with each other in the implementation of the instructional model. Success is measured when the learner is able to meet the demands of academic needs in the grade level classroom.

In view of O'Malley and Chamot's instructional model and the present researcher's observation about the students' common difficulty on academic language, it is deemed essential to give and take appropriate treatment. This prompted the researcher to conduct this study and find out in particular, the effectiveness of CALLA in a mathematics classroom.

1.4 Statement of the Problem

The main purpose of the study is to determine the applicability of the Cognitive Academic Language Learning Approach (CALLA) in dealing with mathematical word-problems.

Specifically, the study hopes to answer the following questions:

1. What is the language and mathematics performance of the students before and after CALLA as measured by
   a. interview and think-aloud protocols;
   b. final grades; and
   d. School Readiness Test result?
2. What is the status of the academic language use of the students before and after using CALLA as measured by the mathematical word-problems?
3. What CALLA learning strategies do students use in solving mathematical word-problems?

1.5 Significance of the Study

The research has a general relevance to efforts in developing cognitive academic language proficiency and in producing good problem-solvers in mathematics. Particularly, the study will be beneficial to the following:

Learners. As the students progress in their language performance, important concepts and skills of the content area will likewise be developed. They will also be guided to develop a repertoire of learning strategies for understanding and solving word-problems simply and properly. Positive attitude towards mathematics will likewise be enhanced leading to a better performance and avoiding summer reinforcement.

Mathematics Teachers. Effective mathematics teaching involves not just a mastery of the content but also an understanding of the role of language in the teaching-learning process. Identifying a specific strategy a student uses and elaborating on how that strategy fits with other students may be helpful and necessary in developing the skills needed for word-problem solving.

Language Teachers. Data from this study may help language teachers understand more how language is used in mathematics. The study may also provide them with baseline data for future collaboration with other content-area teachers. Further insights may also assist them on what English structures and/or areas will be given emphasis in their lessons.

Curriculum Experts. The study provides empirical data in curriculum planning as well as the development of instructional materials which may include explicit instruction of learning strategies to make teaching and learning of any content-area easier and practical.

School Administrators. The study serves as a baseline empirical data for planning quality education that will satisfactorily address different programs or activities in mathematics and the developmental needs of students. The vital role of English language in the development of critical thinking may inspire administrators to undertake measures in giving more importance to the role of language in mathematics and other content areas.

Textbook Writers. The study may provide them insights on how to include exercises or activities that will hone academic language proficiency and learning strategies.

Parents. The study is relatively significant because parents are primarily responsible in monitoring the learning tasks of their children. Their knowledge of academic language and learning strategies will help them find an effective way of teaching their children especially with lessons in mathematics.

Counselors. The study may give them a good insight on cognitive academic language proficiency and how students acquire it. The basic understanding of learning strategies may later on help in their process of counseling and consequently be incorporated into their program design.

Researchers._ The study may pave the way for more comprehensive researches on academic language and the use of the CALLA model in different contexts. Researchers may also be inspired to conduct longitudinal studies on the academic language proficiency of Filipino students with their threshold level of the English language.

1.6 Scope of the Study

The research is confined to the study on how cognitive academic language proficiency (CALP) is acquired by the grade one students of Assumption Antipolo for mathematical word-problems. The Cognitive Academic Language Learning Approach by O'Malley and Chamot is the instructional model used, thus, putting CALLA in primary grade classrooms. Major academic objectives of primary grade programs are to develop literacy and mathematical concepts and skills that will allow students to read for information as well as appreciation, to communicate in written form, and to use mathematical concepts and computational skills to solve problems (O'Malley and Chamot, 1994). This study, therefore, is concentrated solely on the use of CALLA as an instructional approach and not as a curriculum approach.

Mathematics is the selected priority content by the researcher because it is in this area where students encounter difficulties and need to be treated with depth. The researcher concentrates on solving one-step word-problems involving addition and subtraction operations. The focus is exclusively on the role language plays in the processes of mathematical problem-solving, thus, giving attention to academic language and problem-solving strategies that will lead to successful solutions.

1.7 Definition of Terms

The following are definitions of terms used for a clear understanding of the study:

Academic Language – This is the language that is used by teachers and students in any content area for the purpose of acquiring new knowledge and skills (O'Malley and Chamot, 1994).

Cognitive Academic Language Learning Approach (CALLA) – This is an instructional model developed by O'Malley and Chamot to meet the academic needs of students learning English as a second language. This model integrates language development, content area instruction, and explicit instruction of learning strategies.

Cognitive Academic Language Proficiency_- This is a language- proficiency dimension related to the literacy skills in any content area or academic subject. This also refers to the language valued in the academe and the

aspects of language proficiency closely related to the development of first and second language literacy skills (Cummins, 1981).

Cognitive Strategies – These are strategies that are linked to individual tasks like classification or grouping, note taking and summarizing, inferencing and elaboration (O'Malley and Chamot, 1994). These are also strategies that involve manipulation or transformation of the material to be learned where the learner interacts directly with what is to be learned (Brown and Palinscar, 1982).

Content Area – This refers to the Mathematics subject in this study.

First Language – This refers to the mother tongue of the learners which is the Filipino language.

Language – This is a functional tool used for learning academic subject matter. The language that is used in this study is English.

Language Performance – This refers to the extent of students' use of English to cope with the demands of Mathematics.

Language Proficiency – This is the students' level of mastery of the English language as shown in the Language Grade and School Readiness Tests result. This also refers to the speaker-learner's ability to produce and understand grammatically-correct utterances in their appropriate linguistic and socio-cultural contexts (Rañon**,** 1997).

Learning Strategies – These are learning processes which are consciously selected by the learners (Cohen, 1998). These refer to the thoughts or activities that assist in enhancing learning outcomes (O'Malley and Chamot, 1994). Further, these are techniques, approaches, or deliberate actions that

students take in order to facilitate the learning and recall of both linguistic and content area information (Chamot, 1984).

Metacognitive Strategies – These are strategies that involve higher level of thinking that allows a learner to think about the learning process, planning for a task, monitoring of learning while it is taking place, evaluating the success of learning, and the plan after learning activities have been completed.

Social/Affective Strategies – These are strategies used that involve cooperation and asking questions for clarification (O'Malley and Chamot, 1994).

Word-Problem Solving – This refers to a task, stated in words, that involves the determination of the nature or relations involved in a challenging qualitative situation and consequent activity that unifies properly chosen reaction into a satisfactory result (Danao, 1999). As used in this study, word-problem solving particularly refers to the mathematical word-problem solving of the grade one students of Assumption Antipolo.

CHAPTER II

REVIEW OF RELATED LITERATURE AND STUDIES

This chapter presents several reviews of related literature and studies which are relevant and have substantiated the present study. These are also information that guided the researcher in the development of the study.

2.1 RELATED LITERATURE

2.1.1 On Language and Mathematics

One aspect of language use that has been highlighted over the last decade is the enormous variability that can exist in what seems on the surface to be the simplest of situations (Orton and Wain, 1994). Consider the variations a language teacher may use to describe $12 \div 3$. The equation may be read as:

Twelve divided by three
Three into twelve
How many threes in twelve?
Twelve divided between 3
Twelve divided into 3 parts
Twelve apples shared among three children

Comprehending mathematical talk is made more difficult, according to Khisty (1995), because symbolically we have one statement ($12 \div 3$), but verbally we can express it in several different ways. Moreover, these expressions are often unthinkingly and freely interchanged by teachers as they instruct (Pimm, 1987).

One of the reasons that mathematical texts are hard to understand is the language that is used in mathematical texts. Khisty in Nivera (2001) wants to emphasize that this is not to be confused with the special terminology used in mathematics. He says that the mathematics register rather extends to the use of the natural language in a way that is particular to a role or function (Halliday, 1978). In other words, it is a set of unique meanings and structures expressed through everyday language.

In mathematics teaching and learning, the role of language cannot be underestimated. Children's language contribute to their mathematical development because language allows thoughts to surface to a level of awareness where individuals can review them and clarify or modify their ideas (Orton and Wain, 1994).

Nivera further explains that one important role of language is to bring to light students' different ideas with the hope that misconceptions will be resolved. The aim therefore, of teachers, will be to help learners to take an active part in their own learning and by putting their thinking into words to develop their ideas and make them their own. These aims and needs make mathematics learning and language learning complement each other.

Martinez (2001) elaborates that mathematics, as a language, is also considered as a specialized form of English. Symbols are used as shorthand, but they do represent words, and mathematical sentences are just as grammatical as sentences in ordinary English. Language is one of the factors when a child is struck with a particular problem. Mathematical problems are often stated in words and although children can read words, they may have difficulties in understanding what is being asked. Assistance in such cases needs helping the child with the language. It is better if you can help him to understand what is written than simply re-stating the problem in different words. By doing so, you are helping in his understanding of English. It is important, therefore, that children be encouraged to express themselves clearly in Mathematics.

Leaño (1995) believes that the development of language processing skills in mathematics is indeed one crucial area of problem-solving. It is clear that many children with poor language skills never reach the stage of understanding the problem, thus the need to improve this skill.

Where arithmetic word problems are concerned, according to Sovik et. al. (Prenger 2001), not only arithmetical knowledge but all kinds of linguistic, conceptual and situational knowledge is involved in the understanding of the problem. What makes word/text problems difficult are often not their formal properties, but the way the problem is expressed linguistically. Hence, arithmetical errors made by pupils can be caused by failure to properly understand the text of the word problem rather than by a faulty knowledge of arithmetic.

Cuevas (1984) points out that, although researchers have long recognized the vital role that language plays in mathematics performance, they have not always acknowledged its equally important role in the process of acquiring mathematical concepts and skills. Mathematical terms give rise to 'an almost totally non-redundant and relatively unambiguous language.' Halliday in Cuevas (1984) has suggested that a mathematics register has the following components:

1. Natural language words reinterpreted in the context of mathematics, such as *set, point, field, column, sum, even,* and *random*
2. Locutions, such as *square of the hypotenus* and *least common multiple*

3. Terms created from combinations of natural language words, such as *feedback* and *output*
4. Terms formed from combining elements of Greek and Latin words, such as *parabola*, *denominator*, *coefficient* and *asymptotic*

According to Shuard and Rothery (1984) in Prenger (2001), three categories can cause difficulty in acquiring the process of mathematical concepts and skills:

1. ***Words which have the same meaning in Mathematical English (ME) as in Ordinary English (OE)*** – When OE words are used in mathematical texts, difficulties are not worse than when the same words are used in other texts.
2. ***Words which have meaning only in ME*** – Students meet these words only in a mathematical context and their meanings must be learnt either from the teacher or the mathematics book. These words are relatively easy to learn because they must be newly learned.
3. ***Words which occur in both OE and ME, but which have a different meaning in ME from their meaning in OE*** – The main cause of students' reading difficulty is the confusion which can arise when a word has a variety of meanings and when the required meaning has to be inferred from the context. Some words have a mathematical meaning which is unrelated to their everyday usage, but other words have related meanings. There are some words where the meaning in ME is similar to the meaning in OE, but where the mathematical word has a more refined or specialized meaning. The student will be forming his own internalized definitions of words. The student may make some sense of his mathematics

lessons, although he is only thinking in terms of the colloquial meaning without fully grasping the extra subtlety of the full mathematical meaning.

According to Newman (1977, 1983), any person confronted with a written mathematics task needs to go through a fixed sequence: Reading (decoding), Comprehension, Transformation (or Mathematising), Process Skills, and Encoding.

On the other hand, O'Malley and Chamot (1994) came up with a list of language skills required in mathematics as they explain the language dependence of mathematics.

Table 1 on the next page shows the list of these language skills.

Table 1

LANGUAGE SKILLS REQUIRED IN MATHEMATICS

	Grades		
Language Skills	**1 – 3**	**4 – 6**	**7 – 12**
LISTENING			
1. Understand explanations without concrete referents.	L	P	M
2. Understand oral numbers.	M	M	M
3. Understand oral word problems.	M	P	L
READING			
1. Understand specialized vocabulary.	L	P	M
2. Understand explanations in the textbook.	L	P	M
3. Read mathematical explanations.	L	P	M
4. Understand word problems.	P	M	M
SPEAKING			
1. Answer questions.	M	M	M
2. Ask questions for clarification.	M	M	M
3. Explain problem-solving procedures.	M	M	M
4. Describe applications of math in other content areas.	M	P	P
WRITING			
1. Write verbal input numerically.	M	P	P
2. Write word problems.	P	P	L
3. Write words for number sentences.	M	P	L

less emphasis	**partial emphasis**	**more emphasis**
L	**P**	**M**

Source: O'Malley, M. and Chamot, A. 1994. The CALLA Handbook: Implementing the Cognitive Academic Language Learning Approach. USA: Addison-Wesley Publishing Company, p. 228.

2.1.2 On Cognitive Learning

Cognitive scientists are particularly interested in human intelligence because intelligence represents, in some sense, the epitome of human functioning, that which makes us distinctively human (Sternburg, as cited by Solso 1995).

While most people possess the full spectrum of intelligences, each individual reveals distinctive cognitive features. When individuals have opportunities to learn through their strengths, unexpected and positive cognitive, emotional, social, and even physical changes will appear (L. Campbell, B. Campbell and D. Dickinson, 1996).

Howard Gardner (1983) generated a refreshingly pragmatic definition of the concept of intelligence. He defines intelligence as the ability to solve problems that one encounters in life; the ability to generate new problems to solve; and the ability to make something or offer a service that is valued within one's culture.

Solso (1995) differentiated two theories of cognitive development: One theory, is that of Piaget which proposes that intellectual growth is biologically determined and governed by two processes: adaptation involving cognitive adjustments to the environment (assimilation and accommodation), and organization involving increasingly complex, integrated mental representation of operations. Cognitive development is characterized by quantitative, linear changes within a stage and qualitative changes across four major stages: sensorimotor, pre-operational, concrete operational, and formal operational.

Another theory of cognitive development is that of Vygotsky which rejects a strict biological determinism and proposes that learning precedes development. Thought and language are believed to originate independently, with thought being biologically determined whereas language is socially determined, and integration occurring when the child connects thought, language, and environment events through naming activity.

Solso (1995) explained further that thinking is the crown jewel of cognition. Most human solving or concept formation involves thinking, and most problem- solving involves concept formation.

In school, students' most important goal is to learn. Learning, as numerous educators have repeatedly pointed out, is a consequence of thinking (Dewey, 1910; Hayes, 1978; Perkins, 1992; Resnick, 1997). In cognitive approach to learning, the learner is seen as an active participant in the learning process using various mental strategies in order to soil out the system of the language to be learned (Williams and Burden, 1997). Cognitive psychologists are, therefore, interested in the mental processes that are involved in learning. This includes such aspects as how people build up and draw upon their memories and ways in which they become involved in the process of learning.

Beyer (1991) suggests that one way to help people become better, more effective thinkers is to help them become proficient in carrying out the skilled operations of which effective thinking, in part, consists. To improve the quality of student thinking means to raise it to a level of performance in academic contexts as well as civic and personal life that consistently exhibits the characteristics of high-quality thinking. Teaching thinking, then, has a purpose of preparing students a future of effective solving, thoughtful decision-making, and lifelong learning. It stresses the dispositional as well as the abilities side of thinking. (Tishman, Perkins, and Jay, 1995).

Thinking of high quality is the inclination and ability to carry out a wide range of cognitive (thinking) operations. This includes especially complex, higher-order operations – in a rapid, accurate, expert, self-critical, and self-correcting manner; in a wide variety of contexts, including unfamiliar ones; and in a comfortable and confident manner to produce sound, accurate thinking products.

Whimbey and Lochead (1982) claim that high-quality thinking is distinguished by the following:

- A concern for accuracy and understanding of the facts and relationships of a problem
- A systematic, step-by-step procedure by which a thinking task is carried out, including breaking the thinking task into smaller parts and starting at a point at which one can make sense of it
- Careful attention to directions, data, and procedure, with continuous assessment of what is being done, used, and produced
- An active effort that includes using a variety of props (such as diagrams, models, mental images, self-questioning) to carry out one's thinking
- Confidence in one's ability to carry out a thinking task successfully

Side by side with cognitive learning, learners also develop their own cognitive styles. According to Wapner et al. (Kim 1997), cognitive style refers to a manner of moving toward a goal, and a characteristic way of experiencing or acting. More specifically, it is a characteristic way in which an individual organizes and processes information (Goldstein and Blackman, 1978).

O'Malley and Chamot (1994) believe that though different psychologists like Anderson, Ausubel, Bruner, Piaget, and Vygotsky has each chosen a somewhat different lens to investigate learning processes, each has operated from the basic belief that human beings think, seek knowledge, enjoy learning, and make intellectual leaps when the right conditions (development, experiential, social, individual) are present.

Other cognitive models of learning that are also considered parallel branches of the Cognitive Academic Language Learning Approach are the following (O'Malley and Chamot, 1994):

Language Across the Curriculum

This model seeks to infuse language teaching and learning into all areas of the curriculum (Marland, 1977). All teachers, including science, mathematics, and social studies teachers, carry out language development activities associated with their individual content areas. Language skills are practiced in all subjects.

Language Experience Approach

Students learn that what is said can be written down and what has been written can be read (Van Allen and Allen, 1976 in O'Malley and Chamot, 1994). Vocabulary and grammatical structures are experienced first within the language knowledge base known by students. This is particularly advantageous with beginning-level ESL students.

Whole Language

This approach to literacy development is based on the belief that language should not be separated into component skills, but rather experienced as a whole system of communication (Edelsky, Draper, and Smith, 1983 in O'Malley and Chamot, 1994).

Activities include reading aloud by the teacher, journal writing, story writing sustained silent reading, higher-order thinking skills discussions about what is read, student choice in reading materials, and frequent conferences with the teacher and other students about what is being read and written.

