THAI NGUYEN UNIVERSITY
UNIVERSITY OF EDUCATION

AMMONE PHOMPHIBAN

TEACHING ALGEBRA IN HIGH SCHOOL OF LAO PEOPLE'S DEMOCRACY REPUBLIC IN THE DIRECTION OF DEVELOPING MATHEMATICAL MODELING COMPETENCE FOR STUDENTS

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3. Dong Thi Hong Ngoc, **Ammone Phomphiban**, Nguyen Danh Nam (2021). Applying modeling teaching in mathematics in high schools. In Dao Thai Lai, Tran Trung, Trinh Thanh Hai (Eds). *Technology and Education*, pp.438-470, Hanoi National University Press.
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INTRODUCTION

1. Reasons for choosing the topic

General education in the 21st century deals with the development of learners' competencies, which emphasizes learning to know, learning to do, learning to be and learning to live together. General education programs of advanced countries in the world have clearly defined the basic fields and requirements for qualities and attitudes. Education development strategy to 2025 of the Lao Ministry of Education and Sports focuses on a number of areas such as: improving the quality of general education inside and outside schools; improve the quality of training and develop teachers' competence.

Currently, the Lao People's Democratic Republic is moving towards a progressive and modern education on a par with other countries in the region and the world, specifically: the 2016 Lao Education Law affirms that "General education is the basic education to improve and develop learned knowledge, some subjects must be deepened at the next learning levels to develop skills and competencies of learners".

The trend of advanced mathematics education in the world has been concerned with assessing knowledge and considering students' ability to apply knowledge and experience to solve practical problems and be able to do new things on the basis of learned knowledge.

The goal of upper secondary education is always to develop and improve skills to apply knowledge in learning situations, research into real life.

Mathematical modeling helps students better understand the application of mathematics in life; since then, students develop the ability to analyze, reason, reason and solve mathematical problems in different practical situations; develop critical thinking and the ability to relate mathematical knowledge to real life and other subjects.

The content and curriculum of high school math textbooks are suitable for students' psychophysiology, the requirements of other subjects and the realities of society. In particular, solving problems in algebra helps students develop mathematical modeling skills. Algebra are mathematical models of reality.

Many current teaching methods in Lao schools are still heavily theoretical and have not yet emphasized practicality; little interaction between teachers and learners; the teacher's teaching methods have not

yet emphasized applicability to life. Meanwhile, in countries around the world, the practicality in the general education program is very high, the teaching method clearly shows the collaboration, teamwork, interaction between teachers and learners.

There have been a number of research projects on modeling and application in teaching high school mathematics. Typically, the works of authors Tran Trung (2011), Le Thi Hoai Chau (2013), Phan Anh (2014), Nguyen Danh Nam (2016), Le Hong Quang (2020), etc.

There are very few research works on teaching mathematics by Lao authors. Mathematical modeling and its application in teaching high school mathematics are not popular among teachers when teaching mathematics and there are no studies on the application of modeling methods in teaching mathematics. Mathematics in the high school of the Lao People's Democratic Republic.

From the above main reasons, the topic: "**Teaching Algebra in high schools of the Lao People's Democratic Republic in the direction of developing mathematical modeling competence for students**" was selected.

2. Research purpose

The purpose of the dissertation is to propose measures to teach algebra in the direction of developing mathematical modeling competence for students and contribute to improving the effectiveness of algebra teaching at high schools of the Lao People's Democratic Republic.

3. Objects, research objects, research scope

- Research object: The process of teaching algebra 10 in high schools of the Lao People's Democratic Republic.

- Research subjects: Teaching measures to develop mathematical modeling competence for students in some high schools in the Lao People's Democratic Republic.

- Research scope: Algebra content in Lao high school curriculum and textbooks.

4. Scientific hypothesis

On the basis of understanding, analyzing and identifying a number of components of the mathematical modeling competence of high school students, if a number of appropriate pedagogical measures can be developed and implemented in teaching and learning algebra will develop mathematical modeling competence for students, contributing

to improving the quality of teaching and learning mathematics in high schools of the Lao People's Democratic Republic.

5. Research tasks

The thesis has the task of researching the following issues:

- Clarifying the conceptual system, the arguments about modeling; mathematical modeling, modeling capacity, teaching algebra in the direction of developing modeling competence as a theoretical basis for the topic.

