Acquiring Cognitive Academic Language Proficiency in Mathematics

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Abstract: This study determined how Cognitive Academic Language Proficiency (CALP) is acquired using the Cognitive Academic Language Learning Approach (CALLA) as an instructional model. This intervention was implemented to a Mathematics content focusing on solving one-step word problems. Action research design was used to achieve this primary objective. Thirty-eight purposively chosen students from the first grade served as participants. A pre-test and post-test consisting of eight word problems in addition and subtraction were given to the participants to determine the academic language used. The CALLA Learning Strategies in Mathematics Questionnaire was accomplished to determine the learning strategy used. Think aloud protocols added information on the language learning strategy used. The statistical treatment included obtaining the mean, frequencies, and percentages. Results showed that academic language proficiency and learning strategy used have improved. The CALLA instruction may have provided positive effect on the initial acquisition and development of competence in the target language. The study suggests that Mathematics teachers may try using the CALLA instructional model to develop their students' use of academic language and learning strategies. This approach necessitates the students' close supervision and proper guided practice in following instructions/directions. Language specialist should help math teachers incorporate the use of academic language and learning strategies in the syllabus design.

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Introduction

The challenge of 21st century learning is to prepare students for future jobs and develop in them the ability to adapt and respond to the new demands and changing circumstances. The competitive global market requires critical thinkers and creative problem-solvers. Therefore, it is a must for students to develop abilities and ways of thinking as early as the primary grades that will enable them to survive and thrive as 21st century learners and citizens. It is towards this noble goal that educators thrust all their efforts in overcoming barriers that hinder and continue to hinder academic progress. These stumbling blocks come in the form of problems in understanding, communicating, interpreting, and analyzing situations encountered in content areas like Mathematics rooted in the lack of proficiency from the academic language, the discipline-specific vocabulary, grammar and punctuation, and applications of rhetorical conventions and devices that are commonly used in a content area (Willis, 2013).

Mathematics is a content area taught using the English language as medium of instruction. Although the participants are English (second language) speakers, they still encounter difficulty in comprehending mathematical word problems. This difficulty proves that the students' fluency in speaking the English language is not a guarantee of better performance in the content area. A certain level of proficiency in the academic language used must be met to exhibit and achieve an excellent performance. In fact, Cunningham (2018) claimed that word problems involve a lot more than just making calculations. Students struggling with word problems have trouble understanding Math phrases and concepts. Haghverdi (2012)

even stated that student difficulties in solving mathematical word problems are caused by several factors such as text difficulties, unfamiliar contexts in problems, and the use of inappropriate strategies.

Cognitive Academic Language Proficiency

The role of language in education cannot be underestimated. These participants have English proficiency on the basis of communicative situations. However, their failure in mathematical tasks is indicative of cognitive deficits, as they lack the academic language proficiency that is necessary for success in content areas. Nagy and Townsend (2012) explained that academic language is the specialized language, both oral and written, of academic settings that facilitate communication and thinking about a disciplinary content. Academic language provides students the skills to communicate, engage, and participate more effectively in content areas. The students become proficient in the language because the focus is on the exchange of important messages, and language use is purposeful. Language is considered as a medium of learning and that language development with content learning should be integrated. Thus, this study recognizes the importance of academic language and calls for instructional focus on words that appear in Mathematics content as well as to provide opportunities for students to develop knowledge of words and concepts through discussion.

Academic Language Instruction

Difficulty in mathematical word problems may be caused by non-comprehension of what is being asked of them. They may well know how to do the math, but they do not have mastery of the language to learn math. They must know the technical language of math in order to create the correct equation. The phrase “put together” or the + sign signifies addition and the word “is” means “equals” or the “=” sign.

Likewise, "take away" or the – sign signifies subtraction. They must also know that the academic language "find the number" means to create an equation and solve the problem.