Process Writing

Students learn that writing involves thinking, reflection, and multiple revisions. The classroom becomes a writing workshop in which students learn that craft of writing through discussion, sharing, and conferencing.

Cooperative Learning

Students work in heterogeneous groups on learning tasks that are structured so that all students share in the responsibility for completing the task. In this type of learning, students of varying degrees of linguistic proficiency and content knowledge work in a group setting that fosters mutual learning rather than competitiveness (Johnson, Johnson, Holubec, and Roy, 1984 in O'Malley and Chamot, 1994).

Cognitive Instruction

This is used to describe a number of approaches to teaching thinking and to infuse thinking into all areas of the curriculum (Jones and Idol, 1990 in O'Malley and Chamot, 1994). Students are co-constructors of knowledge. Teachers foster the development of higher-order thinking skills through challenging questions, modeling the learning process, and engaging in interactive dialogue with students (Jones, Palincsar, Ogle, and Carr, 1987 in O'Malley and Chamot, 1994).

2.1.3 On Learning Strategies

The term "learning strategy" generally includes both cognitive strategies and metacognitive strategies (Yu-ping Hsiao, 1997). However, some researchers include social/affective strategies as particularly important in second language acquisition because language is so heavily involved in cooperation and asking questions for clarification (O'Malley and Chamot, 1994). Learning strategies are considered to be the most significant current contributions of cognitive psychology to instructional design (West, Famer and Wolff, 1991). Learning strategies serve an important role to the learning process.

A learning strategy is like a tactic used by a player. It is a series of skills used with a particular learning purpose in mind. Thus, learning strategies involve an ability to monitor the learning situation and respond accordingly. This means being able to assess the situation, to plan, to select appropriate skills, to sequence them, to co-ordinate them, to monitor or assess their effectiveness and to revise the plan when necessary (Williams and Burden, 1997).

Mikusa (1998) states that developing techniques and strategies will enable the students become more powerful problem-solvers. Demonstrating to the students the value of problem-solving and emphasizing that patience and persistence are necessary in being successful problem-solvers.

Table 2 on the next page presents the definitions of itemized learning strategies in the mathematics classroom (O'Malley and Chamot, 1994).

Table 2

Learning Strategies in the Mathematics Classroom

Metacognitive Strategies

- Planning
  - Advance Organization – previewing the main ideas and concepts of a text, identifying the organizing principle.
  - Organizational Planning – planning how to accomplish the learning task; planning the parts and sequence of ideas to express.
  - Selective Attention – attending to key words, phrases, ideas, linguistic markers, types of information.
  - Self-management – seeking or arranging the conditions that help one learn.

- Monitoring
  - Monitoring Comprehension – checking one's comprehension during listening or reading.
  - Monitoring Production – checking one's oral or written production while it is taking place.

- Evaluating
  - Self-assessment – judging how well one has accomplished a learning task.

Cognitive Strategies

- Resourcing – using reference materials such as dictionaries, encyclopedias, or textbooks.
- Grouping – classifying words, terminology, quantities, or concepts according to their attributes.
- Note-taking – writing down key words and concepts in abbreviated verbal, graphic, or numerical form.
- Elaboration for Prior Knowledge – relating new to known information and making personal association.
- Summarizing – making a mental, oral, or written summary of information gained from listening or reading.
- Deduction/Induction – applying or figuring out rules to understand a concept or complete a learning task.
- Imagery – using mental or real pictures to learn new information or solve a problem.
- Auditory Representation – replaying mentally a word, phrase, or piece of information.

- Making Inferences – using information in the text to guess meaning of new items or predict upcoming information.

Social/Affective Strategies

- Questioning for Clarification – getting additional explanation or verification from a teacher or other experts.
- Cooperation – working with peers to complete a task, pool information, solve a problem, get feedback.
- Self-talk – reducing anxiety by improving one's sense of competence.

2.1.3.1 Metacognitive Strategies

Effective thinkers think about how they think before, during, and even after carrying out a cognitive task (Beyer, 1991). In order to be more successful in the classroom, children should be taught to engage in metacognitive skills. Children should be taught to become aware of their own learning process, monitor their current task performance, and gain control of academic tasks. The use of metacognitive skills requires active participation of the learner which enhances the likelihood that students can then translate them into improved academic performance (Manning and Payne, 1996).

Metacognitive strategies are set of strategies operating at a different level which involve learners stepping outside their learning, as it were, and looking at it from the outside. Such strategies include an awareness of what one is doing and the strategies one is employing, as well as knowledge about the actual process of learning. They also include the ability to manage and regulate consciously the use of appropriate learning strategies for different situations (Williams and Burden, 1997).

Metacognitive strategies have been considered as a very important aspect of learning strategy. Metacognitive strategies focus on establishing one's metacognition on learning (Yu-ping Hsiao, 1997).

Metacognition, as first introduced by Flavell (1970, 1976, 1981) involves an awareness of one's own mental processes and an ability to reflect on how one learns. In other words, knowing about one's knowing (Williams and Burden, 1997).

Likewise, Brezin (1980) elaborated that metacognition relates to an individual's awareness, knowledge, and task of the monitoring process of the cognitive goals for the purpose of increasing understanding and retention of learning materials.

According to Bonds et al. (1992) metacognition includes two aspects. The first is that the learner is aware of the nature of the learning task and the requirement for reaching this. The second one is that the learner possesses knowledge pertinent to finishing the learning task. Therefore, people with metacognitive strategies have the knowledge of new information and cognitive strategies. Such strategies include an awareness of what one is doing and the strategies one is employing, as well as knowledge about the actual process of learning. Their function is to monitor learning rather than to produce it (Jonassen, 1988).

Metacognitive strategies in Mathematics are simply memorable plans or approaches that students use to problem-solve. These strategies include the student's *thinking* as well as their *physical actions* (Lenz, Ellis, and Scanlon, 1996). Some of the most metacognitive strategies come in the form of mnemonics, which are meaningful words where letters in the word each stands for a step in a problem-solving process or for important pieces of information about a particular topic of interest.

Metacognitive strategies positively impact students who have learning problems because they provide these students an efficient way to acquire, store, and express information and skills (Mercer and Mercer, 1993).

2.1.3.2 Cognitive Strategies

Cognitive strategies help “process and transform information” and “assist the learner [to] actively engage in the knowledge acquisition process.” Cognitive strategy use for any academic task has a “direct and specific impact on learning (McCrindle and Christensen, 1995).

On one hand, Williams and Burden (1997) mentioned that cognitive strategies are seen as mental processes directly concerned with the processing of information in order to learn, that is, for obtaining, storage, retrieval or use of information.

Cognitive psychologists have also identified three types of knowledge: declarative, procedural and conditional knowledge. Each type of knowledge requires a different function of the memory system. *Declarative knowledge* refers to the aspect of “knowing what” and implies the awareness of information. *Procedural knowledge* refers to the aspect of “knowing how” and relates to the information about procedures, rules, and principles. *Conditional knowledge* refers to the aspect of “knowing when and why” and implies the decision to select and use specific procedures, rules and principles.

Cognitive strategies may be referred to as declarative and procedural knowledge; they help assimilate information into long-term memory (Yu-ping Hsiao 1997).

Weinstein and Mayer as cited by McCrindle and Christensen (1995) have identified three types of cognitive strategies: (a) *rehearsal strategies*, which involve the repetition of the information to be learned; (b) *organization strategies*, which rearrange information to be learned to make it more meaningful; and (c) *elaboration strategies*, which link new and previously acquired information.

Stewner-Manzanares et al. (Oxford, 1986) mentioned that cognitive learning strategies involve manipulation of learning materials in order to enhance learning or retention. These strategies should always be accompanied by metacognitive learning strategies. Examples include using mnemonic devices, thinking inferentially, and recombining already learned material into new patterns.

West, Farmer, and Wolff (1991) introduced nine kinds of cognitive strategies: a) chunking, b) frames, type one, c) frames, type two, d) concept mapping, e) advance organizer, f) metaphor-analogy, g) rehearsal, h) imagery, and i) mnemonics. They concluded that instructional designers can make use of these strategies.

2.1.3.3 Social/Affective Strategies

Oxford (1986) stated that researchers have also recognized a category of "socially mediated" or "social" learning strategies (Fillmore, 1976; Russo and Stewner-Manzanares, 1985). One social learning strategy is cooperating with peers to obtain feedback, to pool information, or to practice. Other social learning strategies include asking questions for clarification; being attentive to social cues such as the speaker's body language, physical distance, sex, age, and social status; and actively seeking social situations in which to practice the L2. These are called *communication strategies*.

Social learning strategies are particularly important for exposing the learner to the target language, increasing the amount of interaction with native speakers, and enhancing motivation (Fillmore, 1976).

Affective (emotional or attitude-related) strategies are valuable in L2 learning especially when oral production demands are high. An example is finding and implementing ways to cope with anxiety (Oxford, 1986).

2.1.4 On Problem Solving

Kim (1997) mentioned that problem-solving can be defined as a goal-oriented sequence of cognitive operation (Anderson, 1980). Problem-solving process comprises cognition as well as emotion and behavior. Skills of problem-solving include the ability to search for information, analyze situations for the purpose of identifying the problem in order to generate alternative courses of action, weigh alternative courses of action with respect to desired or anticipated outcomes, and select and implement an appropriate plan of action (Janis and Mann, 1977).

Krulik and Rudnick (1995) gave a formal definition of a *problem*. It is a situation, quantitative or otherwise, that confronts an individual or group of individuals, that requires resolution, and for which the individual sees no apparent or obvious means of path to obtaining a solution.

Szetela and Nicol in Ibañez (1997), define problem solving as a process of confronting a novel situation, formulating connections between given facts, identifying the goal and exploring possible strategies for reaching the goal. A *problem*, then, is a situation in which the individual initially does not know any algorithm or procedure that will guarantee solution of the problem, but the individual desires to solve it.

Likewise, Krulik and Rudnick (1989) claim that the problem-solving approach provides the link between facts and algorithms on the one hand, and real-life situations on the other. One can teach and learn problem-solving as a skill (Polya 1957).

Problem solving as an educational method has received a good deal of attention. The term *problem-solving* is broad and refers to a complex cognitive activities and skills. Problem-solving involves word-problems, real-world applications, non-routine problems and puzzles, and the creation and testing of mathematical conjectures leading to new discoveries (Branca, 1980).

Siamons (1993) clearly stated that mathematical problem-solving should be an accepted integral part of any mathematics program by the students. On one hand, the teachers should not regard it as an add-on activity requiring little attention. Students should not become over anxious and worried at the prospect of not being able to cope with a problem situation. Given sufficient planning and preparation, this aspect of mathematical learning can be the most rewarding and enjoyable for all concerned.

As stated in the National Council of Teachers of Mathematics (NCTM) in 1989:

> Mathematics problem solving must become central if mathematics education is to respect the nature of the discipline … if we are entrusted in developing the capacity of lifelong learning, so that students can

> explore, create, accommodate to changed conditions, and actively create new knowledge over the course of their lives.

Hadaway (1993) claimed that the primary goal of most students in mathematics classes is to see an algorithm that will give them the answer quickly. Students and parents struggle with and against the idea that the mathematics class can and should involve exposition, conjecturing and thinking. When students struggle with a mathematical word-problem, parents often accuse them of not paying attention in class.

However, Pestel (1993) pointed out that solving a problem requires thinking or "gap-crossing" not just the application of an algorithm; it develops from active intellectual engagement not just passive observation.

Problem-solving integrates all areas of the curriculum since it draws on reading, writing, social studies, economics, science, etc. when developing real world examples. Mathematics across the curriculum helps the marriage of words and numbers, both of which must be understood and processed before a problem can be solved. The subjects of problems can convey information about nearly any topic, and students can learn a variety of facts while they are applying strategies to solve problems. Perhaps most importantly, students acquire the basic problem-solving skills and methods that will serve them well throughout their lives (Bitter, Hatfield, Edwards, 1989).

Tindal (1982) emphasized that in problem-solving, mathematical problems are expressed within the context of a social situation in which the information needed to solve the problem must be identified first and then utilized. Only principles can be applied at this level and the operations of prediction, evaluation, and application are possible. The context within which the problems are expressed may include information unnecessary to solve the problem.

Improving children's problem-solving skills is an important aim of mathematics education. While solving problems, students not only use the mathematical knowledge they have already gained (Wyndhamn ve Saljo, 1997) but also improve their knowledge and understanding for a successful solution. Therefore, problem-solving should be used as the basis for teaching mathematical concepts so that students construct their own knowledge (Peterson, Fennema and Carpenter, 1989).

Chua (1999) is also one with the others in the belief that developing pupils' problem solving skills begins with understanding a given problem. The teacher then has a role in finding ways to help pupils visualize a problem; that is, to transform the given facts/situations in a problem from words to diagrams.

Leaňo (1995) clearly cited a statement about problem-solving from the position of the National Council of Supervisors of Mathematics:

> Learning to solve problems is the principal reason for studying mathematics. Problem-solving is the process of applying previously acquired knowledge to new and unfamiliar situations. Solving word problem in texts is one form of problem-solving, but also should be faced with some textbook problems.
>
> Problem-solving strategies involve posing questions, analyzing situations, translating results, illustrating results, drawing diagrams and using trial and error. In solving a problem, students need to be able to apply the rule of logic necessary to arrive at a valid conclusion. They must be able to determine which facts are relevant. They should be unfearful of arriving at a tentative conclusion, and they must be willing to subject these conclusions to scrutiny.

Students use different processes and skills to solve problems. Baur in Leaňo (1995) presented some skills that are useful to many students:

1. *Ability to understand the meaning of vocabulary and symbols.* A student must have a clear understanding of all vocabularies and symbols presented in a problem situation before the process of solving the problem can be started. This understanding is necessary for the students to get a clear sense of the problem to be solved.
2. *Ability to do basic mathematical computation.* Many problems to be solved are quantitative in nature. This means that the problem solution requires a student to be able to do basic computation even if a calculator is used.
3. *Ability to estimate*. Estimation is a useful tool; often neglected by the classroom teacher. It is useful because it can help students approximate the solution to a problem and may assist in determining which strategy should be used in the process of solution.
4. *Ability to organize and interpret data*. Being able to take the information given in the problem and put it into tables, graphs, or charts may be the key to solving the problem. This skill is also one that has application to everyday life outside of the problem-solving situation.
5. *Ability to test the results of a problem-solving process*. The student must be able to test the adequacy of the results from the problem- solving process. It is difficult, if not possible, to declare that a problem has been solved until the results have been checked for accuracy.
6. *Ability to ask question that yield maximum information*. Asking good questions is very important if a student is to become a good problem- solver. Students must

learn to ask questions that give needed information. Formulating such questions will give the students insight into the problem and enhance the chances of reaching a successful solution.

7. *Ability to design and use different problem-solving strategies*. Many times a student will need more than one strategy to make a given problem. The original technique chosen may reach a dead end for one reason or another, so the student must be able to come up with a different strategy to complete the problem solution.

The above mentioned skills suggest an important role of any mathematics teacher to create the type of classroom environment that will foster good problem- solving behavior. Baur further recommends tips for presenting problems:

1. Present problems that are realistic and interesting to your students.
2. Present problems in an environment where students feel free to explore.
3. Present problems that are appropriate for your students' level of reading, vocabulary, and mathematical understanding.
4. Present problems in more than one medium.
5. Give a summary of the problem after initially presenting the problem.

Newman (1977, 1983) created a procedure for students who have already attempted to solve a mathematics word problem. They are asked a sequence of questions which are aimed at seeing whether they can:

a. read the questions;
b. comprehend what they have read;

c. carry out a mental transformation from the words of the questions to the selection of an appropriate mathematical strategy;

d. apply the *process skills* demanded by the selected strategy; and

e. encode the answer in an acceptable written form.

George Polya (Musser and Burger, 1991), the father of modern problem- solving, developed the four steps in problem-solving approach: a) understand the problem; b) devise a plan; c) carry out a plan; d) look back. To solve a problem, one has to pause, reflect, and perhaps take some original steps never taken before to arrive at a solution.

Keedy (1992) also stated five steps for problem-solving:

1. Familiarize yourself with the problem situation.
    a. Read carefully
    b. Reread the problem and try to verbalize the problem to yourself
    c. List the information given and questions to be answered
    d. Find further information, if necessary
    e. Make table of information given and information collected (look for pattern that may help in the translation to an equation)
    f. Make a drawing and label it with known information and indicate unknown information using specific units, if given
    g. Guess or estimate the answer
2. Translate the problem to an equation – as you study more mathematics, you will find that the translation may be to some other kind of mathematical language, such as inequality.

3. Solve the equation – if the translation is to some other kind of mathematical language, you would carry out some other kind of mathematical manipulation.
4. Check the answer – in original situation, this doesn't mean to check in the translation equations. It means to go back to the original worded problem.
5. State the answer to the problem clearly.

Schwartz and Reisberg (1991) consider problem-solving as a process that can be identified only from the point of view of the learner and not the designer of the task. Thus, a learner-centered approach, can be used in any subject matter domain with any academic task. In line with this, they suggested five problem-solving processes or phases:

1. Problem Identification – this acknowledges that academic tasks must be identified as belonging to a particular subject matter domain before a search of prior knowledge can be initiated.
2. Problem Representation – with a successful memory search and retrieval, the task may be represented in a manner consistent with the way tasks of this particular type are represented in the discipline.
3. Problem Representation – a learner selectively searches memory for procedural knowledge in the form of strategies, procedures, heuristics, algorithms, and the like.
4. Solution Selection – involves planning and trying out ideas.
5. Solution Execution – last phase of successful problem-solving.

