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Developing Mathematical Language for Elementary Students Through Specific Math Activities: A Proposed Study

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Abstract

Mathematical language is a communication method in the process of mathematics teaching and researching. In terms of developing communication skills with mathematics languages, the first grades of elementary school should be imparted through lesson and teaching activities to create more opportunities relating to math understanding and the receptive ability of required tasks. This paper focuses on researching and proposing some specific activities in primary school math teaching, in order to improve the mathematical language for students.

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1 Introduction

Thinking and language are inseparable when the conception can be demonstrated through communication and completed by expression. On the other hand, language is formed by thinking (Whitin & Whitin, 2020; Bossé et al., 2018). However, language is not only a tool of thinking but also a product of that process; communication participates in the process of forming and developing a human's mindset. In general, mathematics is an abstract subject aiming to describe and explain relationships, ideas, and specialized content that people need to use in a specific language (mathematics language) instead of using the normal one to present them (Rothman & Cohen, 1989; Lin & Yang, 2005). As with other common idioms, mathematical language plays an essential role in the development of mathematical awareness in particular and in the general consciousness of students. In other words, the combination between mathematical language and natural speech is a means of pondering activities, directly involved in the process of forming and developing wisdom in general and mathematical thinking in particular (Goldhaber, 2006; Whitin & Whitin, 2020).

2 Mathematical Language

In the past, Mathematical language has been studied and applied in teaching practice, some common studies on mathematical language can be listed following:

The research by Hoang Chung (1994); Bossé et al. (2018), claimed that "Teaching math is delivering a special language in a certain sense, which has brought several benefits to describe facts or methodologies in different fields of science and practice. In the author's perspective, a proficient teaching method of definitions can contribute to students' knowledge enrichment of mathematical terms and symbols that is an opportunity to develop the language of mathematics - a compulsory condition for the development of mathematical competence, and applying the subject to reality or other majors. The specific terms and symbols were formed and expanded during the foundation and development of mathematical concepts and the utilization of solving problems. Each determinant reflecting the same statement can be defined in many equivalent ways. Additionally, Hoang Chung (1994); Goldhaber (2006); Whitin & Whitin (2020), regards that when using mathematical symbols, it is necessary to distinguish whether those icons are intact, unchanged, and being familiar to the majority, or being optional according to the certain situation. However, the study shows that the process of mathematical development always requires updating and changing a concept, followed by the expansion and various understandings for a term or a symbol. In mathematics, the appliance of different symbols to refer to the same object is possible but avoids reflecting the two individuals with the same icon in one problem.

When considering the requirements of developing a mathematical culture in schools, The author (Tran Kieu 1998; Vanluydt et al., 2021), affirmed that mastering the language of mathematics also "contributes to strengthening the common language - a crucial element of culture" and the language of mathematics helps to become familiar with "a means of communication with very high efficiency of notice, generality, accuracy, and neatness is also a basis for the construction of machine tongue.

In the works of Le Van Hong (2013), there is an evaluation of the incentives from the language of mathematics to high school teaching through communication adaptation. The researcher clarifies the meaning and constructs of mathematical language in an extended sense (three languages in math teaching, multi-signature of mathematical discourse, etc). Therefore, he analyses mathematical language in the study according to Pisa's mathematical competencies. Moreover, (Le Van Hong 2013; King & Purpura, 2021) also emphasizes language activities in Math content and appliance, syntax relationships, and semantics of the mathematical language in some specific cases. Besides, when discovering the mathematics expression in the current textbooks in Vietnam, (Le Van Hong 2013; Purpura & Logan, 2015) has pointed out some core features in the expanded sense then suggests numerous new researches on math vocabulary in textbooks. In terms of the relationship between mathematical language and learning competencies based on the Pisa approach, the author mentions that mathematical language is directly related to Pisa's capacity and four other abilities: Thinking, reasoning; deducting with the relation of Thinking, and Language (Kaur & Kumar, 2016; Sager, 1978; Bellegarda, 2005). Simultaneously, the problems of mathematics linking to the ability to learn and teach have been identified by Vietnamese educators: Mindset and language are inextricable. The thought belongs to the content category while expression tends to be a formality. Thus, purport and forms are mutual influences.