- Analyze and synthesize some views of scientists on applying mathematics in real life, especially the problem of mathematical modeling in teaching algebra in high schools.

- Analysis of opportunities to develop mathematical modeling competencies for students in teaching algebra in high schools.

- Analysis of the current situation of teaching algebra in high schools in the direction of developing mathematical modeling competence for students.

- Proposing pedagogical measures on teaching algebra in high schools in the direction of developing mathematical modeling competence for students.

- Organize pedagogical experiments to verify the feasibility and effectiveness of the proposed pedagogical measures.

6. Research methods

To carry out the dissertation, the author used a number of research methods such as: Theoretical research method; methods of investigation and observation; in-depth interview; experimental teaching method.

7. Defensive arguments

- Concepts of modeling, mathematical modeling, modeling competence and teaching modeling.

- Proposing components of mathematical modeling competence, levels and manifestations of mathematical modeling competence in teaching algebra.

- Assessment of the current situation of teaching algebra; the current situation of developing mathematical modeling competence for students in some high schools of the Lao People's Democratic Republic.

- Proposing some pedagogical measures to contribute to the development of students' mathematical modeling competence in the process of teaching algebra.

8. New contributions of the dissertation

8.1. Theoretical contributions

- Clarifying the mathematical modeling ability of high school students, on the basis of analyzing modeling activities, describing this activity for high school students in teaching mathematics, characteristics of modeling in teaching algebra of high school students, components and levels of modeling competence demonstrated in teaching algebra.

- Orientation to develop mathematical modeling competence for students in teaching algebra in high schools.

- Contributing to clarifying the concept of modeling, modeling capacity, teaching modeling, some specific modeling competencies in teaching algebra. Clarifying the idea of developing modeling competence and use cases for developing modeling competence.

8.2. Practical contributions

- Clarifying the reality of developing modeling competence in teaching algebra in high schools of the Lao People's Democratic Republic.

- Proposing a number of feasible and effective pedagogical measures on teaching algebra in high schools in the direction of developing mathematical modeling competence for students.

- Contributing to innovating teaching methods of mathematics, verifying the feasibility and effectiveness of teaching algebra in the direction of developing mathematical modeling competence for students.

9. The detailed structure of the dissertation

In addition to the introduction, conclusion, recommendations, references and appendices, the dissertation is structured into four chapters:

Chapter 1: Theoretical basis

Chapter 2: Practical basis

Chapter 3: Some pedagogical measures to develop students' modeling competence through teaching algebra

Chapter 4: Pedagogical experience

Chapter 1
THEORETICAL BASIS

1.1. Overview of relevant studies in Laos, Vietnam and some countries around the world

1.1.1. Research situation in Laos

In general, there are very few research works on teaching mathematics by Lao authors. Currently, the Lao People's Democratic Republic has only trained teachers of mathematics with university degrees and has not had a training facility for Master's and Doctoral degrees in Theory and Teaching Methods of Mathematics.

Some doctoral theses on Theory and Methods of Teaching Mathematics graduated in Vietnam: “Exploiting teaching methods to actively study algebra and calculus 10 of high school students in the Lao People's Democratic Republic” by Khamkhong Sibouakham (2010); "Operational perspectives on teaching mathematics in high schools, innovating teaching methods, program contents and reality of teaching grade 6 mathematics in high schools of the Lao People's Democratic Republic" of Outhay Banavong (2010); "Developing teaching capacity for students of mathematics pedagogy at Laos National University through teaching specific content of mathematics" by Xaysy Linphitham (2017); etc.

In summary, the research works of Lao authors in the field of theory and methods of teaching mathematics are very few and mainly carried out by a number of biological researches in Vietnam. There is no research on modeling methods in teaching mathematics in Laos.

1.1.2. Research situation in Vietnam

In Vietnam, the modeling method is still quite new for teachers when teaching mathematics in high schools. There have not been many studies on the application of modeling in teaching mathematics in high schools.

Other studies related to modeling and application in teaching mathematics such as the work of Tran Trung (2011); Nguyen Danh Nam, Tran Trung (2013); Vu Nhu Thu Huong and Le Thi Hoai Chau (2013); Nguyen Danh Nam (2016).

There are a number of research theses "Contributing to the development of mathematical competence in practical situations for high school students through teaching algebra and calculus" by Phan

Anh (2014); "Reinforcing mathematical modeling capacity for high school students in teaching algebra" by Le Hong Quang (2020); etc.