There are a lot of academic language words to comprehend in order to get a correct answer. The language for formal academic learning and for written texts in content areas should be taught and learned by the students. According to Moschkovich (2011), vocabulary is necessary but not sufficient. The question is not whether students should learn vocabulary, but rather how instruction can best support students as they learn both vocabulary and mathematics. Instruction that is deliberate, systematic, and contextualized is necessary for students to engage in mathematical thinking and learning. It is in this regard that the Cognitive Academic Language Learning Approach, an instructional model by O'Malley and Chamot was utilized to further develop academic language in English. The model includes three components: a) *Topics from the major content subject*; b) *Development of academic language skills;* and, c) *Explicit instruction in learning strategies for both content and language acquisition.*

The researcher tried to look for different strategies to help the students improve their comprehension of mathematical word problems. The discussions above suggest that the gap in students' performances in mathematical word problem solving may be bridged when teachers provide proper instruction. As a Math teacher, the researcher decided to help the first grade students develop cognitive academic language proficiency by making them fully understand the technical terms used in Math. It is hoped that this approach will enable the students to critically and constructively handle a mathematical word problem with confidence and efficiency, resulting in a markedly improved performance.

Purposes of the Research

This research determined how the students acquired Cognitive Academic Language Proficiency in Mathematics using the Cognitive Academic Language Learning Approach. The study attempted to answer the following questions:

1. What is the status of the academic language use of the students before and after using CALLA as measured by the mathematical word problems?
2. What CALLA learning strategies do students use in solving mathematical word problems?

Methodology

Action research as a process was employed in this study. Quantitative and qualitative approaches were used to address the purpose. The one-group pre-test-post-test strategy assessed and compared the students' academic language use before and after the intervention. The study included thirty-eight students in the first grade. They were chosen on the basis of accessibility and the rapport established with the researcher since the latter also teaches Mathematics to this group of learners. These students use English as their second language.(L2). Parents' informed consent was easily secured through the help of the academic coordinator and parent officers. Names were withheld to respect the confidentiality and anonymity of the research participants.

Instruments

CALLA Learning Strategies in Mathematics Questionnaire - This questionnaire was developed by O'Malley and Chamot and was adopted in this study to identify how students understand and solve word problems in Math. It contains nine items and has five possible response options namely: Never, Rarely, Sometimes, Usually, and Always. The referee validity determined the accuracy and effectiveness of each item in the questionnaire. A group of English teachers

and all the grade level teachers (total of 10 teachers) reviewed the questionnaire for comments or suggestions as regard the content it is supposed to measure, the words or terms used, the statement of instructions, and if the language used fits the level of the students. There were no modifications in the items thus, the questionnaire was retained and approved for use in this study. A test-retest scheme determined the reliability of the instrument. The reliability coefficient was 0.76-0.86, making the instrument reliable for use in this study.

Interview and think aloud protocols - This content-validated instrument includes set of questions asked to students for them to explain their process in solving the problems. The protocol includes the following question:

a. What is the story in the problem?
b. What is asked of you to do?
c. How are you going to do this?
d. What are the key words in the problem that tell what operation to use?
e. How do you add/subtract numbers?
f. How are you going to answer the question in the problem?

Portfolio and journal - The portfolio is a collection of students' works and other information that show their use of academic language and learning strategies. The journal is the teacher's daily record of observations regarding students' learning, performance, and important notes on how they develop the academic language and learning strategies used.

Data Collection

Preliminary (Plan)Stage

The researcher identified the students' difficulty in solving mathematical word problems. She then selected mathematical word problems in addition and subtraction with emphasis on language use from different resources. The pre-

test and post-test used this same selection which served as baseline data to determine the students' level of performance in solving mathematical word problems and their use of academic language. The researcher also secured a permit from the school's academic coordinator to conduct the pre-test and give CALLA instruction to the participants. The CALLA lesson plan was prepared for the purpose of integrating instructional strategy with language development and content skills. The lesson plan includes the Mathematics Content Objectives, Mathematics Problem-Solving Strategies, Language Objectives, Learning Strategies, Materials to Be Used, Procedures: Preparation, Presentation, Practice, Evaluation, and Expansion; and Assessment.