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Overall, from many educators' perspectives on the language of mathematics, I realize that the meaning of mathematical language for students at high schools study in general and elementary schools, in particular, includes: mathematical thinking development, practicing mathematical communication, mastering the subject knowledge, applying studies, and responding many other requirements, including mathematical culture (Purpura & Reid, 2016; Hornburg et al., 2018).

3 Math Teaching Situation Proposal in Elementary School to Improve the Ability of Mathematical Language for Students

After determining the processes of organizing typical math teaching situations for primary school students, including common lessons such as teaching the formation of concepts, symbols, formulas, rules, properties, algorithms, problem-solving, reviewing, consolidating, and systematizing knowledge and skills, etc, I suggest several activities related to the mathematical language below:

Activity 1: Practice expressing and describing the definition of mathematical concepts and objects in the process of forming mathematical concepts and objects

Practicing how to express the definition of a concept, an object is an activity to consider many specific objects that have similarities or resemblances in some aspect of the object, from which, to find out and state features of a group of objects (Mullender-Wijnsma et al., 2016). In the process of teaching mathematical concepts and objects for elementary students, teachers should focus on identifying similarities of the objects under consideration and describing these common characteristics in their ways, from which to generalize about the concept (Purpura & Logan, 2015).

Example 1. Concept formation 2. When the teacher interacts with groups of objects such as a picture of 2 flowers, two-dotted cardboard, etc. Then, the students realize the "common features" of the groups of objects. With the appropriate instruction of the teacher, students can state: *The above groups of objects have **two** flowers, **two** round dots (Figure 1).*

Figure 1. Groups of objects have two flowers, two round dots

Activity 2: Express, explain and describe the definition of the newly defined concepts and objects in many different forms

This is quite a challenging activity for students, in general, and for primary school students, in particular. To express, explain, and describe the definition of mathematical concepts and objects, it is required that students mobilize knowledge and be able to use language, in general, and mathematical language, in particular, reasonably, accurately, and logically (Lin & Yang 2005; Donlan et al., 2007; Schmitt et al.,2019). In this activity, students can recall symbols and terms indicating concepts that need to be expressed, described, then students determine the characteristics of the concept, then fully and accurately restate and redescribe them. Furthermore, students can link concepts together, consider the relationship between them and then, state the concept definition and describe this object through similar objects (maybe partially similar) (Polat et al., 2017).

*Example 2***.** We can define the concept of a Rectangle as follows: “A rectangle is a quadrilateral with four right angles and two equal length sides and two equal short sides” or “A rectangle is a parallelogram with a right angle”.

Activity 3: Practice expressing and commenting on rules and properties in the steps of the process of forming rules, properties and memorizing

The process of forming mathematical rules and properties in teaching Mathematics in primary schools always follows the path of inductive reasoning, to be specific, incomplete induction (Polat et al., 2017). To form rules, this mathematical property often considers the specialties of many particular objects through practical and experimental activities (calculation, measurement, identification, etc) to compare, contrast and detect those specialties.

Example 3. Find the missing addend, then make comments.

$$6 + 4 = \dots$$
$$6 = 10 - \dots$$
$$4 = 10 - \dots$$

Students conclude that “for the similar operations, taking the given addend and subtracting it from the sum will give you the missing addend”. Through the accumulation of experience, at the same time, there must be the activation of requirements to help students practice speaking and expressing the most common characteristics of the rules, the properties that help form the rules, and the properties, which brings great value in gaining knowledge and developing thinking for primary school students.

Activity 4: Express, restate rules, properties, memorize and define in many different ways

In order to help students understand correctly and accurately mathematical rules and properties, activities of expressing and stating rules and properties in many different ways not only help students remember and acknowledge the essence of the rules and properties but also help students practice the use of mathematical language fluently, accurately, and logically (Croft & Cruse, 2004; Woods, 2009).

Example 4. The rule for calculating the area of a trapezoid can be stated in the following ways:

Method 1: The area of a trapezoid is equal to the sum of the lengths of the two bases multiplied by the height (same unit) and then divided by 2.
Method 2: If S is the area of the bar; a and b are the lengths of the bases of the trapezoid; h is the corresponding height, then S = $\frac{a+b}{2} \times h$.