Most of the studies on mathematical modeling in Vietnam have drawn the conclusion that teaching by modeling has not been interested.

1.1.3. Research situation in some countries around the world

Some modeling studies in mathematics education:

At Freudenthal's Conference in 1968, the term modeling in formal mathematical education first appeared. At the 1977 Conference of German-speaking countries, the relationship between mathematics and modeling continued to be mentioned. After Pollak's study in 1979, modeling was introduced into schools.

Modeling and applications in mathematics education are of particular interest to mathematics educators, educators, researchers, educational administrators, curriculum developers, teachers, and students.

There are different views in specific mathematical modeling studies such as: The "real" perspective; the "educational" perspective; "reflecting" point of view; the "context" point of view; "perception" point of view.

Some countries in the world in education have been interested in mathematical modeling for primary and lower secondary students many years ago, they value the practicality of their teaching. Research also showed that mathematical modeling is essential in teaching mathematics.

1.2. The basic concepts

1.2.1. Mathematical models and models

The dissertation has introduced model concepts and mathematical models such as: Mason & Davis (1991); Lesh and Doerr (2003); Le Thi Hoai Chau (2014); Nguyen Danh Nam (2016).

In this dissertation, the author conceives a mathematical model as a representation, which is structurally described by formulas and mathematical symbols of real objects to be studied.

1.2.2. Modeling

The concept of modeling shared in the field of mathematics education depends on the theoretical perspective that each author chooses.

On the basis of studying and analyzing different understandings of modeling. In this dissertation, the author conceives: Modeling is the cycle of developing a model between reality and mathematics that is repeated many times, by establishing and using a mathematical model to solve problems.

1.2.3. Mathematization

A concept commonly encountered in the mathematical modeling literature related to the modeling process is mathematization and can be divided into the following three groups:

- Mathematization involves two processes - vertical and horizontal;
- Mathematization is part of the modeling process;
- Mathematization is the whole modeling process.

1.2.4. Mathematical modeling

From the concept of mathematical modeling of Iu.M. Xviregiev (1988); Edwards and Hamson (2001); Haines and Crouch (2010); Nguyen Danh Nam (2016). In the dissertation, the author conceives that: mathematical modeling is a process of converting from real model to mathematical model and vice versa by establishing and solving mathematical problems, expressed under the check how the solution of the problem is implemented in the process.

1.2.5. Modeling process

The modeling process is the process of establishing a mathematical model of the problem to be solved in the model.

From the comments of the modeling and from the modeling process of the studies Pollak (1979); Blum and Leiß (2006); Hamson (2001); Freudenthal (1991); Nguyen Danh Nam (2015). According to the teaching of mathematics in high schools of the Lao People's Democratic Republic. The author proposes a modeling process (Diagram 1.6) as follows:

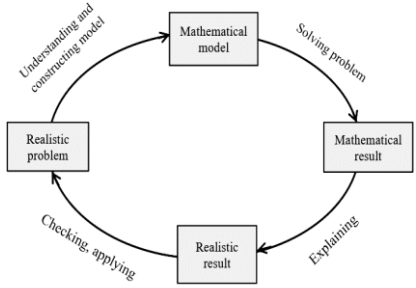


Diagram 1.6: Modeling process

When applying and operating the process in teaching mathematics, teachers need to guide and help students understand and

grasp the specific requirements of the stages in the process of modeling problems as follows:

- Stage 1 (Understanding and building mathematical models): Understanding practical problems; simple assumption; collect data related to the problem to be solved; build a mathematical model for that problem.

- Stage 2 (Problem solving): Use appropriate mathematical tools and methods to connect mathematical knowledge to solve problems or problems that have built a mathematical model.

- Stage 3 (Understanding and interpreting): By understanding the solutions or making predictions; represent mathematical models by tables; chart; graph of the function.

- Stage 4 (Test and apply): Review hypotheses, learn the limitations of mathematical modeling but the solution of the problem, review the mathematical tools and methods used, announce the results achieved, draw conclusions and contrast mathematical models with reality.

1.3. Role of modeling in teaching

In this study, the dissertation author also pointed out the use of modeling in teaching some situations such as:

- ❖ Creating problematic situations in math teaching;
- ❖ Clarifying some elements of mathematics in practice;
- ❖ Understand the meaning of statistics from practice.