The participants answered the CALLA Learning Strategies in Mathematics Questionnaire after trying it out with another section of the same grade level. The results determined the use of language learning strategies before CALLA instruction and served as important data in planning and conducting explicit instruction of learning strategies.

Intervention (ACT) Stage

The CALLA instruction was implemented for two quarters following the procedures indicated in the prepared lesson plan (see Appendix A). Academic language should be taught like other types of procedural knowledge. This involves identifying both authentic language functions and the language skills needed to carry out the tasks. Learning strategies were taught side by side with academic language. The selection of strategies taught was in accordance with the instructional task.

Table 1. CALLA Instruction on Academic Language and Learning Strategies

Instruction of Academic Language	Instruction of Learning Strategies
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.	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. 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.	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. 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 video presentations on word-problem solving. Post-listening discussion is done where students share and describe what they understood and what comprehension difficulties they experienced.	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. 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 you 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.

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.

Post Intervention

The post-test on the eight mathematical word problems was administered after the academic language and learning strategies instruction. A comparative evaluation and means of the pre-test and post-test were computed to determine the students' progress and cognitive academic language proficiency.

Interview and think-aloud protocols were conducted to determine if the students have developed their language skills. The students were asked to explain and describe their process of solving word problems in English. Solutions to the same word-problems were shown in written form. These substantiated the developed skills in mathematical word-problem solving. The research participants' performance was determined using a 4 point scoring rubric. The results were tabulated and subjected to statistical treatment and analysis.

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.

The participants accomplished the CALLA Learning Strategies in Mathematics Questionnaire after instruction of learning strategies. The result was compared and analyzed with the answers to the same questionnaire given before CALLA instruction. Frequency count and percentage of test responses

in an item-by-item mode was computed to elicit the same strategies with similar tasks.

The students also shared what strategies they used to solve the problems. The eight addition and subtraction word-problems were utilized 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.

Results and Discussions

Academic Language Use as Measured by the Mathematical Word Problems

The academic language use of the students was analyzed based on the results of the pre-test and post-test consisting of eight mathematical word problems.

Table 2. Degree of academic language use in the eight mathematical word-problems before and after CALLA

WORD PROBLEMS	4		3		2		1		0	
	f[1]	%[2]	f[1]	%[2]	f[1]	%[2]	f[1]	%[2]	f[1]	%[2]
BEFORE CALLA										
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	31.28	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
AFTER CALLA										
Addition										
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										
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	-	-

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.
Legend: f^1 – frequency of research participants' degree of academic language use
$\%^2$ – distribution of research participants' degree of academic language use

The data in Table 2 shows that before CALLA instruction, 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. The addition problems reveal that there are students who were able to explain the process used to solve the problem and got the correct answer. A few of them can explain the process used to solve the problem but incur computation error due to improper alignment of digits in their solution. However, some of them are unable to explain the problem solving process but got the correct answer because they know the basic addition facts. There are also students who tried solving the problem but failed to get the correct answer or explain the process. It is therefore relative to note that proper comprehension leads to accurate answer.

The subtraction problems are difficult for the students to explain and solve. This result suggests mastery of the basic facts and capability to follow correct subtraction process. The results show that only a few students can explain the process used to solve problems and got the correct answer. Some of them can explain the process but made computation error. Most of the students tried to solve the problems but were unable to explain the process of problem solving and get incorrect answers.