Krulik and Rudnik (1995) believe that problem-solving can and should be taught. The process has been analyzed and can be represented as a series of steps, referred to as a heuristic plan, or, simply, *heuristics.* This shows the mental and physical activities that a person engages in when resolving a problem.

Figure 4 on page the next page presents the flowchart of Krulik and Rudnik's problem-solving process.

Figure 4

Flowchart of Krulik and Rudnik's Problem-Solving Process

1. Read and Think → **2. Explore and Plan** → **3. Select a Strategy** → **4. Find an Answer** → **5. Reflect and Extend**

1. Read and Think

1a. Identify the facts.
1b. Identify the question.
1c. Visualize the situation.
1d. Describe the setting.
1e. Restate the action.

2. Explore and Plan

2a. Organize the information.
2b. Is there sufficient information?
2c. Is there too much information?
2d. Draw a diagram or construct a model.
2e. Make a chart, a table, a graph, or a drawing.

3. Select a Strategy

3a. Pattern recognition
3b. Working backwards
3c. Guess and test
3d. Simulation or experimentation
3e. Reduction/Expansion
3f. Organized listing/ Exhaustive listing
3g. Logical deduction
3h. Divide and conquer

4. Find an Answer

4a. Estimate.
4b. Use computational skills.
4c. Use algebraic skills.
4d. Use geometric skills.
(Use a calculator when appropriate.)

5. Reflect and Extend

5a. Check your answer.
*Is the computation correct?
*Is the question answered?
*Is the answer reasonable?
*How does the answer compare with your estimate?
5b. Find alternate solution?
5c. What if …?
5d. Extend to either
*a generalization or
*a mathematical concept.
5e. Discuss the solutions.
5f. Create interesting variations on the original problem.

O'Malley and Chamot (1994) are one in recommending specific problem-solving procedures. These procedures typically take the form of guidelines such as the following five-point checklist:

- Understand the problem.
- Find the needed information.
- Choose a plan.
- Solve the problem.
- Check the answer.

After several educators have attempted to analyze the act of problem- solving and have generated models as a result of these analysis, Suarez (1996) stated that problem-solvers must:

a. be aware of the problem;
b. translate the problem into terms he can handle;
c. generate information and strategies necessary for solving the problem;
d. implement strategies necessary for solving the problem; and
e. evaluate solution for the problem.

With the stated procedures and steps in problem-solving, Musser and Burger (1991) further explained that a problem is usually stated in words, either orally or written. Therefore, to solve a problem, one translates the words into an equivalent problem using mathematical symbols, solves this equivalent problem, and then interprets the answer. It involves several aspects of learning and teaching – how to decode the problem (a reading skill) and how to translate the answer to a meaningful end (a writing skill). Many educators support the technique of having students write the numerical answer in a full sentence. This approach forces students to reflect on their answer as they translate it. It may also provide an opportunity to consider the reasonableness of the answer. Asking students to verify and justify their answers in written form often helps them classify their thinking.

All of these studies share with the study of the present concern on Mathematics.

2.2 RELATED STUDIES

2.2.1 On Language and Mathematics

Otterburn and Nicholson (1976) investigated school children's understanding of a variety of mathematical terms and demonstrated that there were many mathematical words teachers commonly use that children were not able to explain. These results highlight a problem of which many teachers were unaware, but there are dangers in using children's ability to explain words as an absolute measure of their understanding of technical mathematical words, an understanding which clearly may act at different levels. A child may be able to respond to a word without being able to recall it, or to use it without being able to define it.

The study conducted by Otterburn and Nicholson differs from the present study as it deals with the variety of mathematical terms used by mathematics teachers that are not fully understood by students. The present study tackles the instruction of academic language to help the students understand clearly these mathematical terms. Both studies are similar in a way that they are concerned with the role of language in mathematics.

Threlfall (1993) studied the responses made by children aged 7 and 11 to two questions – one requiring the children to name a shape when shown its picture and the other requiring children to identify the shape when given its name. The results suggest that it is considerably more difficult for children to recall the correct vocabulary items associated with a mathematical concept than to respond to it. For example, 91% responded to the word 'pyramid'. In linguistic terms they acted at the productive level by recalling the same word and using it to describe a picture. This research illustrated two levels, receptive and productive, at which a mathematical term can be used within the linguistic dimension and this reflects the knowledge we all have that we can respond to a wider vocabulary than we use ourselves.

The above study of Threlfall is different from the present study. The former focuses on vocabulary associated with mathematical concept while the latter focuses on the acquisition of academic language in mathematics. However, both studies tackle the role of language in mathematics.

In 1995, the Third International Mathematics and Science Survey (TIMSS) measured the mathematics and science achievement of more than 500,000 students from 15,000 different schools in 41 countries. The result was alarming on the part of South Africa considering the poor performance of their students in the Grade 8 category. In this country, Math and Science are taught in English. However, one of the dominant factors for the poor results is charged to *language*. They believe that South African students, and probably many teachers as well, are not able to demonstrate a personal understanding of mathematical and scientific concepts in their own words, relying rather on the superficial repetition of formulaic phrases. For South Africa to increase its technological competitiveness, this is not good enough.

The survey conducted involves achievement of students in mathematics with English as the medium of instruction. The present study deals with the instruction and development of academic language with the objective of gaining better performance in mathematics particularly word-problem solving. Both studies recognize the significant role of language in mathematics teaching and learning. The students' ability to understand and comprehend the language of mathematics leads to better achievement.

Javier (2001) determined the relationship of language proficiency and mental ability and critical thinking and academic achievement of secondary students. Among the variables, language proficiency has the biggest degree of influence on academic achievement. Language proficiency is a vital tool in the students' quest for academic excellence. The study confirms the findings of certain studies that show that language proficiency is really influential not only in the academic achievement of the students but also in their performance in other subject areas.

Javier's study is different from the present study. The former identifies the relationship of language proficiency and academic achievement. The latter is about the acquisition of cognitive academic language proficiency. Both studies are related because they deal with language proficiency.

Several studies conducted decades ago in the different schools of the Philippines about difficulties encountered by students in mathematics revealed that failure to comprehend problems is a major difficulty (Mazon, 1965; Tandinco, 1965; Ramos, 1967; Agustin, 1980; Lingan, 1983).

Likewise, U.S. based studies in the past have the same findings of lack of adequate comprehension in the four fundamental processes that caused errors and wrong answers in mathematics (Harris, 1960; Morton, 1962;Buswell, 1965; Brueckner, 1970).

The above-mentioned studies indicate that good comprehension skills are needed to understand and solve a problem properly. This perennial problem on comprehension is what the present study is trying to address. Both past and recent studies are one in the conclusion that language plays a significant role in mathematics learning.

2.2.2 On Learning Strategies

Learning strategies explain how learners approach a problem, both inside and outside of the classroom. They also involve the cognitive processing learners use in second language acquisition as well as problem solving.

Sotto (1984) determined the relationship between strategies utilized by a group of grade 6 pupils in solving mathematics word-problems and the pupils' socioeconomic status, attitude toward mathematics, and reading comprehension. The findings clearly revealed that: a) problem-solving strategies employed by the pupils were direct computation, trial and error, writing an equation, and drawing/constructing a model; b) the choice of problem-solving strategies was significantly related to the pupils' performance in mathematics word-problem solving; c) SES was significantly related to performance in mathematics word-problem solving; and d) there was a significant relationship between attitude toward mathematics and choice of problem-solving strategies.

The study conducted by Sotto is different from the present study. The former identifies the relationship between strategies used by the students in solving mathematics word-problems and their socioeconomic status, attitude toward mathematics, and reading comprehension whereas the latter focuses on the instruction of learning strategies to assist the students in their process of solving mathematics word-problems. Both studies however, claim that strategies are significant for a successful solution to mathematics word-problem thus, leading also to a better performance**.**

Studies done by Rubin (1987), Oxford (1990), O'Malley and Chamot (1990) and other researchers have considered the language-learning task from the learners' perspective. They found out that if learners could learn how to take control of their own learning, then they can become less dependent on the teacher and can continue to learn even without the presence of the teacher.

The studies conducted by the above-mentioned researchers are similar to the present study as the students are guided to develop their own learning strategies to become independent learners who can work autonomously with their lessons.

Balansay (1993) conducted a study on the language-learning strategies of the precollege students of St. Camillus College Seminary. She discovered that the choice of learning strategies used depends on the type of the learner. High achievers use varied strategies while low achievers are not confident of exploring other strategies.

The study of Balansay focused on the identification of language- learning strategies used by students according to their performance. However, the present study deals with the instruction of learning strategies which students may try and apply in their process of solving mathematical word-problems. Both studies are related as they recognize the significance of learning strategies for better understanding of lessons as well as becoming good problem-solvers.

Leaño (1995) identified the achievement in mathematics among junior high school students of Nueva Vizcaya General Comprehensive High School in terms of the different mathematical skills. The results presented that problem- solving skills ranked last among the different mathematical skills. This was attributed to the students' lack of knowledge of the different problem-solving strategies, heuristics, and approaches in problem solving.

Although the above study dealt with the identification of students' mathematics performance in terms of problem-solving skills, it implies that problem-solving strategies must be learned by the students. The present study suggests instruction of problem-solving strategies that may help students achieve better performance.

Suarez (1996) studied the problem-solving strategies employed by the grade 4 students of Notre Dame of Greater Manila. She found out that: 1) problem-solving strategies employed by the students are direct computation, writing an equation and using a pattern; 2) the process identified from these strategies were identifying the problem, using of relevant data in the problem, identifying the authentic operation/s and solving the problem; 3) the choice of problem-solving strategy was significantly related to the pupils' performance in solving mathematical word-problems.

The study conducted by Suarez is different from the present study. The former focuses on the problem-solving strategies employed by the students while the latter focuses on the instruction of learning strategies and problem-solving strategies. Both are related as they deal with problem- solving strategies.

Reyes (1997) conducted an exploratory study on learning-strategy use of college freshmen and she found out that successful second language learners were aware of the strategies they used and why they used them. Less successful learners, on the other hand, did not know how to choose appropriate strategies for their own language learning needs, although they were able to identify their learning strategies.

Specifically, the High Achiever group favored the frequent use of metacognitive and cognitive strategies, the Average Achiever group preferred the metacognitve and social strategies, and the Low Achiever group frequently used the memory and metacognitive strategies.

Reyes' study focuses on the identification of the learning strategies of students with different learning abilities. The present study identifies and elaborates on those strategies for the students to become best achievers in mathematics. Both studies deal with learning strategies.

Cudia (1997) found out that the utilization of cooperative learning strategies accompanied by appropriate and effective supervisory practices resulted in the better academic achievement in College Algebra. Her study was conducted to the trade technical freshman students of the Nueva Vizcaya State Polytechnic College.

The study conducted by Cudia is different from the present study. The former study focuses on the positive effect of cooperative learning strategies on the students' performance while the latter touches on the different learning strategies that will assist the students in their performance. However, both studies are related as they tackle the utilization of cooperative learning strategies in mathematics.

2.2.3 On Problem Solving

In 1971, Concepcion made a study to determine and analyze the performance of the grade six pupils of Lakan-Dula Elementary School, in Tondo, Manila for the school year 1970-1971. He examined the students' difficulties and errors using a teacher-made test. His study showed that the most crucial problem was the inability of the students to understand the problem. This difficulty was attributed to the *language factor*, particularly poor reading comprehension and inadequate vocabulary. Added to this were the following causes: (a) the students' lack of ability and skills in functional arithmetic and in knowing the meaning and relations of the different quantities, and (b) the failure to recognize the need for further facts not given in the problem but essential to the solution of the problem.

The two studies differ from each other as they focus on different mathematical concerns. Concepcion's study determines and analyzes the performance of grade six students in mathematics. The present study involves acquisition of cognitive academic language proficiency of the grade one students in mathematics. However, they are related as both studies consider language factor as one of the problems encountered by students when dealing with mathematical word-problems**.**

Platon (1977) conducted a similar study with grade six students at Sipocot Central School on February 4, 1977. She utilized a randomly chosen diagnostic test of the "yes-no" type. The results of her study were similar to Concepcion's.

Soto (1985) found a significant relationship between the students' attitude towards Mathematics, their reading comprehension, and their choice of problem-solving strategy. Her study involved the grade six students of the Ateneo de Manila Grade School, school year 1984-1985. It revealed that the tendency of the successful problem-solvers was to write equations. On the other hand, the unsuccessful problem-solvers tended to use trial and error.

The study conducted by Sotto is different from the present study as the former identifies the problem-solving strategies of successful and unsuccessful problem-solvers while the latter elaborates on the problem- solving strategies to become successful problem-solvers. Both studies deal with mathematical problem-solving strategies.

Dube (1988) described how the analysis of the 240 students' responses led to the development of two models for mathematical problem-solving behavior. She studied 240 grade 12 students in the National High School in Papua New Guinea in June 1988. Two of her findings were: (a) one hundred thirty-six of the students in the sample wrote the wrong equation, and b) two hundred thirty-two did not check their solutions. Most of the wrong equations were a result of confusion or lack of understanding, if at all, of the problem.

The study conducted by Dube clearly states the causes of unsuccessful problem-solving while the present study involves the teaching of problem- solving procedures and strategies. Both deal with mathematical problem-solving strategies.

Pepino (1988) studied the problem-solving difficulties of 349 grade five and 348 grade six students of Garcia-Hernandez school district, Division of Bohol, school year 1987-1988. Her study supported the findings of Concepcion, but she identified six other difficulties namely, the students: (a) lack of ability to identify appropriate processes for the situations indicated in the problem, (b) lack of ability to perform the fundamental processes accurately and readily, (c) lack of mastery of the basic facts regarding the fundamental operations, (d) absolute inability to do reflective thinking, (e) failure to arrange numbers in columns correctly, and (f) carelessness.

One of the recommendations she gave was the use of smaller numbers in practice problems to increase the ease of comprehension of the problems and decrease the amount of inaccuracy. The size of numbers may subsequently be increased as the students' skill and ability in dealing with numbers correctly improves.

The study of Pepino is different from the present study as it focuses on the identification of problem-solving difficulties. The present study suggests problem-solving strategies to avoid such difficulties. Both studies deal with mathematical problem-solving.

Wood and Sellers (1991) compared the performance of students using problem-centered instruction for two years against that of students in a problem-centered class for one year, and that of another class which had textbook-based instruction for two years. The duo conducted their study among Caucasian students in Indiana, school year 1990-1991. Their findings exhibited a significant difference between the problem-centered class and textbook-based instruction regarding arithmetic learning, as shown in the result of the standardized achievement test and the arithmetic test. Students of the problem-centered class held stronger beliefs on the importance of finding their own way to solve problems.

The study conducted by Wood and Sellers is different from the present study. The former is on the comparison of students' performance using problem-centered instruction and textbook-based instructions. The latter tackles instruction of problem-solving strategies.

Both studies are related as they find the importance of problem-solving strategies in mathematics.

Ibañez (1997) conducted a study on the competencies of high school students in solving word-problems in physics at the Bataan National School of Arts and Trade during the school year 1995-1996. The results identified four difficulties encountered by the problem-solvers in solving word-problems: a) difficulties in analyzing the problem; b) difficulties in planning the problem- solving process; c) difficulties in the execution of routine operations; and d) difficulties in evaluating/writing answers.

The study of Ibañez differs from the present study as the former deals with the high school students' word-problem solving in physics while the latter studies the grade one students' word-problem solving in mathematics. Both are similar as they consider the teaching of word-problem steps or procedures very significant to help students become good problem solvers.

Lumpas (1977) analyzed the Mathematics error, difficulties, and thought processes of Filipino students who participated in the Third International Mathematics and Science Study (TIMSS) administered in February 1995. The subjects of the study were grade six and first year high school students aged 13 years, from 39 schools. She identified eight error patterns of students in answering open-ended problems: (a) wrong operation, (b) wrong data, (c) incompletely learned concepts, (d) misinterpreted mathematical language and English language deficiencies, (e) incomplete algorithm, (f) defective algorithm, (g) obvious computational errors, and (h) random responses.

Lumpas' study is different from the present study. The former is about errors and difficulties of students in answering open-ended mathematical problems. The latter is about instruction of strategies to avoid errors and difficulties in solving mathematical word-problems. Both deal with mathematical word-problems.

Banawe (1998) assessed the difficulties of pupils in solving word-problems in Mathematics V. The results showed that many students had negative perception about mathematics particularly word-problem solving to the extent of considering the subject as their waterloo. Negative attitude was a factor that causes difficulties.

Banawe's study is different from the present study because of the unique result that negative attitude causes difficulties in word-problem solving. The present study suggests different procedures to avoid difficulties in solving word-problems. However, both studies believe that mathematics instruction must involve the teaching of academic language and learning strategies that may help improve students' word-problem solving skills.

Opiniano (2001) analyzed the errors, difficulties and strategies applied by the intermediate students of Assumption Antipolo when solving mathematical problems for the school year 2000-2001. The findings indicated that:

a) errors revealed inadequate understanding of mathematical concepts;
b) students' solutions reflected errors due to weak analytical skills as seen in the students' failure to distinguish relevant from irrelevant information, relate relevant information to one another, apply previously learned concepts, identify missing information essential to the problem and apply appropriate operations;

c) intermediate students' consistent failure to check the reasonableness of their answers is indicative of their lack of exposure to this step when solving problems;

d) expert problem-solvers have inadequate understanding of mathematical concepts and an organized system of processing information while novice problem-solvers have an inadequate system of processing information and tend to have erroneous system for processing information; and

e) expert and novice problem-solvers favored the following strategies when solving problems – writing an equation, using a formula, and direct computation.

Opiniano's study differs from the present study in its focus, that is, the analyses of errors, difficulties, and strategies applied by the students in solving mathematical problems. The present study elaborates on the strategies and procedures for mathematical problem-solving. Both studies recognize the significance of problem-solving strategies to become expert problem-solvers.