1.4. Teaching of mathematical modeling

Modeling in teaching Mathematics, author Le Van Tien (2005), distinguishes two concepts of teaching by modeling and teaching by modeling.

Nguyen Danh Nam (2013) also conceived and proposed the modeling teaching process.

In the dissertation, the author has conceived: teaching modeling is teaching how to build mathematical models of practical situations, describe those situations in mathematical language, in order to answer those questions. Questions and problems arise from real life.

Since then, the author has proposed the modeling teaching process in math teaching according to the following steps:

- Step 1: Identify the problem;
- Step 2: Problem setting;
- Step 3: Develop knowledge of math problems;
- Step 4: Set up mathematical models and solve problems;
- Step 5: Explanation of explanations and practical conclusions.

1.5. Competence and mathematical modeling competence

1.5.1. Competence

There are many different views on competence, even there are disagreements within countries in the world and in Vietnam.

The general education program 2018, in the part of the requirements to be achieved by students on competencies, clearly states: forming and developing core competencies for students.

In the dissertation, the author agrees on the concept of competence proposed by the General Education Program 2018 of the Ministry of Education and Training of Vietnam.

1.5.2. Mathematical modeling competence

1.5.2.1. Mathematical competence

Currently, there is still no unified definition of mathematical competence and there are many studies on mathematical competence from different perspectives.

In the dissertation, the author agrees on the concept of mathematical competence proposed by the Ministry of Education and Training of Vietnam in the 2018 General Education Program.

1.5.2.2. Mathematical modeling competence

Mathematical modeling competence is the ability to represent the process involved in building and verifying mathematical models. On the basis of studying and analyzing different understandings of mathematical modeling capabilities.

In the dissertation, the author believes that modeling is the ability to operate according to the stages of the modeling process and reflect on that process in order to solve the initially identified problem.

1.5.3. Components of mathematical modeling competence

Modeling and application is considered a very important topic in teaching mathematics. An experiment by Maaβ (2006), has shown the component capabilities of the mathematical modeling process. Qi Dan & Jinxing Xie (2011), identified the skills of mathematical modeling.

Within the scope of the dissertation, we consider the activity of mathematical modeling competence as a means in teaching, so some of the component competencies of the mathematical modeling competence in the algebra subject for high school students.

Some studies in Vietnam related to modeling competence such as Phan Anh (2012); Le Hong Quang (2020), has also identified a number of components of mathematical modeling competence.

In the dissertation, the author determines the mathematical modeling ability of students in teaching high school algebra which is constituted by the following components:

(1) Moving from a practical problem to a math problem;

(2) Set up/build algebraic model;

(3) Choosing a mathematical model to solve the problem;

(4) Use diagrams and graphs to represent relationships and solve problems;

(5) Comparing mathematical models with reality.

1.5.4. Level and description of mathematical modeling competence

To be able to assess students' modeling ability in learning, the study of Ludwig & Xu (2010), has identified the modeling level.

On the basis of learning and based on the students' modeling competency components, the author has determined that the author evaluates the mathematical modeling ability according to the student's knowledge level to easily absorb the process steps to solve practical problems.

1.6. Chapter 1 conclusion

In chapter 1 of the dissertation, the author has learned and researched a number of issues that are important theoretical foundations of the dissertation.

The author of the dissertation has reviewed the research related to modeling; capacity in modeling and teaching modeling in some countries around the world and some dissertation research by the author of Laos. The author has clarified on some general issues such as: mathematical modeling, mathematical modeling, mathematical modeling competence.

The system is the mathematical modeling perspective, the diagram of the modeling process, in which the author has proposed the diagram of the modeling process. Moreover, it has a relationship with the elements of modeling competence and the skills of mathematical modeling, the above factors are the theoretical basis for the formation and development of this competence for the students.

Realizing that there is a relationship between the steps in the modeling process of the diagram from the studies of Pollak (1979), Hamson (2001), Nguyen Danh Nam (2016) and the components of the modeling capacity of the diagram. Maaβ (2006) and has since proposed the components and levels of modeling competence in teaching algebra.

Chapter 2
PRACTICAL BASIS

2.1. Algebra content in math curriculum and textbooks at high schools of the Lao People's Democratic Republic

2.1.1. Content and characteristics of algebra in the current math curriculum at high schools

2.2.2. Math problems with practical elements in high school algebra textbooks

2.2. The current situation of teaching algebra in high schools in the direction of developing mathematical modeling competence for students

2.2.1. Survey purpose

The purpose of the survey is to assess the mathematical modeling competence of high school students; exploring the current situation of teaching algebra in upper secondary schools of the Lao People's Democratic Republic.