It is remarkable to note that some students could explain the process used to solve the problems but made computation

errors due to carelessness and the use of inappropriate symbol or operation sign. The acquisition and development of academic language proficiency is needed for students to become successful in any content area. Under developed academic language skills are largely responsible for poor reading comprehension which is a keystone in mastering any content (Willis, 2013). As a Mathematics teacher, it is important to ask why students are underperforming. Is it because they lack the skill to write the correct equation or is it because they don't understand what is asked of them? Mathematical problems are often stated in words and although students can read words, they may have difficulties in understanding what is being asked. Assistance in such cases entailed providing the students with the proper instruction on academic language use.

The students' language use after instruction of academic language showed a very big improvement. They spontaneously explained the process used in solving the set of word problems. They also became mindful in the use of correct grammar while constructing sentences with the proper subject-verb agreement. Their comprehension skills likewise improved as displayed in the retelling of the story in their own words. They acquired the skill of identifying important data in the problem and the words that signify the operation used in getting the correct answer.

The results on addition problems show that majority of the students could already explain the problem solving process and got the correct answer. Likewise, the students became accurate in their mathematical computation of addition problems. Few students, however, tried to solve the problem but were unable to get the correct answer or explain the problem-solving process. This weakness calls for more exposure to similar problems and venues where they can improve or develop their academic language.

The students' performance in subtraction problems also improved. The process used to solve the problems became easier for the students to explain. However, computation error is still evident to several students which may be attributed to the 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. The students usually commit the common error of subtracting the smaller number in the minuend from the bigger number in the subtrahend. Therefore, students should be provided more subtraction drills and exercises that would minimize computation errors and develop mastery of skills.

Below are sample transcripts on how students express and explain their process in solving word problems.

Table 3. Transcript on Addition Problem

Before CALLA Instruction	After CALLA Instruction
Ana collected 16 dolls and brought it to Liza's house who had 19 dolls. How many dolls did they play with?	
Student 1 – Add…Ana collected 16 dolls and Liza bring 19.	I put together the dolls of Ana and Liza so they have 35.
Student 2 – 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.
Student 3 – Ahh…dolls…16 and 19	Ana has 16 and Liza has 19. I add them and they have 35 dolls in all.

The students' limited vocabulary and insufficient knowledge in grammar use before CALLA instruction caused anxiety. Hamouda (2012) confirmed that students' reluctance to participate in class is caused by the lack of vocabulary and difficulty in grammar. It was also their first time to experience having their voices recorded while explaining their thoughts. However, one observed positive behavior is their willingness to try explaining their process of solving the problems. In spite of their difficulty in using the correct terms to explain what they understood about the problem, they did not hesitate

to talk. The instruction of CALLA may have developed the students' academic language use. They learned how to seek information in a problem to come up with accurate answers, describe or retell the story in a problem, sequence objects or situations, classify what are needed, analyze to separate whole into parts, and solve problems. The students acquired the language skills in mathematics and developed the listening skills as they understand oral numbers and word problems; reading skills as they comprehend specialized vocabulary and read mathematical explanations; speaking skills as they learned to ask questions for clarification, explain how they arrive at their answers, and describe the application of math in other content areas and real life situations; and writing skills as they write verbal input numerically, write their own word problem, and write final answers in complete sentences. Moreover, they became spontaneous in explaining their process of solving word-problems as well as in giving their answers to the problems. Concerns in correct grammar and syntax were addressed as evidenced by the use of complete and well-constructed sentences.

Additionally, below is the scenario for subtraction problems.

Table 4. Transcript on Subtraction Problem

Before CALLA Instruction	**After CALLA Instruction**
Frances has 64 crayons in her box. Daniel borrowed 18 pieces. How many crayons are left in Frances' box?	
Student 1 - Frances 64…Daniel 18 subtract…	How many are left? I will subtract…64 minus 18 equals…
Student 2 - Daniel borrow 18… minus 64 of Frances	Frances has 64 and gave 18 to Daniel so minus the numbers.
Student 3 - Left in the box…minus	To know the number of crayons in the box of Frances, get 18 from 64.