These studies have proven the significant role of language in analyzing and comprehending mathematical word-problems. Learning strategies, on the other hand, are helpful in arriving at accurate and successful solutions to mathematical word-problem solving.

CHAPTER III

METHODOLOGY

This chapter describes the research design used in this study, the phases involved in carrying out the research design, and the instruments used.

3.1 Action Research

Educational research has been "democratized" and is emerging in schools where researchers conduct studies to inform and enhance the teaching pedagogy. Data on daily classroom activities or problems encountered inside the classroom are collected for the main purpose of improving teachers' methodology and approaches as well as enhancing students' attainment.

Action research is a term used for a school-based research carried out by practitioners. It is done to improve the practitioner's practice where the action implies doing or changing something. It is a process in which individual or several teachers collect evidence and make decisions about their own knowledge, performance, beliefs, and effects in order to understand and improve them (Kennedy, 1997).

This study is carried out by the researcher to address concerns about the improvement of students' mathematical word-problem solving through acquisition and development of Cognitive Academic Language proficiency (CALP) using Cognitive Academic Language Learning Approach (CALLA).

Action research as a process was employed in this study and may be considered unique in its kind as the researcher identified the problem, gave treatment to it, and interpreted resulting data that may provide valuable information to teachers about their teaching practices and effects.

Figure 5 on page 67 is a flowchart on the phases of action research (Wiersma, 1995): Phase I – Topic Identification; Phase II – Data Gathering; Phase III – Decision Making; Phase IV – Resulting Action and the added phase by the researcher; Phase V – Analysis and Reporting of Results.

3.1.1 The Research Setting

The research was conducted during the second semester of school year 2004-2005 in Assumption Antipolo. Assumption Antipolo is an exclusive school for girls located at Sumulong Highway, Antipolo, Rizal. It offers basic education and one of its objectives is for students to acquire basic knowledge and develop foundation skills, Gospel values and attitudes and be ready for tertiary education. (Assumption Antipolo Student Handbook 2003).

3.1.2 The Research Subjects

The study included one section of the grade one level comprising of thirty-eight (38) students who are heterogeneously grouped. The researcher chose them on the basis of accessibility and rapport since she was then teaching mathematics in the grade level for the school year 2004-2005.

Thirty-five students underwent formal schooling in the pre-school of Assumption Antipolo and three students from nearby pre-schools. These students use English as their second language.

3.1.3 The Research Instruments

3.1.3.1 Instruments for Determining Language Performance

3.1.3.1.1 School Readiness Tests Result

The School Readiness Tests is a standardized instrument designed to identify learning factors that might interfere with the learning process in a formal education set-up. It is a group test intended to be given by the teacher at the end of the kindergarten (Prep level) or before the third full week of first grade.

The Guidance Office of Assumption Antipolo administered this test during the fourth quarter of the students' pre-school days to determine the tests validity as a screening instrument for in-coming grade one students and to determine the readiness level of the students. The test includes eight separate tests as follows:

1) Vocabulary – Each item requires the student to mark the one out of the three pictures, which corresponds to a word read by the teacher. Essentially, this test measures vocabulary acquired without formal training.
2) Identifying Letters – Each item requires the student to mark the one out of five lower-case letters that corresponds to a letter read aloud by the teacher. This test measures student knowledge of small letters acquired without formal learning.
3) Visual Discrimination – The items on this test require the students to mark the one figure in a row of four that corresponds to the fifth at the beginning of the row. The test calls for visual discrimination using numerals, letters, and geometric designs.
4) Auditory Discrimination – Each item requires the student to mark one of the four identified pictures that rhymes with, or has the same beginning, middle, or ending

sound as that of a word read aloud by the teacher. The test is useful in determining student readiness for formal phonics instruction.

5) Comprehension and Interpretation – Each item requires the student to mark the one out of four pictures which corresponds to a short "story" or directions that are read aloud by the teacher. The test goes beyond pure vocabulary, requiring comprehension and interpretation skills.

6) Number Knowledge - Each item requires the student to mark the numeral or figure called for by specific directions. The test samples number meaning, numeral recognition, recognizing order among numbers, recognizing fractional parts, recognizing common measure of time and money, and informal understanding of applied basic process.

7) Handwriting Ability – Each item requires the student to "draw" a figure matching a preprinted figure. The test utilizes letters, numerals, and geometric figures and generally indicates student readiness for formal instruction in handwriting.

8) Developmental Spelling Ability – Each item requires the student to spell a word read aloud by the teacher. These words contain a representative sample of long and short vowels and a variety of consonants and consonant blends. The test is useful in predicting later student performance in reading.

3.1.3.1.2 Language Grade

The Language grade has the following components: a) Oral Expressions where students are provided with a venue to develop fluency in speaking with proper diction, correct pronunciation and spontaneous organization of thoughts; b) Written

Expression where students apply correct usage of grammar and express thoughts or ideas in written form; c) Unit Tests; and d) Quarterly Tests where students are evaluated on spelling, grammar and sentence construction.

3.1.3.2 Instrument for Determining Mathematics Performance

3.1.3.2.1 Mathematics Grade

The Mathematics Grade has five components: a) Class Standing which includes students' classroom participation like recitation, group activities, compliance with assignments and other written works; b) Speed Tests which evaluate the students' mastery of basic facts; c) Quizzes for immediate evaluation of lessons learned; d) Unit Tests and e) Quarterly Tests for the overall evaluation of the students' acquired knowledge in the subject content.

3.1.3.3 Instrument for Determining Language Learning Strategies Use

3.1.3.3.1 CALLA Language Learning Strategies in Mathematics Questionnaire

This questionnaire was developed by O'Malley and Chamot to identify how students understand and solve Math word-problems (See Appendix A, p. 120). It contains only nine items and is projected to take 5-10 minutes to administer. It has five possible response options namely: A. Never; B. Rarely; C. Sometimes, D. Usually and E. Always.

After the try-out of this questionnaire to another section of the grade level, it was administered to the students before and after CALLA. The researcher explained to the students that the purpose of this questionnaire is to determine the learning strategies they use and apply in dealing with mathematical word-problem solving.

Instructions were read clearly by the researcher and students were given a few minutes to pose questions for clarifications, after which, they answered the questionnaire independently. The students were reminded to accomplish the questionnaire in 10 minutes and a bell would be rung to signal the time. If they finish ahead of time, they would put their paper upside down and wait for the bell. They should pass their paper whether finished or unfinished once the bell was rung.

The results of this questionnaire determined the learning strategies used by the students in a particular language task. They also served as important data in planning and conducting explicit instruction of learning strategies.

3.1.3.4 Other Instruments

3.1.3.4.1 Interview and Think-Aloud Protocols

These are venues where students individually explained and described their process of solving mathematical word-problems. First, the researcher met the students as a group for general directions on how the interview and think-aloud protocols will be conducted. The researcher explained that the students will be called one at a time in the activity room either during the study period or any of their free periods.

To prepare the students, the researcher explained that the purpose of the interview was to ask them to share what they did to solve mathematical word-problems and the strategies they used. They were reminded to use the English language in expressing their thoughts. The eight addition and subtraction word-problems were used so that elicitation questions for strategy use would be clearly focused and understood. A type of strategy was counted as having occurred once each time it was mentioned in the interview.

Students' responses were audio-taped, transcribed, and analyzed for occurrences of learning strategies and for possible information that would answer questions about students' academic language use. Each session was conducted and lasted for twenty to thirty minutes.

By "thinking aloud", the students let their thoughts flow verbally in a stream-of-consciousness manner without trying to control, direct, or observe them (Reyes, 1997). Through modeling, the researcher acquainted the students with the concept of "thinking aloud" as mental process and provided them with a new word-problem for practice.

After each problem was read, the students were asked to tell what they understood, followed by non-directive probe questions as necessary (Reyes, 1997). The questions would encourage the students to generate hypotheses (What do you think the problem is about?); to describe what they based the hypotheses on (What clues/words in the problem helped you?); and to comment on what they thought was the function of the sentences to the overall solution of the word-problem (Can you tell me more?). After this, the students were asked to re-tell the story problem in their own words, allowing them to reread the whole problem.

3.1.3.4.2 Portfolio

This is a collection of students' work and other information that show students' academic language use and learning strategies. The portfolio may include activity sheets, quiz results, written work, learner diary, and Math self-evaluation form (See Appendices B and C, pp. 122 and 123).

3.1.3.4.3 Journal

This is the teacher's daily record of observations regarding students' learning and performance. It may also include important notes on how the students develop academic language and use of learning strategies.

3.2 Phases of the Action Research

PHASE I → **TOPIC IDENTIFICATION**

Observation in Class
Evaluation of Students' Academic Performance

a. Language Use in Mathematical Word-Problem Solving

PHASE II → **DATA GATHERING**

Collect Information from School Records
Conduct Interview
Journal Observations
Collate Questionnaire Results

a. School Readiness Tests Result
b. Language Grade
c. Mathematics Grade
d. Learning Strategies
   d.1. Try-out of Learning Strategies Questionnaire

PHASE III → **DECISION MAKING**

Review CALLA Instruction

a. Use of CALLA in Lesson Instruction

PHASE IV → **RESULTING ACTION**

Prepare Materials Needed for Instruction
Conduct Pre-test and Post-test
Implement CALLA Instruction

a. Selection of Mathematical Word-Problems
b. Development of Scope and Sequence
c. Preparation of Lesson Plan
d. Administration of Pre-Test
   d.1. Interview
   d.2. Think-Aloud Protocols
e. Instruction of Academic Language
f. Instruction of Learning Strategies
g. Administration of Post-Test
   g.1. Interview
   g.2. Think-Aloud Protocols

PHASE V → **ANALYSIS & REPORTING OF RESULTS**

Prepare Statistical Data
Evaluate Results of Language and Strategies Use

a. Academic Language Use
b. Learning Strategies Use
c. Statistical Treatment

Figure 5
The Methodology Framework

3.2.1 Topic Identification

Considering the given fact that most students of Assumption Antipolo are English speakers, the researcher observed that the students' fluency in speaking the English language is not a guarantee of their better performance in any content area. Mathematics is one among those content areas where the students encounter difficulty particularly in word-problem solving. The researcher, being a Mathematics teacher, thought it an interesting study to be undertaken with appropriate treatment. This may improve not only teaching practices but also students' academic performance, in particular.

3.2.2 Data Gathering

3.2.2.1 School Readiness Tests Result

A copy of this was secured from the Guidance Office. The results were grouped according to students' performance in the eight separate tests: Vocabulary, Identifying Letters, Visual Discrimination, Auditory Discrimination, Comprehension and Interpretation, Number Knowledge, Handwriting Ability, and Developmental Spelling Ability.

The percentage of scores of the total average in the eight tests were distributed under the following description:

Superior

Above Average

Average

Below Average

Inferior

3.2.2.2 Language Grade

The Language grades of the students before and after CALLA instruction were obtained from the Language teacher. The first and second quarter grades determined the students' language performance before using CALLA and the third and fourth quarter grades after using CALLA. These grades were grouped according to the subject components. The researcher computed for the percentage of grades according to distribution.

95 – 100 Outstanding

90 – 94 Highly Satisfactory

85 – 89 Satisfactory

80 – 84 Moderately Satisfactory

75 – 79 Needs Improvement

72 – 68 Unsatisfactory

3.2.2.3 Mathematics Grade

The researcher, being the Mathematics teacher, grouped the students' grades according to the subject components. The first and second quarter grades were considered before CALLA instruction. Likewise, the third and fourth quarter grades were considered after the CALLA instruction. The researcher computed for the percentage of grades according to distribution.

95 – 100 Outstanding

90 – 94 Highly Satisfactory

85 – 89 Satisfactory

80 – 84 Moderately Satisfactory

75 – 79 Needs Improvement

68 – 72 Unsatisfactory

3.2.2.4 Learning Strategies Use

The learning strategies used by the students were determined using the CALLA Learning Strategies Questionnaire in Mathematics. The results served as a baseline data to guide the researcher in her explicit instruction of learning strategies.

The frequency of learning strategies use was categorized using a five-point scale:

5 - Always

4 - Usually

3 - Sometimes

2 - Rarely

1 - Never

3.2.2.4.1 Try-out of Learning Strategies Questionnaire

The CALLA Learning Strategies Questionnaire in Mathematics by O'Malley and Chamot was used. It was presented to the grade level teachers for comments or suggestions as regard the words or terms used, the statement of instructions, and if the language used fits the level of the students. The questionnaire was retained and approved for use in the study.

The researcher tried out the questionnaire to the students from another section. Instructions were read to them and the questionnaire was accomplished within ten minutes. The students answered each item with ease and confidence thus, leaving the researcher with no problem.

3.2.3 Decision Making

After collection of pertinent information and assessment of students' performance in Mathematics particularly word-problem solving, the researcher chose an instruction that would address the difficulty of the students. The CALLA instructional Model by O'Malley and Chamot is a significant tool that was used by the researcher in the academic language and learning strategy instruction.

One deciding factor to consider that inspired the researcher to use this instructional model is a study conducted in the same school where the researcher is teaching. The study made by Opiniano in 2001 is about the analyses of errors, difficulties, and strategies applied by the intermediate students of Assumption Antipolo when solving mathematical problems. Though the study dealt more on analyses, the researcher deemed it necessary to address the situation rather than just indentifying the problem.

3.2.4 Resulting Action

Planning, preparation, and implementation are offshoots of the decision to use the CALLA instructional model in this study.

3.2.4.1 Preparation of Lesson Plan

The structured nature of CALLA lesson plan is ideal for the integration of strategy instruction with language development and content skills. This has been proven by several studies when it comes to the linkage between language and content skills. Teachers need to see language as a medium of learning and that they should integrate language development with content learning.

In the lesson plan, the English language was used in an academic context. To teach lessons on solving addition and subtraction problems, the focus of learning strategy use allowed the students to perform the task autonomously. They also recognized the value of cooperative learning and effective group work.

This is different from the usual lesson plan used by the researcher in her daily class as it includes the following:

a. Mathematics Content Objectives

b. Mathematics Problem-Solving Strategies

c. Language Objectives

d. Learning Strategies

e. Materials to Be Used

f. Procedures – Preparation, Presentation, Practice, Evaluation, ‘ Expansion

g. Assessment

The usual lesson plan in mathematics includes only the following:

a. Mathematics Content Objectives

b. Materials to Be Used

c. Procedures – Preparation, Presentation, Practice, Evaluation, Expansion

d. Assessment

A lesson plan model used by the researcher is found in Appendix F on page 129.

3.2.4.2 Selection of Mathematical Word-Problems

Eight mathematical word-problems on addition and subtraction operations were chosen from different resources available like books, textbooks, and the Assumption workbook in Mathematics. Emphasis was on the language use in these problems.

These problems were used for the pre-test and post-test. The pre-test result served as a baseline data to determine the students' level of performance in mathematical word-problems. Post-test was given after the academic language and learning strategies instructions using CALLA. Both results were compared to determine students' progress in solving mathematical word-problems.

The list of mathematical word-problems is found in Appendix D on page 124.

3.2.4.3 Development of Scope and Sequence

This was prepared by the researcher in accordance with the content topic. This is significant as it served as a guide in lesson planning. It provided a description of content, language and learning strategy objectives for each unit or strand, including sample activities, suggested materials, and specific book pages or resources.

The scope and sequence used in this study is found in Appendix E on page 125.

3.2.4.4 Administration of the Pre-Test

The eight mathematical word-problems on addition and subtraction were given to the students to determine their level of performance in mathematical word-problem solving. This was administered by the researcher before academic language and learning strategy instructions.

The researcher let the students answer the problems in two forms. First, they answered them orally where they explained and described their process of solving word-problems. This was audio-taped and transcribed to form a part of the data. Second, to determine the accuracy of their responses, they answered the problems in written form. The researcher studied the students' presentation of answers and process involved in mathematical word-problem solving.

3.2.4.5 Instruction of Academic Language

Like other types of procedural knowledge, academic language should be taught. This involves identifying both authentic language functions (Appendix G, p. 131) and the language skills (Appendix H, p. 132) needed to carry out these functions or tasks. The researcher carried out academic language instruction following O'Mallet and Chamot's procedure:

a. **Modeling** – A mathematical word-problem is presented on the board. The researcher demonstrates how to solve it correctly as the students observe how she uses the academic language. While presenting and explaining the solution, appropriate vocabulary and grammatical structures are used. Students are provided with definitions and examples to clarify meanings after which they are also encouraged to use the same academic language as the researcher uses them.

b. Student Input – Before elaborating on the five steps of solving a problem, students listen to important mathematics words (*added to, sum, put together, deducted from, difference, remove, take away***,** etc**.)** and write them down as they hear them. The purpose in writing down the words is to help the students identify content-specific vocabulary by using the learning strategy ***selective attention.*** While the students are reading the problem, they are also asked to identify new or confusing grammatical structures. They are given time to discuss and explain their understanding of unfamiliar structures with their seatmate.

c. **Listening** – As the researcher gives explanation and lecture on the content topic, students develop good listening skills. They understand and learn by listening attentively. To vary listening activities, the researcher shows filmstrips and CD presentations on word-problem solving. Post-listening discussion is done where students share and describe what they understood and what comprehension difficulties they experienced.

d. **Oral Language -** The researcher provides opportunities for using academic language interactively through cooperative activities. The students are grouped by fives according to class number and are given a task to create a story problem with the given mathematical operation. They take turns in sharing their ideas until they come up with a story. Representatives of the groups share the story to the whole class.

e. Speaking - Students need to develop speaking skills to express their ideas and to ask questions for clarification, for explaining and justifying their answers, and for evaluating their performance. In mathematics problem-solving, the students are given opportunities to explain and justify their solutions. They are asked to go to the board and present their process of solving the problem.

f. **Reading and Writing** – The students read aloud word-problems to be solved and mathematics explanations. They are also asked to write their own word-problem with the given illustration or equation. Reading and writing activities develop students' written academic language.

g. **Thinking Skills –** Higher-level questions are asked by the researcher to develop critical thinking skills. For example, in response to a mathematical word-problem, questions like *Do you think a good solution was found for the problem? How else could she have solved the problem? What would have happened?* These kinds of questions initiate the students to really think and not just to state the facts.