2.2.2. Survey object and content

- Subjects are 54 teachers and 200 10^{th} graders of 7 high schools in Vientiane Capital.

- Content of surveying the current situation of teaching algebra in the direction of developing mathematical modeling competence for students and assessing mathematical modeling competence of high school students.

2.2.3. Survey methods

Survey by questionnaire: This method is used for the survey in high schools for selected subjects according to the identified contents.

For each questionnaire stated, the dissertation author asked about the level of modeling capacity development activities (with a score of 1 being the lowest and gradually increasing to a score of 4 being the best).

2.2.4. Analysis of the actual results

2.2.4.1. The current situation of teachers about the interest, necessity and implementation of using practical problems in the process of teaching algebra in high schools (investigation through questions 1 to 4, in Appendix 1)

2.2.4.2. Perception of teachers and students about the importance and necessity of organizing modeling activities in teaching algebra in high schools (questions 5 to 7, in Appendix 1)

2.2.4.3. Results of the assessment of mathematical modeling competence of high school students (questions 8 to 16, in Appendix 1)

2.2.4.4. Actual situation of feasibility and necessity to develop mathematical modeling capacity for students (question 17 to question 21, in Appendix 1)

2.3. Chapter 2 conclusion

Surveyed the current program of 10^{th} grade Math textbooks in algebra about the channels of pictures, exercises related to practice and found the number of interdisciplinary exercises, applied math exercises and practical situations.

Surveying the interest, necessity and implementation of using practical problems in the process of teaching algebra in high schools: teachers and students have an interest and need in the use of algebraic problems. Practical mathematics in the process of teaching algebra in high schools.

The awareness of teachers and students about the necessity of modeling activities in teaching algebra in high schools is important in the process of teaching mathematics at school.

Modeling capacity of teachers and students in high schools is still limited, while math curriculum and textbooks have not encouraged the application of mathematics in practice. The survey results have been specifically analyzed by the author for the level of each competency component. The survey results show important evidence for the dissertation author to propose appropriate measures to overcome the current limitations of teaching methods, contributing to the development of students' mathematical modeling competence.

Chapter 3
SOME PEDAGOGICAL MEASURES DEVELOPING STUDENTS' MODELING COMPETENCE THROUGH ALGEBRA TEACHING

3.1. Principles of building methods of teaching Algebra in high schools in the direction of developing modeling competence for students

Researching and proposing methods of teaching Algebra in the direction of developing mathematical modeling competence for high school students according to the following principles:

Principle 1: Pedagogical measures should be based on students' mathematical knowledge, students' mathematical understanding of other subjects and practice.

Principle 2: Pedagogical measures should be structured in a certain scientific order, ensuring systematic consistency of all elements of the development process.

Principle 3: Pedagogical measures must be feasible, effective, easy to implement, close to teachers and students, not too complicated.

Principle 4: Pedagogical measures must make an important contribution to helping students to well acquire mathematical knowledge and skills and complete subject tasks.

Principle 5: Pedagogical measures must highlight the focus on teaching algebra in high schools in the direction of developing students' mathematical modeling competence.

3.2. Some methods of teaching algebra in the direction of developing modeling competence for high school students

3.2.1. Measure 1: Train skills to switch from real-life situations to math problems

a) **The goal of the measure**

Help students understand the problem, describe the real situation; simplify and hypothesize the problem; determine the expression of the real model into a mathematical model.

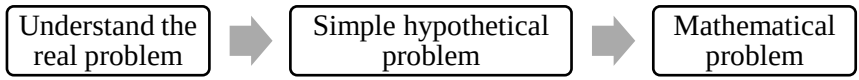
b) **The basis of the measure**

Before a real situation, the removal of unimportant factors, keeping the elements related to the problem to be solved, that is, the ability to recognize the problem that the student evaluates the level of modeling in the modeling process (Peter Galbraith, Haines, Izard & world, 1998).

According to Blum and Leiß (2006), Kaiser (2006), Niss (2012), when students enter the process of mathematization, the real situation has been specialised, idealized non-mathematical objects and relations into mathematical objects.

c) How to perform

The author suggested the following procedure:



It is the process of turning problems from practical to mathematical problems by creating their respective mathematical models.