Activity 5: Approve (or disprove) an object that satisfies the concepts, rules, and properties just defined

The operation of approving or disproving an object within the defined conceptual scope is a mathematical activity in which we consider if the object satisfies the conditions of the definition. To approve a rule, memo or comment is to see if a given situation satisfies that rule, memo, remark.

Example 5. Given the expression $6 : 2 \times 3 + 8$, find the correct solution among the following ways: (Approve or disapprove the implementation of the rules for math expressions)

Method 1 $18 + 6 : 2 \times 3 = 18 + 3 \times 3$ $= 18 + 9 = 27$	Method 2 $18 + 6 : 2 \times 3 = 18 + 6 : 6$ $= 18 + 1 = 19$
Method 3 $18 + 6 : 2 \times 3 = 24 : 2 \times 3$ $= 12 \times 3 = 36$	Method 4 $18 + 6 : 2 \times 3 = 24 : 2 \times 3$ $= 24 : 6 = 4$

Activity 6: Create an object that satisfies the newly defined concept, rule, and property

Creating an object satisfying mathematical concepts, rules, and properties is the act of expressing concepts, rules, and properties. Expressing a concept is creating an object that satisfies the concept. Expressing a rule, the mathematical property is to build a situation satisfying that rule and property (Brown & Stillman, 2017).

Example 6.

a) Write fractions greater than 1 where the sum of the numerator and denominator is 7. (Show concepts of fractions)
b) Calculate the area of a rectangular plot of land that is 16m long and 4m wide. (Show a rule for calculating the area of a rectangle)

Approving (or disproving) and *expressing* are two activities of opposite characteristics related to a mathematical definition, rule, or property. These two activities are closely related and often intertwined. Along with *expressing* a concept, rule, or property, *identifying* often occurs as a testing activity.

Activity 7: Summarize the problem.

The use of diagrams, pictures, or short language and signs to most clearly describe the conditions of the issue is known as summarizing the problem. Summarizing the problem is the methods in removing non-essentials and focusing on the mathematical nature of the situation. There are a variety of methods for summarizing a problem such as: summing up the problem with a line diagram, a doodle, a flowchart, a "rectangular graph," or in short language and symbols. Besides, this can plot the problem or summarize the formula in words… Overall, summarizing the problem is essentially converting a complete problem into an issue using a large amount of math vocabulary such as signs, terms, symbols (Mercer & Sams, 2006).

Example 7. Summarize the following issue: "The sum of father and son's ages is 58." Dad is 38 years older than his son. "How old is the father, and how old is his son?" (Page 47 of Maths Textbook 4)
We can summarize using the line segment diagram as follows:

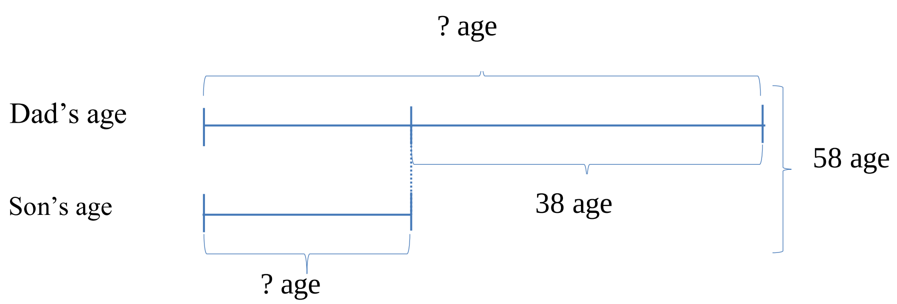


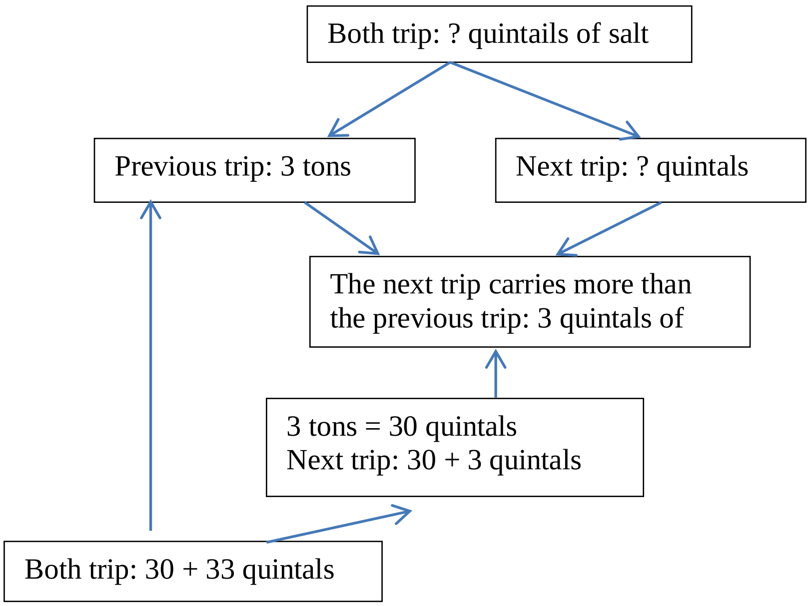
Figure 2. The line segment diagram

In the preceding example, summarizing the problem means expressing the solution in the form of pictures, diagrams, and signs in a concise and easy-to-understand manner, while also assisting students in visualizing the reasoning on that basis to find a solution to the problem. Therefore, summary tasks help students improve using pictures, diagrams, and mathematical signs to see the connection between these objects.

Activity 8: Solve the problem and document the solution

A problem always has three components: data (what is known), unknowns (what is looking for), and conditions (relationships between data and unknowns). The process of solving a problem is the finding of the issues unknowns. The problem-solving process is an inference or series of consecutive assumptions that generate the unknown from the problem's data and conditions (Mercer & Sams, 2006). The solution process is documented. In the answer, there are steps to solve the problem. Each solution step includes the answer as well as the calculation that corresponds to the solution. Solving problems and documenting an issue is an activity in which students express (write or speak) mathematical inferences and present (write or speak) these presumptions in a logical, accurate, and reasonable manner.

Example 8. A truck on the previous trip can carry 3 tons of salt, and it on the next trip can carry 3 tons more salt than the previous one. How much salt can both transport?
We use the diagram below to solve the problem:



The solution is as follows:
Exchange 3 tons = 30 quintals
The next trip can transfer the quintals of salt is: 30 + 3 = 33 (quintals)
Both trucks can transfer the quintals of salt is: 30 + 33 = 63 (quintals)
Solution: 63 quintals of salt

In problem-solving, we frequently employ some thinking processes such as analysis and synthesis. These two inferences are closely linked. First, it is analysis - analysis to find and create a solution plan, next is synthesis - synthesis once implementing the plan and stating the solution. The mathematical language process is performed in building the answer structure and presenting the solution in the previous example (Suweken et al., 2017).

Activity 9. Approve and disprove the solution of a problem

Approve or disprove a feasible solution is an activity in which students review the process of steps and whether or not the inferences of a solution are accurate, reasonable, and logical (Mahayukti et al., 2017). This is the process of testing and evaluating the solution. To approve and disprove a solution, students have to review the summary of the statement, the sentences expressed in the answer, the selection and implementation of calculations, and the correct and reasonable sequence of steps to solve still not? What content can be modified? How does it change? Is that change resulting in a new or better answer? Language activities are expressed by students considering the appearance in inference, the structure of math, the summary, etc.

Activity 10. Create a problem and convert it.

Creating and converting problems is an activity in the teaching situation of solving math problems in elementary school (Mercer & Sams, 2006). It allows students to complete their generalization and problem-solving skills, as well as practice creativity in learning. In this activity, students use language to express new problems and problems, and they continue writing to obtain new issues.

4 Conclusion

This report's recommendations close a significant gap in the literature on math activities in Vietnamese primary schools. Mathematical language activities in traditional math classroom situations in primary schools consider mathematical language as a tool, a medium, and a result of mathematical activities (Lavy & Shriki, 2010; Susperreguy et al., 2020). In particular, mathematics has fully demonstrated its functions in learning activities. This finding builds on previous research that found a significant relationship between specific math learning activities and students' mathematical language improvement. Especially, the research findings show that problem-solving activities increase students' performance in mathematical language. These research results serve as a foundation for future research into the use of mathematical language in problem-solving activities in real contexts. Besides, these findings are a first step toward comprehending broader mechanisms for developing elementary school students' mathematical competence.

Conflict of interest statement
The author declared that he has no competing interests.

Statement of authorship
The author has a responsibility for the conception and design of the study. The author has approved the final article.

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