3.2.4.6 Instruction of Learning Strategies

Learning strategies are needed to assist students in their academic language acquisition. Using appropriate learning strategies can facilitate every aspect of academic language learning. Learning useful strategies are beneficial to students in carrying out academic language functions, in the acquisition of discrete language such as academic vocabulary, and integrative language such as listening, reading, speaking and writing.

The selection of strategies taught was in accordance with the instructional task. These are relevant and useful not only on the part of the teachers but also to the students for important classroom activities.

Learning strategies were taught side by side with academic language. As the word-problem solving procedures were discussed, the researcher names the strategy, models how it is used and explains its usefulness or importance. The students will be given time to describe the entire problem-solving process while also demonstrating the strategy applied.

The teacher conducted the instruction of learning strategies following the five-step procedure that is consistent with the five-phases of CALLA.

a. Preparation – The researcher chooses mathematical word-problem as the specific language learning task. The researcher elicits students' prior knowledge on word-problem solving. Their current strategy use is assessed as they try to share and describe their thoughts in solving the given mathematical word-problem.

b. **Presentation** - The researcher teaches the strategy explicitly by modeling how the strategy is used. She thinks aloud as she works through the process of correct problem-solving, giving the strategy a name and referring to it consistently by that name. The researcher explains to the students how the strategy will help them solve. She also describes when, how, and for what kinds of tasks they can use the strategy.

c. **Practice** – At this time, the researcher provides opportunities for strategy practice through cooperative learning. The class is divided into groups of five and is given another set of mathematical word-problem. Following the steps in problem-solving, each student is given the opportunity to use and apply a strategy. Each member is encouraged to report her thinking and solving process aloud for other groups to hear.

d. **Evaluation** – In this phase, the students appraise their success in using the strategies as well as the importance of strategies to their learning. The students write on their notebook the strategies they used and indicate how the strategy worked. They are also guided to compare their own performance on a problem solved with and without using learning strategies. After this, the researcher explains further that learning strategy use differs from one student to another. Students are encouraged to explore more on the use of different strategies.

e. **Expansion** - Follow-up activities are given in a form of assignments, enrichment exercises or activity sheets. The students this time apply the strategies they have learned and take note of their effectiveness. They are also encouraged to use these strategies in their other subjects. (See Appendices I and J on pages 134 to 135 for the Mathematics Learning Strategies and Learning Strategies for Mathematics Word-Problem Solving, respectively.)

3.2.4.7 Administration of the Post-test

To assess students' progress in their performance and to determine if they acquired and developed CALP, a post-test on the eight word-problems was administered. Students' explanations and descriptions of their process of solving was again audio-taped and transcribed. They were also asked to answer the problems in written form to determine the accuracy of their answers.

The researcher made a comparative evaluation of the pre-test and post-test as regards language use and learning strategies use. It is at this point when successful solution to word-problems is determined.

3.2.5 Analysis and Reporting of Results

3.2.5.1 Academic Language Use

Based on the comparative analysis of the pre-rest and the post-test on the students' process of solving mathematical word-problems, a scoring rubric with a scale of 0 - 4 was used. The results were tabulated and subjected to statistical treatment and analysis.

4 = Student can explain the process used to solve the problem and go the correct answer.

3 = Student can explain the process used to solve the problem but made a computation error.

2 = Student is unable to explain the problem-solving process but got the correct answer.

1 = Student approached the problem but was unable to get the answer correct or explain the problem-solving process.

0 = No obvious strategy to solve the problem and did not get the correct answer.

3.2.5.2 Learning Strategies Use

The students were asked to answer again the Learning Strategies Questionnaire in Mathematics. The result was compared and analyzed with the answers to the same questionnaire given before CALLA instruction.

The answers were tabulated and subjected to statistical treatment to elicit the same strategies with similar tasks.

3.2.5.3 Statistical Treatment

The following statistical treatment was used in this study.

1. Percentage computation of students' language grade, mathematics grade, and results of school readiness test
2. Frequency count and percentage of test responses in an item-by-item mode of the learning strategies questionnaire
3. Mean for Grouped Data

   Formula: $\frac{X}{N} = \Sigma fM$

Where: X = the mean
M = the midpoint
fM = the product of the frequency and midpoint
N = the total number of cases

CHAPTER IV

PRESENTATION, ANALYSIS AND INTERPRETATION OF DATA

This chapter discusses the presentation, analysis and interpretation of data which answer the problems of the study. The presentation of data follows the order in which the questions are stated in Chapter 1. Tables are used to illustrate the findings of the study.

Question Number 1. What is the language performance of the students before and after using CALLA as measured by:

A. Interview and Think-Aloud Protocols

In general, the researcher observed anxiety in the behavior of the students while they were explaining their process of solving the word-problems before CALLA instruction. This may be due to their limited vocabulary and insufficient knowledge of correct grammar use. It was also their first experience to have their voice recorded while explaining their thoughts. However, one positive behavior is their willingness to try explaining their process of solving the problems. In spite of their difficulty to use correct terms in explaining what they understood about the problems, they did not hesitate to talk.

The instruction of CALLA developed the students' academic language use. The researcher observed that the students acquired the language skills in mathematics as they improved in their manner of speaking. They became spontaneous in explaining their process of solving word-problems as well as in giving their answers to the problems. Concerns on correct grammar and syntax were also addressed as the students were provided with venues and opportunities to speak their thoughts, either orally or in writing. They understood oral word-problems and were able to read mathematical explanations correctly.

However, one remarkable insight is the use of “code switching” or first language by one student in explaining her process of solving the word-problems. She was very confident and spontaneous in her explanation using the first language and the mathematical computation of answers was also very accurate.

Below is a sample transcript of the students’ interview and think-aloud protocols before and after CALLA instruction.

Table 3
Sample Transcript from Interview and Think-Aloud Protocols
Before and After CALLA

Question: What do you understand about the problem? What will you do to solve it?

(S1, S2, S3 – student 1, student 2, student 3)

Before Instruction of CALLA		After Instruction of CALLA
Addition Problems		
Problem 1 – Ana collected 16 dolls and brought it to Liza’s house who had 19 dolls. How many dolls did they both play with?		
S1 – Add…Ana collected 16 and Liza bring 19.	→	I put together the dolls of Ana and Liza so they have 35.
S2 – I understand is how many dolls. Ana…16 and Liza ….19	→	16 plus 19 equals 35 dolls in all. I added because it says how many.

S3 – Ahh…dolls…16 and 19 → Ana has 16 and Liza has 19. I add them and they have 35 dolls in all.

<u>Problem 2</u> – Jerry found 23 coins in his mother's drawer. He asked her if he could have them. Mother said yes and gave him 34 more. How many coins did Jerry have in all?

S1 - coins… Jerry…23…mother give 34. Add them all. → The story is about Jerry with 23 coins. Mother gave him 34 so he has 57 coins.

S2 – Jerry coins, 23. Mother coins, 34. How many in all? Fifty-seven. → Jerry asked permission to have 23 coins of mother and mother added 34 more. He has… he had 57 coins in all.

S3 - Drawer is 23 coins….mother give 34…57 in all. → In the drawer are 23 coins of mother. Jerry asked mother to have them and mother is very good…She gave 34 more. Jerry had 57 coins in all.

<u>Problem 3</u> – Daniel owns 21 books and his friend Martha has 69 books in her house. If we put them together, how many books would they have in all?

S1 - How many books….21 and 69 are 90. → Put together means add. If Daniel has 21 books and Martha has 69, they have 90 books in all.

S2 – Daniel and Martha play. They play with 21 and 69 books. → I added the books of Daniel and Martha and the total is 90.

S3 - Books…21…69….who (*how*) many in all? → How many books in all? Add 21 and 69 and you get the answer.

<u>Problem 4</u> – Samantha gathered 14 flowers for Mama Mary and her sister Denise gathered 18 flowers. How many flowers will the statue of Mama Mary have?

S1 – Mama Mary…flowers….14 Samantha and 18 Denise…. → Samantha got 14 flowers and Denise got 18 flowers, too. I put them all together and Mama Mary will have (*thinks)*…

S2 – Statue….standing…not moving 14 flowers and 18 flowers…add → Mama Mary will have 32 flowers when I add 14 and 18.

S3 – Bulaklak…kumuha si Samantha at Denise. → Pagsamahin po yun nakuha ni Denise ng labing-apat at *eighteen* si Samantha na bulaklak at ibigay kay Mama Mary lahat.

Subtraction Problems

Before Instruction of CALLA	**After Instruction of CALLA**

Problem 5 – Frances has 64 crayons in her box. Daniel borrowed 18 pieces. How many crayons are left in Frances' box?

S1 - Frances 64….Daniel 18 subtract… → How many are left? I will subtract… 64 minus 18 equals…..

S2 – Daniel borrow 18…minus 64 of Frances → Frances has 64 and gave 18 to Daniel so minus the numbers.

S3 – Left in the box….minus → To know the number of crayons in the box of Frances, get 18 from 64.

Problem 6 – In a small plate of cookies, there are 58 pieces. Daniel and Anne ate 19 cookies. How many were left on the plate?

S1 - cookies…58 in the plate and 19 was ate by Daniel and Anne… subtract them → Subtract 19 cookies that Daniel and Anne ate from 58 cookies on the plate.

S2 – cookies…like brownies…58 and 19…minus → If there are 58 cookies and Daniel and Anne ate 19, remove 19 so there will be left cookies.

S3 – Who (*How*) many left? Means remove…58 and 19 → 58 minus 19 equals the number of cookies left on the plate….because Daniel and Anne ate 19.

Problem 7 - Anton collected 80 toy soldiers in his room. He gave 46 to his poor neighbor. How many toy soldiers were left with him?

S1 – toy soldiers…my brother has… 80 and gave 46…so…remove	→	Anton collected 80 toy soldiers. 46…he gave to the poor…80 minus 46…
S2 – When you collect, you put in a a box so Anton has 80 toy soldiers. How many left?	→	Anton has 80 toy soldiers and he gave 46 to the neighbor who is poor. Subtract, 80 minus 46.
S3 - means…how many toy soldiers.. gave to the poor…46	→	80 minus 46 because Anton collected 80 and gave 46 to the poor

Problem 8 – Martha has 28 sheets of paper for drawing. She gave her 5 seatmates one each. How many sheets were left for Martha?

S1 – 28 papers…and…5 each…minus	→	Solve for the sheets of paper of Martha. 28 minus 5 equals 23.
S2 – drawing…I can draw dolls. Martha…28…gave 5…remove	→	Martha gave 5 papers and she has 28 in all. So I will subtract and I get….eight minus five five is…equals…three….23.
S3 – May papel po si Martha at binigyan ang mga katabi… bibilangin ang naiwan.	→	Si Martha ay may labing walo na papel na ginagamit sa drawing at binigyan ang kaklase ng tig-iisa. Lima po sila kaya ibawas sa labing walo. Ang natira ay labing tatlo.

Different samples of the students' written answers to the eight word-problems are found in Appendix K on page 139.

B. Final Grades

The Language grades were obtained from the Language teacher. These were computed by getting the overall average of the components: Oral Expressions, Written Expressions, Unit Tests and Quarterly Test. The first and second quarter grades were taken before

CALLA and the third and fourth quarter grades were considered after CALLA. The researcher computed for the frequency and percentage of grades according to distribution.

Table 4 below illustrates the research participants' language performance.

Table 4
Frequency and Distribution of the Research Participants' Degree of Language Performance Based on the Language Grade Before and After CALLA

PERFORM-ANCE	NUMERIC GRADE EQUI-VALENT	BEFORE CALLA				AFTER CALLA			
		FIRST QTR.		SECOND QTR.		THIRD QTR.		FOURTH QTR.	
		NO. OF STUDS.	PERCENT-AGE	NO. OF STUDS.	PERCENT-AGE	NO. OF STUDS.	PERCENT-AGE	NO. OF STUDS.	PERCENT-AGE
O	95 – 100	4	10.53	4	10.53	7	18.42	4	10.53
HS	90 – 94	15	39.47	15	39.47	8	21.05	15	39.47
S	85 – 59	11	28.95	12	31.58	6	15.79	8	21.05
MS	80 – 84	6	15.79	6	15.79	11	28.95	8	21.05
NI	75 – 79	2	5.26	1	2.63	6	15.79	3	7.89
U	68 – 72	-	-	-	-	-	-	-	-
T O T A L		38	100	38	100	38	100	38	100

Legend: O - Outstanding
HS - Highly Satisfactory
S - Satisfactory
MS - Moderately Satisfactory
NI - Needs Improvement
U - Unsatisfactory

As a whole, the students' language performance before and after using CALLA is satisfactory. A large number is grouped within the brackets of satisfactory categories: *Highly*

Satisfactory or numeric grade equivalent of 90-94 is 39.47% on both first and second quarters before CALLA, and 31.05% and 39.47% on the third and fourth quarters, respectively, after CALLA; *Satisfactory* or numeric grade equivalent of 85-89 is 28.95% on the first quarter and 31.58% on the second quarter before CALLA, and 15.79% on the third quarter and 21.05% on the fourth quarter after CALLA; *Moderately Satisfactory* or numeric grade equivalent of 80-84 is 15.79% on both first and second quarters before CALLA, then 28.95% on the third quarter and 21.05% on the fourth quarter after CALLA .

The data shows that the students posses the language skills needed for academic demands in the grade level. However, a decline of 10.16% in the students' performance from Satisfactory to Moderately Satisfactory during the third quarter was marked due to the level of difficulty of lessons. The grammar lesson focused on preposition which is one of the most difficult parts of speech. It is significant to note that improvement in the Language performance of students may take place if the students have fully acquired and developed cognitive academic language proficiency.

The Mathematics grades are composed of five components: Class Standing, Speed Tests, Quizzes, Unit Tests and Quarterly Tests. The researcher computed for the frequency and percentage of grades according to distribution. The first and second quarter grades were taken before CALLA and the third and fourth quarter grades were considered after CALLA.

Table 5 shows the research participants' mathematics performance.

Table 5
Frequency and Distribution of the Research Participants' Degree of Mathematics Performance Based on the Mathematics Grade Before and After CALLA

PERFORM-ANCE	NUMERIC GRADE EQUI-VALENT	BEFORE CALLA				AFTER CALLA			
		FIRST QTR.		SECOND QTR.		THIRD QTR.		FOURTH QTR.	
		NO. OF STUDS.	PERCENT-AGE	NO. OF STUDS.	PERCENT-AGE	NO. OF STUDS.	PERCENT-AGE	NO. OF STUDS.	PERCENT-AGE
O	95 – 100	-	-	1	2.63	-	-	-	-
HS	90 – 94	9	23.68	4	10.53	1	2.63	3	7.89
S	85 – 59	12	31.58	15	39.47	11	28.95	10	26.32
MS	80 – 84	9	23.68	4	10.53	14	36.84	10	26.32
NI	75 – 79	8	21.06	11	28.95	12	31.58	11	28.95
U	68 – 72	-	-	3	7.89	-	-	4	10.52
T O T A L		38	100	38	100	38	100	38	100

Legend: O - Outstanding
HS - Highly Satisfactory
S - Satisfactory
MS - Moderately Satisfactory
NI - Needs Improvement
U - Unsatisfactory

As a whole, the students' mathematics performance before and after CALLA is satisfactory. A large number is grouped within the bracket of satisfactory categories: *Highly Satisfactory* or numeric grade equivalent of 90-94 is 23.68% for the first quarter and 10.53% for the second quarter before CALLA, and 2.63% for the third quarter and 7.89% for the fourth quarter after CALLA; *Satisfactory* or numeric equivalent of 85-89 is 31.58% for the first quarter and 39.47% for the second quarter before CALLA, and 28.95% for the third quarter and 26.32% for the fourth quarter after CALLA; *Moderately Satisfactory* or numeric equivalent grade of 80-84 is 23.68% for the first quarter and 10.53% for the second quarter before CALLA, and 36.84% for the third quarter and 26.32% for the fourth quarter after CALLA.

C. School Readiness Tests Result

The School Readiness Tests Result was obtained from the Guidance Office. It was computed by getting the general average of the test results in the eight areas, namely: Vocabulary, Identifying Letters, Visual Discrimination, Auditory Discrimination, Comprehension and Implementation, Number Knowledge, Handwriting Ability, and Developmental Spelling Ability.

Table 6 shows the students' language performance based on these data.

Table 6
Frequency and Distribution of the Research Participants' Degree of Language Performance Based on the Results of School Readiness Tests

PERFORMANCE	NO. OF PARTICIPANTS	PERCENTAGE
Superior	7	18.42%
Above Average	7	18.42%
Average	10	26.32%
Below Average	11	28.95%
New Students	3	7.89%
TOTAL PARTICIPANTS	38	100%

As a whole, the students' language performance based on the above results is average. A large number are grouped within the brackets of average categories: *Above Average* is 18.542%; *Average* is 26.32%, and *Below Average* is 28.9%. The remarkable percentage of *below average* indicates that the students falling on this bracket need to be guided in their learning process. Likewise, content area teachers must be made aware of the areas where the students scored low as these may be the factors that might interfere with their learning process in the formal education set-up.