- Understanding practical problems: Students understand a given real-life situation, students find a real model through the structure of a real-life situation or exercise.

- Simple hypothetical problem: Students collect data related to the problem, hypothesize the relationship between factors using mathematical language.

- Math problem: Students describe the real model and translate it into a math problem.

3.2.2. Measure 2: Practice the skills of setting up/building mathematical models

***a)* The goal of the measure**

Help students represent practical elements with concepts, appropriate mathematical notation, and establish a mathematical model of the problem.

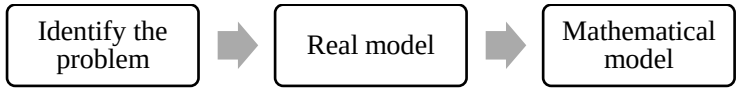
***b)* The basis of the measure**

Nguyen Danh Nam (2016) builds a mathematical model for a real-life situation by describing that situation in mathematical language.

Barbosa (2006), the support of information technology in the process of building models requires learners to focus on understanding formulas, setting parameters and adjusting models when necessary.

c) How to perform

The process of building mathematical models for practical situations is the process of describing events and phenomena in mathematical language.



- Defining the problem: Define the goal of the problem, simplify the real situation, and introduce the right variables to model the real situation.

- Real model: Represent the variables in the situation and select the important variables that describe the situation and express the real model.

- Mathematical models: Choosing to use mathematical models suitable to real-life situations, describing relationships between variables and establishing mathematical models.

Example: According to the regulations on installment payment at a car shop, uncle Phon has to pay the remaining 40,000 kip (no interest). The first month you pay 100,000 kip, and every month after

that you have to pay another 200,000 kip. So how many months does Mr. Phon have to pay to run out of money?

Solution:

- Determine the problem: Let S be the amount to be paid in kip (no interest), the first month to be paid is a kip, each additional month must be paid *d*. Let $n;(n>0,n\in N)$ be the number of months to pay as prescribed.

The first month to pay is a_1.

Because each month after that, you have to pay an additional amount of *d* kip. So the second month the payment is: a_1+d.

In general, the amount to be paid after the nth month is: $a_1+(n-1)d$.

- Real model: Let *S* be the amount to be paid (kip).

Each subsequent month must pay an additional fee of *d*, for a period of *n* months. We have the following table:

No.	The money have to pay
1st month	a_1
2nd month	a_1+d
3rd month	$a_1+d+d=2d$
4th month	$a_1+2d+d=a_1+3d$
.....	.....
Last month (*n*)	$a_1+(n-1)d$

- Mathematical model: The problem becomes: The amount to be paid is *S* kip (no interest), the first month to be paid is a kip, each additional month must be paid *d*, knowing the number of times (months) to be paid is calculated by the formula:

$$a_1+(a_1+d)+(a_1+2d)+(a_1+3d)+...+(a_1+(n-1)d)=S$$

$\Rightarrow S=\frac{n}{2}\left[2a_1+(n-1)d\right]$ is the arithmetic progression formula.

We have: $S=40000000;a_1=1000000;d=200000$

According to the formula, we have:

$$S = \frac{n}{2}\left[2a_1 + (n-1)d\right] \Leftrightarrow 40000000 = \frac{n}{2}\left[2.1000000 + (n-1)200000\right]$$

$$\Leftrightarrow 100000n^2 + 900000n - 40000000 = 0 \Leftrightarrow n^2 + 9n - 400 = 0$$

$$\Leftrightarrow (n+25)(n-16) = 0 \Rightarrow \begin{cases} n = -25 \\ n = 16 \end{cases}$$

According to the calculation formula from the above arithmetic progression, we have $n = -25$ (eliminated) $n = 16$ (satisfied). So, uncle Phon needs to pay the remaining installment for 16 months.

3.2.3. Measure 3: Practice skills in choosing mathematical models and solving problems

***a)* The goal of the measure**

Help students connect mathematical knowledge in real-world problems and solve established problems or problems.

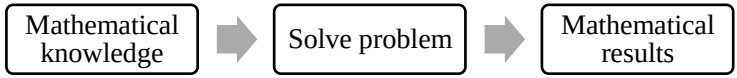
***b)* The basis of the measure**

According to Blum & Niss (1991), in addition to providing students with knowledge and skills related to mathematics such as concepts, theorems, formulas, and rules, teaching math needs to help students develop abilities connecting those knowledge and skills to solve real-life situations.