The students identified and used appropriate vocabulary words like *subtract, minus, get from,* and *how many are left*

to explain what they understood about the problem. This strategy guided them on what to do to come up with the correct answer. The students' use of appropriate vocabulary words also validated the students' understanding and learning of the academic language. Knowledge of academic language is also knowing the special language used in school like the language of the story problems in Math. Academic language proficiency is critical for reading comprehension and overall academic success (Friedberg et al, 2016).

Learning Strategies Used in Solving Mathematical Word Problems

Table 5 exhibits the students' learning strategies used in solving mathematical word problems based on the results of CALLA Learning Strategies in Mathematics Questionnaire and think aloud protocols before and after the instruction of learning strategies.

Table 5. Learning strategy used in solving mathematical word problems before and after CALLA

Question Number	Strategy	Mean		Response Option	
		Before Instruction	After Instruction	Before Instruction	After Instruction
Questionnaire					
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	3.60	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
		Frequency		Percentage	
		Before Instruction	After Instruction	Before Instruction	After Instruction
Think-Aloud Protocols					
	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

Table 5 reflects that before CALLA instruction, the students were already using strategies to solve mathematical word problems. However, they still lack the knowledge of identifying these strategies, their importance in using them to solve problems, and how they should be used. The participants improved in their use of learning strategies after CALLA instruction. The strategies that the students always use are selective attention, planning, and self-evaluation. They recognize that cooperation, elaboration, and imagery are also effective strategies. On the other hand, negative strategy was never used.

Think aloud divulged an insightful strategy application in mathematical word problem solving. Selective attention topped the list before and after instruction. Through selective attention, students were able to interpret the message of the problem by monitoring the language production in words, phrases or sentences. They understood that the conjunction 'and' and the phrase 'put together' signify addition while the word 'left' signifies subtraction. They identified important data needed to solve the problem. The use of planning strategy is second to the list. Successful problem solvers plan what to do and decide on the appropriate approach. Students who plan succeed at a higher rate than students who do not plan. The students' planning strategy were evidenced by the following statements: 1) I added them.; 2) I put them together.; 3) I will subtract to get the number.; and 4) How many are left? Imagery as a strategy was also effective as the students create pictures in their minds or draw pictures of the given data for a clearer understanding of the problem. Students' actions like pausing and looking up while saying the name of objects mentioned in the problem is an indication of creating pictures in their minds. Effective problem solvers who use imagery often find a pattern or a way to solve the mathematical word problem. However, a decrease in the use of elaboration strategy and self-evaluation was noted.

The students became confident in the use of these strategies claiming that they already know the topic or type of problem. Students are recommended to use elaboration strategy so they would know how to relate one information to another in the problem. Self-evaluation should also be used as students are enabled to identify which strategy works best in a certain task. Cooperation strategy is also recommended. Nguyen (2013) discovered that peer-tutoring in Mathematics is effective in improving mathematics performance. The students, while working with their classmates, are given a chance to express themselves orally. Also, listening to their classmates' explanations develops their listening skills. They also learn how to take down important notes that are helpful in their solving process.

The findings gave an apparent picture of the relationship between strategy use and successful learning. Yang (2007) explained that effective strategy use can determine student success. Furthermore, Wilson and Conyers (2018) assert that the brain has the capacity to learn at higher levels when effective learning strategies are used.

The table below presents how learning strategies were codified based on the participants' explanation of their process in solving mathematical word problems.