There are three new students who did not take the above mentioned test. They represent 7.89% of the total number of participants.

Question Number 2. What is the status of the academic language use of students before and after using CALLA as measured by mathematical word-problems?

The students' academic language use was analyzed based on the results of the pre-test and post-test on the eight mathematical word-problems. As discussed in the gathering of data phase of the methodology framework, the students were asked to explain and describe their process of solving word-problems to determine if they have developed their language skills. Solutions to the same word-problems were shown in written form and these substantiated developed skills in mathematical word-problem solving. A scoring rubric with the scale of 4-0 was used to determine the research participants' performance:

4 = Student can explain the process used to solve the problem and got the correct answer.

3 = Student can explain the process used to solve the problem but made a computation error.

2 = Student is unable to explain the problem-solving process but got the correct answer

1 = Student approached the problem but was unable to get the answer correct or explain the problem-solving process.

0 = No obvious strategy to solve the problem and did not get the correct answer.

On the next pages are Tables 7 and 8 presenting the tabulated data of pre-test and post-test results.

Table 7
Frequency and Distribution of the Research Participants' Degree of Academic Language Use in the Eight Mathematical Word-Problems Before CALLA

WORD	4		3		2		1		0	
PROBLEMS	f	%	f	%	f	%	f	%	f	%
Addition										
1	9	23.68	9	23.68	13	34.21	7	18.43	-	-
2	15	39.47	3	7.89	13	34.21	7	18.43	-	-
3	13	34.21	6	15.79	12	31.58	6	15.79	1	2.63
4	13	34.21	4	10.53	12	31.58	8	21.05	1	2.63
Subtraction										
5	6	15.79	11	28.95	2	5.26	18	47.37	1	2.63
6	5	13.16	14	36.84	4	10.53	13	34.21	2	5.26
7	8	21.05	11	28.95	3	7.89	15	39.48	1	2.63
8	16	42.11	5	13.16	13	34.21	2	5.26	2	5.26

The data clearly exhibits that the students' ability to explain their process of solving mathematical word-problems largely depends on their understanding of the words used in each word-problem. Some students, however, are good in written mathematical computation only. The problems on addition have these results: 1) 34.21% of the students were unable to explain the problem-solving process but got the correct answer; 2) 39.47% could explain the process used to solve the problem and got the correct answer although 34.21% were unable to explain the process but got the correct answer; 3) 34.21% could explain the process used and got the correct answer while 31.58% were unable to explain the process but got the correct answer; and 4) 34.21% could explain the process used and got the correct answer while 31.58% were unable to explain the process but got the correct answer.

The subtraction problems are difficult for the students to explain and solve. This suggests mastery of the basic skills in subtraction operation. The results show that: 5) 47.37% tried to solve the problem but were unable to get the correct answer or explain the problem-solving process; 6) 36.84% could explain the process used to solve the problem but made a computation error although 34.21% tried to solve the problem but were unable to get the correct answer or explain the process; 7) 39.48% tried to solve the problem but were unable to get the answer correct or explain the process and 8) 42.11% could explain the process used to solve the problem and got the correct answer although 34.21% were unable to solve the process but got the correct answer.

It is remarkable to note that some students could explain the process used to solve the problems but made a computation error due to carelessness and the use of inappropriate symbol or operation sign.

Table 8
Frequency and Percentage of the Research Participants' Degree of Academic Language Use in the Eight Mathematical Word-Problems After CALLA

WORD PROBLEMS	4		3		2		1		0	
	f	%	f	%	f	%	f	%	f	%
Addition Problems										
1	29	76.32	4	10.53	-	-	5	13.15	-	-
2	32	84.21	2	5.26	-	-	4	10.53	-	-
3	32	84.21	3	7.89	-	-	3	7.89	-	-
4	33	86.85	2	5.26	-	-	3	7.89	-	-
Subtraction Problems										
5	13	34.21	24	63.16	-	-	1	2.63	-	-
6	15	39.47	22	57.90	-	-	1	2.63	-	-
7	13	34.21	23	60.53	-	-	2	5.26	-	-
8	36	94.74	1	2.63	-	-	1	2.63	-	-

The students' language use after the instruction of academic language marked a very high improvement. The students became spontaneous in their explanation of the process of word-problem solving, and correct grammar use was also evident. Comprehension was developed as they also learned the different language functions and skills.

The results on addition problems in Table 8 show that: 1) 76.32% could explain the problem-solving process and got the correct answer; 2) and 3) 84.21% could explain the process in solving the problem and got the correct answer; and 4) 86.85% could explain the process and got the correct answer. Likewise, the students became accurate in their mathematical computation of addition problems. Few students, however, tried to approach the problem but were unable to get the correct answer or explain the problem-solving process. This calls for more exposure to similar problems and venues where they can improve or develop their academic language.

The subtraction problems became easier for the students to explain. However, computation error is still a problem with several students. This is because of their weakness in regrouping skills. It is also important to consider the fact that even if subtraction and addition are inverse operations, subtraction is generally more difficult to master than addition.

On the same table, the students' performance in subtraction problems show that: 5) 97.37% could explain the process used to solve the problem but 63.16% got a computation error; 6) 97.37% could explain the process used but 57.90% got a computation error; 7) 94.74% could explain the process but 60.53% got a computation error; and 8) 94.74% could explain the process and got the correct answer.

Question Number 3. What CALLA learning strategies do students use in solving mathematical word-problems?

The researcher computed the frequencies and percentages of test responses in an item-by-item mode before and after using CALLA. Students' item-by-item mode was analyzed in terms of absolute and cumulative frequencies and percentages (See Appendices L and M). Possible response options are defined as follows: (A.) "NEVER" means that the statement is not at all true of you; that is, you do not do the behavior which is described in the statement; (B.) “RARELY” means that the statement is usually not true of you; that is, you seldom do the behavior which is described in the statement; (C.) “SOMETIMES” means that the statement is true of you about half the time; that is, on some occasions you do the behavior which is described in the statement, on some occasions you don’t and these instances tend to occur with about equal frequency; (D.) “USUALLY” means that the statement is habitually true of you; that is, you do the behavior as described in the statement more than half the time; and (E.) “ALWAYS” means that the statement is true of you in all instances; that is, you do the behavior as described in the statement continually.

To determine whether the strategy represented in each item is used or not, the mean (with A translated into 1, B into 2, C into 3, D into 4, and E into 5) is also calculated. Averaging the responses to create means implies that the data are of interval level. This can be justified to some extent by the definitions of terms as shown above, with “sometimes” being the midpoint represents half the time, “rarely” and “usually” represents less than and more than half the time, respectively, and “never” and “always” speak for themselves. The means were computed on the 38 cases which had complete data for all items on the CALLA Learning Strategies Questionnaire for Mathematics.

This procedure is important on the part of the researcher to be aware of the students’ language learning strategies. It also motivated the researcher to plan and present instruction to improve language teaching and problem-solving skills.

Table 9 presents the mean of each item and the response option before learning strategies instruction.

Table 9
Item Mean and Response Option
Before and After Learning Strategies Instruciton

Question Number	STRATEGY	MEAN		RESPONSE OPTION	
		Before Instruction	After Instruction	Before Instruction	After Instruction
1	Selective Attention	3.58	4.53	Usually	Always
2	Negative Strategy	2.13	1.29	Rarely	Never
3	Planning	3.52	4.53	Usually	Always
4	Cooperation	3.08	3.6	Sometimes	Usually
5	Elaboration	3.47	4.32	Sometimes	Usually
6	Planning	3.87	4.53	Usually	Always
7	Imagery	3.55	3.63	Usually	Usually
8	Self-Evaluation	3.23	4.68	Sometimes	Always

The result of this mean response options are linked to the CALLA Learning Strategies Questionnaire for Mathematics items as follows:

<u>Before Learning Strategies Instruction</u>

- No item had a mean response option of "never", although this response option was chosen by some students for particular strategies.
- One item had a mean response of "rarely": 2, If I don't understand a word, I stop working on the problem.

- Three items had a mean response of “sometimes”: 4, If possible, I work on the problem with some students; 5, I remember how I solved other problems like this one; 8, I check my answer after I solve the problem.
- Four items had a mean response of “Usually”: 1, When I read the problem, I look for the important information; 3, I make a plan of what to do; 6, I use problem solving steps; 7, I draw a picture or chart to help solve the problem.
- No item had a mean response option of “always”, although this response option was also chosen by some students for particular strategies.

The number nine item is an open question where students can write other things they do to solve word problems in mathematics. Some answers are related to the above mentioned items while other students use different strategies. Below are sample answers:

a. count fingers, skip count, count in paper
b. draw in the mind*
c. think harder/ solve in the mind*
d. read the problem as a story to myself*
e. translate the problem in Pilipino*
f. just write answer even if wrong

<u>After Learning Strategies Instruction</u>

- One item had a mean response option of “never”: 2, If I don’t understand a word, I stop working on the problem.
- No item had a mean response option of “rarely” although this response option was chosen by some students for particular strategies.

- No item had a mean response option of “sometimes” although this response option was also chosen by some students for particular strategies.
- Three items had a mean response of “usually”: 4, If possible, I work on the problem with some students; 5, I remember how I solved other problems like this one; 7, I draw a picture or chart to help solve the problem.
- Four items had a mean response of “always”: 1, When I read the problem, I look for the important information; 3, I make a plan of what to do; 6, I use problem solving steps; 8, I check my answer after I solve the problem.

Students’ answer to number nine are similar to those stated before instruction of learning strategies. This means that the students found it helpful to use these strategies:

a) translate the problem in Pilipino;
b) draw lines/bars to represent given data;
c) seek help from parents, tutor or sister; think hard and understand the problem well;
d) re-tell the story to oneself; and
e) solve in the mind.

It is very evident that the students generally improved in their learning strategies. They became autonomous learners and better problem-solvers. However, it is noted that one item falls on the same response option “usually” although, the mean increased from 3.55 to 3.63. This is item 7, Draw a Picture or Chart to Solve the Problem. Students need to develop more on this strategy because visualization helps in a clearer understanding of the problem.

To determine the percentage of students who used such kind of strategy, the researcher computed the frequencies and percentages of responses on an item-by-item mode using the CALLA Learning Strategies Questionnaire Mathematics Key (Appendix N). Table 10 and Table 11 on the succeeding pages present, respectively, the computed data before and after learning strategies instruction.

Table 10
Item Frequencies and Percentages of Responses
Before Learning Strategies Instruction
Using the CALLA Learning Strategies Questionnaire
Mathematics Key

	RESPONSES									
STRATEGIES	A Never		B Rarely		C Sometimes		D Usually		E Always	
	f	%	f	%	f	%	f	%	f	%
Planning – Q3	1	2.63	10	26.32	6	15.78	10	26.32	29	28.95
Q6	3	7.90	4	10.53	6	15.78	7	18.42	18	47.37
Selective Attention - Q1	8	21.15	-	-	10	26.32	2	5.26	18	47.37
Self-Evaluation – Q8	5	13.16	9	23.69	9	23.69	2	5.26	13	34.20
Elaboration – Q5	4	10.52	4	10.52	11	28.95	8	21.06	11	28.95
Imagery – Q7	7	18.42	2	5.26	7	18.42	7	18.42	15	39.48
Cooperation – Q4	10	26.32	4	10.52	7	18.42	7	18.42	10	26.32
Negative Strategies – Q2	20	52.63	2	5.26	11	28.95	1	2.63	4	10.53

From the table above, the researcher found out that: 76.32% use Planning Strategies broken down as 28.95% for question 3 and 47.37% for question 6; 47.37% use Selective Attention; 34.20% use Self-Evaluation; 28.95% use Elaboration although the same percentage of students use the strategy "sometimes"; 39.48% use Imagery; 26.32% use Cooperation and the same percentage of 26.32% "never" use this strategy; and 52.63% do not use Negative Strategies.

Table 11
Item Frequencies and Percentages of Responses
After Learning Strategies Instruction
Using the CALLA Learning Strategies Questionnaire
Mathematics Key

STRATEGIES	RESPONSES									
	A Never		B Rarely		C Sometimes		D Usually		E Always	
	f	%	f	%	f	%	f	%	f	%
Planning – Q3	-	-	-	-	7	18.42	4	10.53	27	71.05
Q6	-	-	-	-	7	18.42	4	10.53	27	71.05
Selective Attention - Q1	-	-	-	-	6	15.79	6	15.79	26	68.42
Self-Evaluation – Q8	-	-	-	-	3	7.90	6	15.79	29	76.31
Elaboration – Q5	-	-	1	2.63	8	21.05	7	18.42	22	57.90
Imagery – Q7	3	7.90	5	13.16	8	21.05	9	23.68	13	34.21
Cooperation – Q4	5	13.16	3	7.90	9	23.68	6	15.79	15	39.47
Negative Strategies – Q2	27	71.05	5	13.16	6	15.79	-	-	-	-

From the table above, 71.05% use Planning Strategies in both question 3 and question 6; 68.42% use Selective Attention; 76.31% use Self-Evaluation; 57.90% use Elaboration; 34.21% use Imagery; 39.47% use Cooperation and 71.05% don't use negative strategy.

The use of strategies according to rank are: first, Self-Evaluation – 76.31%; second, Planning Strategies and don't use Negative Strategies – both 71.05%; third, Selective Attention - 68.42%; fourth, Elaboration - 57.90%; sixth, Cooperation - 39.47% and seventh, Imagery – 34.21%.

It is a positive result in that based on the above data, the students discovered and used the best strategies to solve mathematical word-problems easily and practically.

Think-Aloud Protocols

Although the data gathered on learning strategies from think-aloud protocols is sparse, their contribution to the study cannot be discounted. The researcher noted the strategies used by the students as they were explaining their process of problem- solving. Each strategy is tallied once regardless of the number of times mentioned by the student.

Table 12 on the next page exhibits the frequency and distribution of the research participants' strategy use from think-aloud protocols before and after instruction of learning strategies.

Table 12
Frequency and Distribution of the Research Participants' Learning Strategy Use from Think Aloud Protocols On the Eight Mathematical Word-Problems Before and After Instruction Learning Strategies

LEARNING STRATEGIES	FREQUENCY		PERCENTAGE	
	Before Instruction	After Instruction	Before Instruction	After Instruction
Selective Attention	110	180	29.26	29.27
Negative Strategy	20	4	5.31	0.65
Planning	85	177	22.61	28.78
Cooperation	15	30	3.99	4.87
Elaboration	49	75	13.03	12.20
Imagery	52	88	13.83	14.31
Self-Evaluation	45	61	11.97	9.92
TOTAL	376	615	100	100

The table above clearly exhibits that the students acknowledged the significance of learning strategies in solving mathematical word-problems. The rank of each learning strategy use before and after CALLA, respectively, are as follows: first, Selective Attention – 29.26% and 29.27%; second, Planning – 22.61% and 28.78%; third, Imagery – 13.83% and 14.31%; fourth, Elaboration – 13.03% and 12.20%; fifth, Self-Evaluation – 11.97% and 9.92%; sixth, Cooperation – 3.99% and 4.87%; and seventh, Negative Strategies – 5.31% and 0.65%.

To develop the students' academic language skills, cooperation strategy may be recommended. The students, while working with their classmates, will have the chance to express themselves orally and likewise, paying attention to their classmates' explanations develops listening skills. They will also learn how to take down important notes that are helpful in their process of word-problem solving.

Self-evaluation is another strategy for the students to consider. Evaluating one's process is helpful not only for the improvement of mathematical skills but also academic language skills.

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATION

This chapter presents the summary, conclusion and recommendation of the study.

5.1 Summary

This study aimed to determine the applicability of Cognitive Academic Language Learning Approach (CALLA) towards the acquisition of Cognitive Academic Language Proficiency (CALP) in Mathematics. Specifically, this study determined the research participants' language performance, mathematics performance, academic language use and learning strategy use before and after CALLA.

The methodology in this study utilized the four phases of an action research and an added phase by the researcher: Phase I – Topic Identification; Phase II – Data Gathering; Phase III – Decision Making; Phase IV – Resulting Action and Phase IV – Analysis and Reporting of Results.

The **topic identification** was inspired by the researchers' classroom observation and experience on the students' use of the English language and its effect in their mathematics performance. Difficulties encountered by students particularly in mathematical word-problem solving can be brought by inability to understand the language of mathematics thus, the researcher thought it necessary to do an action for the improvement of students' performance and teaching practices as well.

The **data gathering** included students' performance data, students' feedback tools, students' portfolios, and teacher's self-reflection tools in the form of rating scale and questionnaire, and journalizing.

The **decision making** involved previous studies on the analyses of errors, difficulties, and strategies on word-problem solving. The results of these studies led the researcher to an insightful idea that the limitations involve specific treatment to address difficulties in mathematical word-problem solving. This study is an attempt to give treatment to such concern of teachers and learners.

The **resulting action** was the adoption of O'Malley and Chamot's CALLA instructional model. This included instructions of academic language and learning strategies. Pre-test and post-test on eight mathematical word-problems were given to gain comparative results of performance.

The **analysis and reporting of results** gave a general view of the effectiveness of CALLA on the acquisition of CALP. Results were tabulated and subjected to statistical treatment for interpretation and analysis.

<u>Results</u>

1. The language performance of the students before CALLA was determined using two instruments: a) First and Second Quarter Language Grades – the students' performance generally falls on the satisfactory categories with a large number grouped on the Highly Satisfactory category or a numeric equivalent of 90-94; and b) School Readiness Tests

Result where the students' performance fell on the Average categories with a large number grouped under Below Average.

Students' performance after CALLA was determined by the third and fourth quarter grades in Language. The students maintained their performance as satisfactory with a large number falling under the Highly Satisfactory or a numeric equivalent of 90-94%.