According to Nguyen Danh Nam (2016), modeling in teaching mathematics is the process of helping students learn and discover situations arising from reality using mathematical tools and language with the support of information technology.

c) How to perform

Training skills in choosing mathematical models, is done according to the proposed process as follows:



-Mathematical knowledge: Selecting appropriate mathematical tools and methods, connecting mathematical knowledge to solve problems.

- Problem solving: Apply appropriate mathematical methods and tools to solve mathematized problems or problems.

- Math results: Work in a mathematical environment to obtain mathematical results, analyze and represent relationships to draw conclusions.

3.2.4. Measure 4: Practice skills in using diagrams and graphs to represent relationships and solve problems

a) **The goal of the measure**

Help students represent situations with tables, charts, graphs, drawings, statistics that describe relationships between variables.

b) **The basis of the measure**

Van de Walle (2004), models describe mathematical concepts and the relationships between those concepts can be specific objects, pictures or drawings like using rectangular blocks to represent represent equal fractions.

Mathematical knowledge plays a fundamental role in the modeling process. It is directly related to mathematical modeling skills. To what extent learners reach in the modeling process depends on the mathematical knowledge they already have (Lester, 1987).

c) How to perform

Tables, charts, graphs,... are mathematical models that represent actual data and predict the trend of data distribution about certain objects and phenomena. Therefore, through the modeling process, teachers need to help students with mathematical models of data that are very close to life, etc. After representing the data with corresponding models, the instructor guides students how to read and make sense of these patterns.

3.2.5. Measure 5. Practice the skills of comparing mathematical models with reality

a) **The goal of the measure**

Help students test, evaluate, and adapt mathematical models; test problem solutions, draw conclusions and compare models with reality.

b) **The basis of the measure**

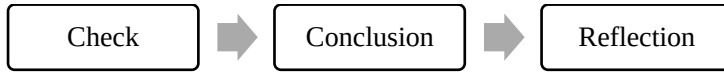
Freudenthal (2006), effective modeling depends on how prepared learners are. Furthermore, modeling competence is also considered as part of mathematical understanding, and modeling competence assessment contributes to clarifying the level of mathematical understanding of students.

Galbraith, Henn & Niss, (2007), researchers show that a degree of modeling competence often comes from recognizing and understanding the modeling process; work with modeling (recognize problems, build models, work with models, draw conclusions,...);

analyze the modeling process, evaluate the obtained modeling, reflect on the modeling process, and reflect on the results.

c) How to perform

The author proposes the process to implement this measure as follows:



- Check: Review the reasonableness of the built model and check the appropriateness of the mathematical results.

- Conclusion: Understand the meaning of the solution, report the results obtained and draw conclusions.

- Reflection: Reviewing assumptions, finding out the limitations of mathematical solutions, comparing mathematical models with reality, and applying mathematical models to similar situations.

Example: The service fee of Unitel's mobile network package has a subscription fee of 100,000 kip per month plus 150 kip per minute of calling. The package of mobile network of Lao Telecom company has a subscription fee of 80,000 kip per month plus 250 kip per minute of calling. In your opinion, which package will be more cost-effective (for one month)? Why?

Solution:

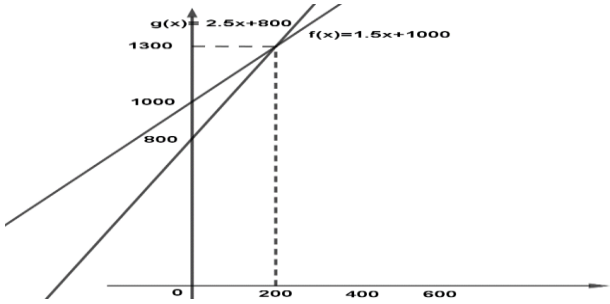
+ Step 1 (Understanding and building a mathematical model): Collect data and simplify the problem. The symbols f(x) and g(x) represent the amount (in kilograms) to pay, respectively, when using the mobile network package of Unitel and Lao Telecom for x minutes (including monthly subscription fee). The teacher asks students to represent f(x) and g(x) as expressions of x and draw graphs of two functions y = f(x) and function y = g(x) on the same system of coordinate axis.