Table 6. Sample transcripts of think-aloud protocols and learning strategy codifications

Ana collected 16 dolls and brought them to Liza's house who had 19 dolls. How many dolls did they play with?			
Learning Strategy	**Responses Before CALLA**	**Responses After CALLA**	**Learning Strategy**
Selective Attention, Planning	S1- 16 dolls and 19 dolls…add	There are 16 dolls and 19 dolls so I added them.	Selective Attention, Planning
Elaboration	S2- I understand…the number of dolls.	(looks up) Dolls in the cabinet. There are 16 and 19 dolls…put them together.	Imagery, Selective Attention, Planning

Frances has 64 crayons in her box. Daniel borrowed 18 pieces. How many crayons are left in Frances' box?			
Learning Strategy	**Responses Before CALLA**	**Responses After CALLA**	**Learning Strategy**
Elaboration	S1- borrowed…How many are left?	64 and 18…subtract them to get the number of crayons left.	Selective Attention, Planning
Elaboration, Planning	S2- left…minus… How many are left in the box?	Daniel borrowed 18 crayons from Frances so remove 18 from 64 and you will get (thinks) 46…(asks a classmate if her answer is correct)	Elaboration, Planning, Cooperation

S1– Student 1

S2 – Student 2

Effective mathematics teaching involves mastery of the content and understanding of the role of language in the teaching-learning process. Identifying specific strategy, a student uses and elaborating on how that strategy fits with other students is helpful and necessary in developing the skills needed.

CALLA as an instructional model applied in this study gave opportunity for students to be aware of themselves as learners and to develop mathematical reasoning, problem-solving, and communication skills. It emphasized mathematical literacy as a communicative approach involving discussion, application, and analysis of alternative paths to problem-solving.

Conclusion and Recommendations

The study aimed to determine how the students acquired Cognitive Academic Language Proficiency in Mathematics through the instructional model, Cognitive Academic Language Learning Approach. It determined the students' academic language and learning strategy use. It addressed difficulties

encountered brought by the inability to understand the language of mathematics.

The findings of the study revealed that the CALLA instructional model was effective in the acquisition and development of cognitive academic language proficiency. The academic language instruction helped the students achieve a better understanding of the content lessons as comprehension skills were also developed. The learning strategies made students autonomous learners as they were able to do their tasks even without the teacher's supervision. Learning was made easy as they were guided with steps and procedures that led them to correct mathematical computations, resulting to improved achievement. Think-aloud activities honed the students' cognitive thinking and developed language skills.

Based on the comparative results of the pre-test and post-test on the eight mathematical word problems, the students' use of academic language and learning strategy improved. The students became spontaneous in their articulation and explanation of the word problem solving process as well as their computational skills. This study is exclusively focused on the role language plays in processing mathematical word problems, thus, giving particular attention to academic language and problem-solving strategies that will lead to obtaining the correct solutions. CALLA was used in this study as an instructional approach and not as a curriculum approach. The study also provides empirical data in curriculum planning which includes explicit instructions in the use of learning strategies that make teaching and learning of any content-area easier and practical. It also gives empirical data in the development of instructional materials like activity sheets, written drills, and practice sheets.

In view of the study, it is recommended that Mathematics teachers may try using the CALLA instructional model to help their students acquire and develop academic

language and learning strategy use. Thus, proper training on how to execute instruction on academic language and learning strategy use is needed. Language teachers are therefore called to work collaboratively with other content-area teachers to make plans for the development of academic language, and to conduct regular articulation to determine students' progress in academic language and learning strategy use. It also challenges other researchers to conduct comprehensive studies on academic language and learning strategy use in different disciplines. Textbook authors are encouraged to include varied activities that hone in the academic language and enable students to apply learning strategies that help them become creative and critical learners.

Reflection

The creativity and spontaneity of learners should be reinforced as they learn and apply varied skills in the different content areas. The teacher has a significant role in providing second language learners with opportunities to facilitate their own learning. Teaching students to acquire and develop academic language and identify the learning strategies to be used will help them achieve a better understanding of content lessons, improve performance, and become successful autonomous learners. Teachers should also equip themselves with varied teaching techniques and learning activities to motivate students to experiment with a variety of learning strategies. They should provide students with avenues where they can explore, analyze, solve problems, and think critically to better prepare them for the primary goal of meeting head-on the challenging as well as exciting tasks of the 21st century and onwards.

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APPENDIX A

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 the 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.