2. The mathematics performance of the students before and after CALLA was determined using the Mathematics Grade. The students' performance fell on the Satisfactory categories with a large number grouped under Satisfactory or numeric equivalent of 85-89 before CALLA, and Moderately Satisfactory or numeric grade equivalent of 80-84 after CALLA.
3. The academic language use by the students based on pre-test and post-test marked a positive result. The students highly improved in articulating and explaining the process used to solve mathematical word-problems. They also improved in their mathematical computation thus, minimizing computation error.
4. The learning strategies aided students in understanding content lessons. The following strategies, arranged according to rank guided the students in their mathematical word-problem solving: 1st) Self-Evaluation, 2nd) Planning, 3rd) Selective Attention, 4th) Imagery, 5th) Elaboration and 6th) Cooperation.

5.2 Conclusion

The following conclusions were drawn based on the significant results gathered:

1. The CALLA instructional model was effective in the acquisition and development of cognitive academic language proficiency of the students.
2. Language and Mathematics performances of the students improved side by side with academic language and learning strategy use.
3. The academic language instruction helped students achieve better understanding of content lessons. The students became spontaneous in explaining their thoughts particularly the process used in solving mathematical word-problems.
4. The learning strategies made students autonomous learners as they were able to do their tasks even without teacher's supervision. Learning was also made easy as they were guided with steps and procedures that led them to correct mathematical computations.
5. Think-aloud activities honed students' cognitive thinking and developed language skills as they were provided with venues to express their thoughts.
6. Other strategies like ***code switching, self-correction, asking questions for clarification, note taking*** and ***making illustrations*** were considered effective strategies in comprehending a problem. This implies that strategy use also relied on the students' prior knowledge and experience.
7. The teacher has a significant role in providing second language learners with opportunities to facilitate their own learning, which they can apply in different content areas.
8. The teacher's varied teaching techniques and learning activities motivated students to experiment with a wide variety of learning strategies.

5.3 Recommendations

The following recommendations are presented based on the conclusions mentioned:

For School Administrators

1. It is helpful if school administrators especially in the primary level will consider CALLA as an instructional model to develop cognitive academic language proficiency of students.
2. The school administrators must train their teachers in the execution of CALLA in different content areas.
3. The school administrators must require teachers to incorporate academic language and learning strategies in the syllabus.

For Curriculum Developers

1. The curriculum developers in the primary and secondary levels must consider CALLA in the curriculum to further enhance academic language proficiency.
2. Instruction on academic language and learning strategies must be a part of the curriculum so that teachers will be equipped with necessary knowledge of strategies which will become a part of their teaching practices.
3. The curriculum developers from different content areas can adopt the CALLA curriculum of O'Malley and Chamot.

For Language Teachers

1. Language teachers must understand the role of language in mathematics so that they will be guided on what English structures will be given emphasis in their lessons.

2. They must work collaboratively with other content-area teachers and make plans for the development of academic language.
3. They must have regular articulation with other content-area teachers to determine students' progress in academic language use.

For Mathematics Teachers

1. Mathematics teachers must use CALLA as an instructional model, thus must be trained on how to execute instruction on academic language use and learning strategy use.
2. They must keep updated on recent studies and issues in effective mathematics teaching and new approaches in mathematical word-problem solving.
3. They must start asking insightful and probing questions to help students develop academic language and critical thinking rather than giving restricted and formulaic responses.
4. They must provide varied teaching and learning techniques where students can articulate their thoughts and apply appropriate learning strategies.

For Textbook Writers

1. Textbook writers from all disciplines can develop materials that include activities honing academic language and applying learning strategies.
2. They must provide varied activities where students are challenged to become creative and critical learners.

For Future Researchers

1. They must consider longitudinal studies on the development of cognitive academic language proficiency using CALLA.
2. They must try conducting the same study in an exclusive boys' school and find out how the learners acquire cognitive academic language proficiency.
3. A true-experimental design using two groups must be conducted for future studies as an offshoot of the present study.

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Appendix A

CALLA LEARNING STRATEGIES QUESTIONNAIRE
FOR MATHEMATICS

(This part will be read and explained by the researcher.)

Introduction:

The CALLA Learning Strategies Questionnaire is designed to gather how you go about solving word problems in mathematics. Below, you will find 8 statements related to how you read, understand, and solve a word problem in math class. Please read each statement carefully. Circle the words that tell what you do. The last number asks you to indicate other things you do to solve word- problems in mathematics. This questionnaire will take about 5-10 minutes to accomplish. THERE ARE NO RIGHT OR WRONG ANSWERS.

A. Never
B. Rarely
C. Sometimes
D. Usually
E. Always

NEVER means that the statement is not at all true of you; that is, you do not do the behavior which is described in the statement.

RARELY means that the statement is usually not true of you; that is, you seldom do the behavior which is described in the statement.

SOMETIMES means that the statement is true of you about half the time; that is, on some occasions you do the behavior which is described in the statement, on some occasions you don't and these instances tend to occur with about equal frequency.

USUALLY means that the statement is habitually true of you; that is, you do the behavior as described in the statement more than half the time.

ALWAYS means that the statement is true of you in all instances; that is, you do the behavior as described in the statement continually.

Name ____________________________________ Date_________________

1. When I read the problem, I look for important information (words and numbers) to solve the problem.

   Never Rarely Sometimes Usually Always

2. If I don't understand a word, I stop working on the problem.

   Never Rarely Sometimes Usually Always

3. I make a plan of what to do.

   Never Rarely Sometimes Usually Always

4. If possible, I work on the problem with other students.

   Never Rarely Sometimes Usually Always

5. I remember how I solved other problems like this one.

   Never Rarely Sometimes Usually Always

6. I use problem-solving steps (such as: Understand the Question, Find the Data, Make a Plan, Find the Answer, and Check Back).

   Never Rarely Sometimes Usually Always

7. I draw a picture or chart to help solve the problem.

   Never Rarely Sometimes Usually Always

8. I check my answer after I solve the problem.

   Never Rarely Sometimes Usually Always

9. What other things do you do to solve word-problems in mathematics?
   (You are free to indicate as many answers as you can.)

   ____

   ____

APPENDIX B

LEARNER DIARY

Name ____ Date ___________________

This week I studied ____

____

This week I learned ____

____

This week I used English in these places ____

____

This week I spoke English with these people ______________________________________

____

This week I made these mistakes ____

____

This is difficult for me ____

____

I would like to know____

____

My plan for learning and practicing for next week is_________________________________

____

APPENDIX C

MATH SELF-EVALUATION FORM

Name ____ Date _______________

These are two important things I learned in Math this week:

1. ____

____

2. ____

____

This is an easy problem for me:

This is a difficult problem for me:

I need more help with:____

____

This is what I feel about Math this week: (Circle the words that are true.)

successful	confused	relaxed
interested	bored	excited
happy	worried	upset

This is where I got help this week: (Circle the words that are true.)

my teacher	my friend	my classmate	my parents

APPENDIX D

LIST OF MATHEMATICAL WORD-PROBLEMS
USED IN THE PRE-TEST AND POST-TEST

ADDITION:

1. Ana collected 16 dolls and brought them to Liza's house who had 19 dolls. How many dolls did Ana and Liza both play with?

2. Jerry found 23 coins in his mother's drawer. He asked her if he could have them. Mother said yes and gave him 34 more. How many coins did Jerry have in all?

3. Daniel owns 21 books and his friend Martha has 69 books in her house. If we put them together, how many books would they have in all?

4. Samantha gathered 14 flowers for Mama Mary and her sister Denise gathered 18 flowers. How many flowers would the statue of Mama Mary have?

SUBTRACTION:

5. Frances has 64 crayons in her box. Daniel borrowed 18 pieces. How many crayons are left in Frances' box?

6. In a small plate of cookies, there are 58 pieces. Daniel and Anne ate 19 cookies. How many were left on the plate?

7. Anton collected 80 toy soldiers in his room. He gave 46 to his poor neighbor. How many toy soldiers were left with Anton?

8. Martha has 28 sheets of paper for drawing. She gave her 5 seatmates one each. How many sheets were left for Martha?

APPENDIX E

SAMPLE LESSON PLAN MODEL USED BY THE RESEARCHER

Topic: Solving Addition Problems

Mathematics Content Objectives:

- Find the sum of whole numbers in a problem situation.
- Apply knowledge of addition in writing problems.

Mathematics Problem-Solving Strategies:

Use a five-point problem-solving procedure to:

- state the question in a problem in own words
- find the data needed to solve a problem
- formulate a plan and an appropriate solution strategy
- implement a solution strategy
- evaluate the reasonableness of an answer

Language Objectives:

- Describe one's own problem-solving procedures
- Read and write problems
- Write word-problems

Learning Strategies:

Demonstrate the following strategies:

- elaboration of prior knowledge
- selective attention
- imagery
- organizational planning
- cooperation
- self-evaluation

Materials:

- pictures
- different objects
- writing materials
- chalk and chalkboard

PROCEDURES:

Preparation 1: What Do You Know About Problem-Solving?

As a springboard, the researcher asks the students to work in pairs or small groups to count objects in the classroom and use the information to develop addition problems on the board. She leads discussion of what the students have written to identify the structure of addition problems by pointing out the numbers to be added (addends) and the sum. She writes a simple word problem on the board and asks students to solve it and to describe how they solved it.

The following sample problems were used.

1. Inside the classroom, there are 5 chairs in the first group, 6 chairs in the second group, and 4 chairs in the third group. How many chairs are there in the three groups?

2. Twelve students are wearing red clips and fifteen students are wearing white clips. How many students in all are wearing hair clips?

The researcher discusses student problem-solving procedures, identifies steps used to solve problem, and writes them on the board grouped into the following five-point checklist.

QUESTION – Understand the question.
DATA - Find the data needed to solve the problem.
PLAN – Develop a plan to solve the problem.
ANSWER – Solve the problem following the plan.
CHECK – Check back to see if the answer was correct.

She discusses what students already know about addition, about the language used in addition, and about problem-solving steps. She stresses that it is important to use their knowledge about addition and about problem-solving.

Presentation 1: Using the Five-Point Checklist to Solve Problem

The researcher reminds students that after ***understanding the question*** and ***finding the data*** in a word-problem, they need to ***make a plan***. She explains that one type of plan is ***making a picture in your mind*** or actually ***drawing a picture***. She writes a word-problem with a strong visual component on the board.

Example:

Martha counted 30 colorful butterflies in the Eco Park.
Andrea counted 20 more butterflies than Martha.
How many butterflies did Andrea and Martha count in the Eco Park?

Individual students will be called to come to the board and (1) underline the question, and (2) rewrite the question as a statement, leaving a blank for the answer. She asks all students to form in their minds a picture of Martha and Andrea with the butterflies they counted. She asks two students to draw a model diagram (block diagram) to represent the butterflies collected by Martha and Andrea. She lets students draw what they see in their notebook and label with the correct number.

Learning strategy instruction: Using the word problem on the board, the researcher names, models and explains usefulness of using ***imagery*** or *making a picture* to solve word-problems.

She calls on a student to complete the solution of the problem on the board by going through the remaining parts of the five-point checklist (***solve the problem*** and ***check back***), then asks the student to describe the entire problem-solving procedure.

Practice 1: Plan What To Do: Draw a Picture

Students complete word-problems by first rewriting the question, then planning what to do by drawing a picture to represent the problem. After working on the problems individually, students work in small groups to share drawings and discuss how they used ***imagery*** to solve their problems.

Preparation 2: What Do You Know About Writing Problems?

The researcher this time leads a discussion about how word-problems are structured, elicits from students and writes on the board the main parts: story or situation, data, and question. Students brainstorm ideas for word problems, and the researcher notes their ideas on the board.

Presentation 2: Planning a Word Problem

Learning strategy instruction: Using some of the ideas written on the board, the researcher names, models and explains usefulness of o***rganizational planning*** as preparation for writing. She explains how to use this strategy to develop and write word-problems, challenges students to create problems that are neither too easy nor too difficult for their classmates to solve. She suggests that adding extra information or data to the problems may increase their difficulty.

Practice 2: Write Your Own Problems

Students use *organizational planning* to develop word-problems involving addition. Students work in small groups, take turns to read their word-problems aloud while other group members write down information needed to solve each problem and solve it.

Evaluation: Complete a Learning Log on Solving Addition Problem

Students complete a learning log identifying what they have learned in the unit, including concepts, vocabulary, problem-solving procedures, language, and learning strategies. The researcher leads a class discussion of Learning Logs, asking students to describe verbally their problem-solving strategies and encouraging students to share different ways of solving problems.

Expansion: Find Out More About Addition Problems

The researcher conducts debriefing discussion of what has been learned. Students work beyond the immediate problem to apply what they have learned to a new situation. Students bring addition problems in class that they experienced in other content classrooms or in their home. They solve problems using the five problem-solving steps by writing them on a piece of paper or in their notebooks.

APPENDIX F

ACADEMIC LANGUAGE FUNCTIONS

Academic Language Functions	Student Uses Language to:	Examples
1. Seek Information	observe and explore the environment; acquire information; inquire	Use who, what, when, where, and how to gather information
2. Inform	identify, report, or describe information	Recount information presented by teacher or text, retell a story or personal experience
3. Compare	describe similarities and differences in objects or ideas	Make/explain a graphic organizer to show similarities or contrasts
4. Order	sequence objects, ideas, or events	Describe/make a timeline, continuum, cycle, or narrative sequence
5. Classify	group objects or ideas according to their characteristics	Describe organizing principle(s), explain why A is an example and B is not
6. Analyze	separate whole into parts; identify relationships and patterns	Describe parts, features, or main idea of information presented by teacher or text
7. Infer	make inferences; predict implications; hypothesize	Describe reasoning process (inductive or deductive) or generate hypothesis to suggest causes or outcomes
8. Justify and Persuade	give reasons for an action, decision, point of view; convince others	Tell why A is important and give evidence in support of a position
9. Solve Problems	define and represent a problem; determine solution	Describe problem-solving procedures; apply to real life problems and describe

Academic Language Functions	Student Uses Language to:	Examples
10. Synthesize	combine or integrate ideas to form a new whole	Summarize information cohesively; incorporate new information into prior knowledge
11. Evaluate	assess and verify the worth of an object, idea, or decision	Identify criteria, explain priorities, indicate reasons for judgment, confirm truth

APPENDIX G

LANGUAGE SKILLS REQUIRED IN MATHEMATICS

	Grades		
Language Skills	**1 – 3**	**4 – 6**	**7 – 12**
LISTENING			
1. Understand explanations without concrete referents.	L	P	M
2. Understand oral numbers.	M	M	M
3. Understand oral word problems.	M	P	L
READING			
1. Understand specialized vocabulary.	L	P	M
2. Understand explanations in the textbook.	L	P	M
3. Read mathematical explanations.	L	P	M
4. Understand word problems.	P	M	M
SPEAKING			
1. Answer questions.	M	M	M
2. Ask questions for clarification.	M	M	M
3. Explain problem-solving procedures.	M	M	M
4. Describe applications of math in other content areas.	M	P	P
WRITING			
1. Write verbal input numerically.	M	P	P
2. Write word problems.	P	P	L
3. Write words for number sentences.	M	P	L

less emphasis	**partial emphasis**	**more emphasis**
L		**M**

Source: O'Malley, M. and Chamot, A. 1994. The CALLA Handbook: Implementing the Cognitive Academic Language Learning Approach. USA: Addison-Wesley Publishing Company, p. 228.

APPENDIX H

LEARNING STRATEGIES FOR MATHEMATICS

METACOGNITIVE STRATEGIES:	Students plan, monitor and evaluate their learning of mathematics concepts and skills.
Advance Organization	What's my purpose for solving this problem? What is the question? What will I use the information for?
Selective Attention	What words or ideas cue the operation?
Organizational Planning	What plan will help solve the problem? Is it a multiple-step plan?
Self-monitoring	Does the plan seem to be working? Am I getting the answer?
Self-Assessment	Did I solve the problem/answer the question? How did I solve it? Is it a good solution? If not, what could I do differently?
COGNITIVE STRATEGIES:	Students interact with the information to be learned, changing or organizing it either mentally or physically.
Elaborating Prior Knowledge	What do I already know about this topic or type of problem? What experiences have I had that are related to this? How does this information relate to other information?
Taking Notes	What's the best way to write down a plan to solve the problem? Table? Chart? List? Diagram?
Grouping	How can I classify the information? What is the same and what is different?
Making Inferences	Are there words I don't know that I must understand to solve the problem?

Using Images	What can I draw to help me understand and solve the problem? Can I make a mental picture or visualize this problem?
SOCIAL/AFFECTIVE STRATEGIES:	Students interact with others to assist learning, or use attitudes and feelings to help their learning.
Questioning For Clarification	What help do I need? Who can I ask? How should I ask?
Cooperating	How can I work with others to answer the question or solve the problem?
Self-talk	Yes, I can do this task – what strategies do I need?

APPENDIX I

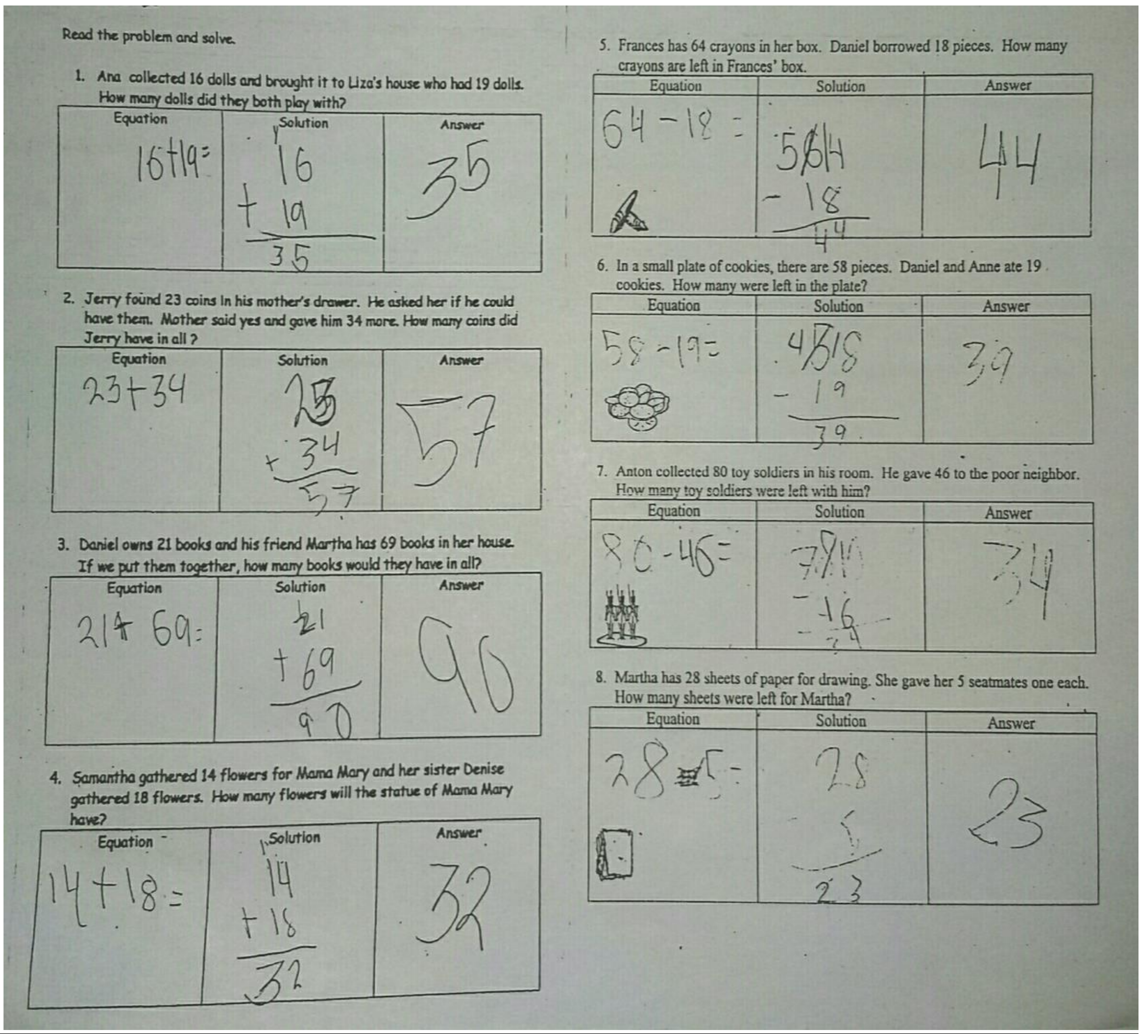
LEARNING STRATEGIES FOR MATHEMATICS PROBLEM-SOLVING STEPS

Problem-Solving Steps	Learning Strategy
1. Understand the Problem	Elaboration
	Imagery
	Inferencing
	Summarizing
	Cooperation
2. Find the Needed Information	Selective Attention
3. Choose a Plan	Prediction
	Imagery
4. Solve the Problem	Cooperation
5. Check the Answer	Self-Evaluation
	Cooperation

APPENDIX J

SAMPLE WRITTEN ANSWERS of STUDENTS
to the EIGHT MATHEMATICAL WORD PROBLEMS

Student 1 : Pre-Test


Read the problem and solve.

1. Ana collected 16 dolls and brought it to Liza's house who had 19 dolls. How many dolls did they both play with?

Equation	Solution	Answer
16+19=	16 + 19 = 35	35

2. Jerry found 23 coins in his mother's drawer. He asked her if he could have them. Mother said yes and gave him 34 more. How many coins did Jerry have in all ?

Equation	Solution	Answer
23+34	23 + 34 = 57	57

3. Daniel owns 21 books and his friend Martha has 69 books in her house. If we put them together, how many books would they have in all?

Equation	Solution	Answer
21+ 69=	21 + 69 = 90	90

4. Samantha gathered 14 flowers for Mama Mary and her sister Denise gathered 18 flowers. How many flowers will the statue of Mama Mary have?

Equation	Solution	Answer
14+18=	14 + 18 = 32	32

5. Frances has 64 crayons in her box. Daniel borrowed 18 pieces. How many crayons are left in Frances' box.

Equation	Solution	Answer
64 − 18 =	64 − 18 = 44	44

6. In a small plate of cookies, there are 58 pieces. Daniel and Anne ate 19 cookies. How many were left in the plate?

Equation	Solution	Answer
58 − 19=	58 − 19 = 39	39

7. Anton collected 80 toy soldiers in his room. He gave 46 to the poor neighbor. How many toy soldiers were left with him?

Equation	Solution	Answer
80 − 46=	80 − 46 = 34	34

8. Martha has 28 sheets of paper for drawing. She gave her 5 seatmates one each. How many sheets were left for Martha?

Equation	Solution	Answer
28 − 5=	28 − 5 = 23	23

Student 1: Post-Test

Read the problem and solve.

1. Ana collected 16 dolls and brought it to Liza's house who had 19 dolls. How many dolls did they both play with?

Equation	Solution	Answer
16 dolls + [illegible] = N	[illegible] 35 dolls	They played 35 dolls in all.

2. Jerry found 23 coins in his mother's drawer. He asked her if he could have them. Mother said yes and gave him 34 more. How many coins did Jerry have in all?

Equation	Solution	Answer
23 coins + 34 coins = N	23 coins + 34 coins = 57 coins	Jerry's coins are total of 57 coins.

3. Daniel owns 21 books and his friend Martha has 69 books in her house. If we put them together, how many books would they have in all?

Equation	Solution	Answer
21 books + 69 book = N	21 books + 69 books = 90 book	If we put it together the books are 90 pieces.

4. Samantha gathered 14 flowers for Mama Mary and her sister Denise gathered 18 flowers. How many flowers will the statue of Mama Mary have?

Equation	Solution	Answer
14 flowers + 18 flowers N	14 + 18 = 32	The statue of Mama Mary will have 32 flowers.

5. Frances has 64 crayons in her box. Daniel borrowed 18 pieces. How many crayons are left in Frances' box.

Equation	Solution	Answer
64 crayons - 18 crayons = N	64 - 18 = 46 crayons	The crayons that was left with Frances are 46 crayons.

6. In a small plate of cookies, there are 58 pieces. Daniel and Anne ate 19 cookies. How many were left in the plate?

Equation	Solution	Answer
58 cookies - 19 cookies = N	58 cookies - 19 cookies = 39 cookies	The cookies that was [illegible] 39 cookies

7. Anton collected 80 toy soldiers in his room. He gave 46 to the poor neighbor. How many toy soldiers were left with him?

Equation	Solution	Answer
80 - 46 = N	80 - 46 = 34	The soldier that was left to him are 34

8. Martha has 28 sheets of paper for drawing. She gave her 5 seatmates one each. How many sheets were left for Martha?

Equation	Solution	Answer
28 - 5 = N	28 - 5 = 23	Martha's paper that was left is 23.

Student 2: Pre-Rest

Read the problem and solve. 10/1/17

1. Ana collected 16 dolls and brought it to Liza's house who had 19 dolls. How many dolls did they both play with?

Equation	Solution	Answer
16+19=	16 + 19 = 35	35

2. Jerry found 23 coins in his mother's drawer. He asked her if he could have them. Mother said yes and gave him 34 more. How many coins did Jerry have in all?

Equation	Solution	Answer
23+34=	23 + 34 = 57	57

3. Daniel owns 21 books and his friend Martha has 69 books in her house. If we put them together, how many books would they have in all?

Equation	Solution	Answer
21+69=	21 + 69 = 90	90

4. Samantha gathered 14 flowers for Mama Mary and her sister Denise gathered 18 flowers. How many flowers will the statue of Mama Mary have?

Equation	Solution	Answer
14+18=	14 + 18 = 32	32

5. Frances has 64 crayons in her box. Daniel borrowed 18 pieces. How many crayons are left in Frances' box.

Equation	Solution	Answer
64-18=	64 - 18 = 46	46

6. In a small plate of cookies, there are 58 pieces. Daniel and Anne ate 19 cookies. How many were left in the plate?

Equation	Solution	Answer
58-19=	58 - 19 = 39	39

7. Anton collected 80 toy soldiers in his room. He gave 46 to the poor neighbor. How many toy soldiers were left with him?

Equation	Solution	Answer
80-46=	80 - 46 = 34	34

8. Martha has 28 sheets of paper for drawing. She gave her 5 seatmates one each. How many sheets were left for Martha?

Equation	Solution	Answer
28-5=	28 - 5 = 23	23

Student 2: Post-Test

Read the problem and solve.

1. Ana collected 16 dolls and brought it to Liza's house who had 19 dolls. How many dolls did they both play with?

Equation	Solution	Answer
16+19=N	16 +19 = 35	They both play 35 dolls

2. Jerry found 23 coins in his mother's drawer. He asked her if he could have them. Mother said yes and gave him 34 more. How many coins did Jerry have in all ?

Equation	Solution	Answer
23+34=N	23 +34 = 57	Jerry have 57 coins in all.

3. Daniel owns 21 books and his friend Martha has 69 books in her house. If we put them together, how many books would they have in all?

Equation	Solution	Answer
21+69=N	21 +69 = 90	They would have 90 book in all.

4. Samantha gathered 14 flowers for Mama Mary and her sister Denise gathered 18 flowers. How many flowers will the statue of Mama Mary have?

Equation	Solution	Answer
14+18=N	14 +18 = 32	There will have 32 flower of the statue of Mama Mary.

5. Frances has 64 crayons in her box. Daniel borrowed 18 pieces. How many crayons are left in Frances' box.

Equation	Solution	Answer
64-18=N	5 ~~6~~ 14 -18 = 46	46 crayons will be left with Frances.

6. In a small plate of cookies, there are 58 pieces. Daniel and Anne ate 19 cookies. How many were left in the plate?

Equation	Solution	Answer
58-19=N	4 ~~5~~ 18 -19 = 39	39 cookies will be left in the paper plate.

7. Anton collected 80 toy soldiers in his room. He gave 46 to the poor neighbor. How many toy soldiers were left with him?

Equation	Solution	Answer
80-46=N	7 ~~8~~ 10 -46 = 34	34 soldiers were left with him.

8. Martha has 28 sheets of paper for drawing. She gave her 5 seatmates one each. How many sheets were left for Martha?

Equation	Solution	Answer
28-5=N	28 - 5 = 23	23 sheets were left for Martha.

Appendix K

ITEM FREQUENCIES AND PERCENTAGES OF RESPONSES
Before Learning Strategies Instructions
CALLA Language Learning Strategies for Mathematics

Question 1 – Look for Important Information

	Frequency (f)	Percentage (%)	Cumulative Frequency (f)	Cumulative Percentage (%)
Never	8	21.05	8	21.05
Rarely	0	-	8	21.05
Sometimes	10	26.32	18	47.37
Usually	2	5.26	20	52.63
Always	18	47.37	38	100

Question 2 – Stop Working on the Problem

	Frequency (f)	Percentage (%)	Cumulative Frequency (f)	Cumulative Percentage (%)
Never	20	52.63	20	52.63
Rarely	2	5.26	22	57.89
Sometimes	11	28.95	33	86.84
Usually	1	2.63	34	89.47
Always	4	10.53	38	100

Question 3 – Make a Plan

	Frequency (f)	Percentage (%)	Cumulative Frequency (f)	Cumulative Percentage (%)
Never	1	2.63	1	2.63
Rarely	10	26.32	11	28.95
Sometimes	6	15.78	17	44.73
Usually	10	26.32	27	71.05
Always	11	28.95	38	100

Question 4 – Work with Other Students

	Frequency (f)	Percentage (%)	Cumulative Frequency (f)	Cumulative Percentage (%)
Never	10	26.32	10	26.32
Rarely	4	10.52	14	36.84
Sometimes	7	18.42	21	55.26
Usually	7	18.42	28	73.68
Always	10	26.32	38	100

Question 5 – Remember How to Solve Other Problem

	Frequency (f)	Percentage (%)	Cumulative Frequency (f)	Cumulative Percentage (%)
Never	4	10.52	4	10.52
Rarely	4	10.52	8	21.04
Sometimes	11	28.95	19	49.99
Usually	8	21.06	27	71.05
Always	11	28.95	38	100

Question 6 – Use Problem Solving Strategies

	Frequency (f)	Percentage (%)	Cumulative Frequency (f)	Cumulative Percentage (%)
Never	3	7.90	3	7.90
Rarely	4	10.53	7	18.43
Sometimes	6	15.78	13	34.21
Usually	7	18.42	20	52.63
Always	18	47.37	38	100

Question 7 – Draw a Picture or Chart

	Frequency (f)	Percentage (%)	Cumulative Frequency (f)	Cumulative Percentage (%)
Never	7	18.42	7	18.42
Rarely	2	5.26	9	23.68
Sometimes	7	18.42	16	42.10
Usually	7	18.42	23	60.52
Always	15	39.48	38	100

Question 8 – Check Answers After Solving

	Frequency (f)	Percentage (%)	Cumulative Frequency (f)	Cumulative Percentage (%)
Never	5	13.16	5	13.16
Rarely	9	23.69	14	36.85
Sometimes	9	23.69	23	60.54
Usually	2	5.26	25	65.80
Always	13	34.20	38	100

Appendix L

ITEM FREQUENCIES AND PERCENTAGES OF RESPONSES
After Learning Strategies Instruction
CALLA Language Learning Strategies for Mathematics

Question 1 – Look for Important Information

	Frequency (f)	Percentage (%)	Cumulative Frequency (f)	Cumulative Percentage (%)
Never	-	-	-	-
Rarely	-	-	-	-
Sometimes	6	15.79	7	15.79
Usually	6	15.79	12	31.58
Always	26	68.42	38	100

Question 2 – Stop Working on the Problem

	Frequency (f)	Percentage (%)	Cumulative Frequency (f)	Cumulative Percentage (%)
Never	27	71.05	27	71.05
Rarely	5	13.16	32	84.21
Sometimes	6	15.79	38	100
Usually	-	-	-	-
Always	-	-	-	-

Question 3 – Make a Plan

	Frequency (f)	Percentage (%)	Cumulative Frequency (f)	Cumulative Percentage (%)
Never	-	-	-	-
Rarely	-	-	-	-
Sometimes	7	18.42	7	18.42
Usually	4	10.53	11	28.95
Always	27	71.05	38	100

Question 4 – Work with Other Students

	Frequency (f)	Percentage (%)	Cumulative Frequency (f)	Cumulative Percentage (%)
Never	5	13.16	5	13.16
Rarely	3	7.90	8	21.06
Sometimes	9	23.68	17	44.74
Usually	6	15.79	23	60.53
Always	15	39.47	38	100

Question 5 – Remember How to Solve Other Problem

	Frequency (f)	Percentage (%)	Cumulative Frequency (f)	Cumulative Percentage (%)
Never	-	-	-	-
Rarely	1	2.63	1	2.63
Sometimes	8	21.05	9	23.68
Usually	7	18.42	16	42.10
Always	22	57.90	38	100

Question 6 – Use Problem Solving Strategies

	Frequency (f)	Percentage (%)	Cumulative Frequency (f)	Cumulative Percentage (%)
Never	-	-	-	-
Rarely	-	-	-	-
Sometimes	7	18.42	7	18.42
Usually	4	10.53	11	28.95
Always	27	71.05	38	100

Question 7 – Draw a Picture or Chart

	Frequency (f)	Percentage (%)	Cumulative Frequency (f)	Cumulative Percentage (%)
Never	3	7.90	3	7.90
Rarely	5	13.16	8	21.06
Sometimes	8	21.05	16	42.11
Usually	9	23.68	25	65.79
Always	13	34.21	38	100

Question 8 – Check Answers After Solving

	Frequency (f)	Percentage (%)	Cumulative Frequency (f)	Cumulative Percentage (%)
Never	-	-	-	-
Rarely	-	-	-	-
Sometimes	3	7.90	3	7.90
Usually	6	15.79	9	23.69
Always	29	76.31	38	100

APPENDIX M

CALLA LEARNING STRATEGIES QUESTIONNAIRE
MATHEMATICS KEY

STRATEGY	CONTENT AREA ITEM NUMBER
Planning	3; 6
Selective Attention	1
Self-Evaluation	8
Elaboration	5
Imagery	7
Cooperation	4
Negative Strategies	2
TOTAL	8

APPENDIX N

Curriculum Vitae

of

Rachel D. Balansay–Agcaoili
118 Ipil Street, Marikina Heights
Marikina City, Philippines

Religion: Roman Catholic

Interest: Reading and Cooking

EDUCATION:

2005 Master of Arts in Education
with specialization in English Language Teaching
Philippine Normal University - Manila

1993 Graduate Certificate in English Language Teaching
Philippine Normal University - Manila

1983 Bachelor of Science in Commerce
Major in Accounting
St. Louis University - Baguio City

WORK EXPERIENCE:

1993 to present **English and Mathematics Teacher**
Assumption School
Antipolo City

1989-1992 **Cashier and Payroll Master**
St. Camillus College Seminary
Marikina City

1987-1992 **Circulation Manager**
ETHOS Today – Camillian Publications
St. Camillus College Sminary
Marikia City

1985-1987 **Receivable Clerk**
Ace Foods Marketing, Inc.
Makati City

1984-1985 **Researcher**
Japan Trade Center
Makati City

1983-1984 **Payroll Master**
Export Processing Zone Authority (EPZA)
Baguio City