+ Step 2 (Solving the problem): Students perform the task given by the teacher. Students discuss and make the following comments: In x minutes the amount to be paid on a Unitel call is: f(x) =100000+150x (kip). The amount to be paid to Lao Telecom in x minutes is: g(x) = 80,000 + 250x (kip). After the discussion, the students find that the costs paid to the two firms are the same after the time period that is the solution of the equation f(x) = g(x). From there, the teacher asks the

group of students to solve the equation: f(x) = g(x). Students in groups receive the task of solving equations: f(x) = g(x)

$100,000+150x=80,000+250x \Leftrightarrow 100x=20,000 \Leftrightarrow x=200$ minutes

Next, students draw graphs of two functions f(x) and g(x) on the same coordinate system.



Representation of the solution of the equation f(x) = g(x)

+ Step 3 (Understanding and explaining): Observing the student graph, it is found that immediately after a call arrives for 200 minutes, that is, if each month does not exceed 200 minutes, the cost of Lao Telecom will be much lower, so choose Lao Telecom's package is more effective and economical.

+ Step 4 (Test and apply): The teacher guides students to analyze the problem in the following cases:

- If you have a mobile call less than 200 minutes, choosing Lao Telecom's service will save more.

- If there is a call more than or equal to 200 minutes, you should choose Unitel's service.

However, in practice, a mobile network package may have usage limits according to the service regulations for the company's customers. Therefore, in this case, we should use the service package of Unitel company.

3.3. Chapter 3 conclusion

In the dissertation, some pedagogical measures have been proposed to develop modeling competence for students through teaching algebra.

In order to develop mathematical modeling competence for high school students, the author of the dissertation proposes 5 measures to

develop modeling competence for high school students through teaching content content. Algebra in the 10th grade Math textbook program of the Lao People's Democratic Republic.

Chapter 4
PEDAGOGICAL EXPERIENCE

4.1. Experimental purpose

- Testing the scientific hypothesis of the dissertation through teaching practice.
- Assess the feasibility and effectiveness of some measures.

4.2. Experimental organization

4.2.1. Subjects, experimental time

- Experimental time: From March 3, 2021 to April 7, 2021.
- Subjects: Students in selected classes to participate in the experiment and control in two 10th grades of PhaiLom High School, Vientiane Capital.

4.2.2. How to conduct the experiment?

- Step 1: Preparation.
- Step 2: Experimental teaching organization.
- Step 3: Evaluation of experimental results.

4.3. Experimental contents

- Compilation of experimental lessons on some teaching methods to develop the elements of modeling competence for students.
- Evaluate the effectiveness and feasibility of teaching to develop modeling competence for students through the content of algebra about first-order and quadratic functions in 10th grade textbooks.

4.4. Experimental results

4.4.1. General comments

+ Students enthusiastically participate in discussions to solve learning tasks.

+ Students were able to conduct discussions, comments, and draw conclusions on their own.

+ Students' task completion skills gradually increase after each lesson.

+ Students actively work, draw conclusions about the problem to be learned.

4.4.2. Effectiveness, necessity and feasibility of measures

- Survey method: The author asked for opinions by questionnaire.
- Subjects of the survey are high school math teachers.

- The formula for data processing is to use algorithms of mathematical statistical methods to calculate the weighted average of the levels to be evaluated for a criterion that must be evaluated according to the following formula:

$$\overline{x}_j = \frac{\sum_{i=1}^{n} f_i x_i}{\sum_{i=1}^{n} f_i}$$

The measures proposed by the author in the dissertation are all feasible in teaching and developing mathematical modeling competence for high school students. From the survey results and evaluate the necessity and feasibility of the proposed measures.

4.4.3. Assessment of students' mathematical modeling competence

Synthesize the results of the assessment of the modeling ability of students in the experimental class through the modeling activities designed in the experimental teaching process.

Evaluation table of modeling ability of experimental class students

No.	Component skills	Experimental class students	
		N=45	Ratio %
1	Moving from a real-life situation to a math problem	32	71,1%
2	Set up/build mathematical models	24	53,3%
3	Selecting mathematical models and solving problems	16	35,5%
4	Use diagrams and graphs to represent relationships and solutions to problems	9	20%
5	Comparing mathematical models with reality	4	8,8%

According to the data in the table above, the modeling competence of students is still limited, many students do not know how to turn a problem in practice into a problem in mathematics. Therefore, the percentage of students who can choose a mathematical model for the problem is still low. Especially the skill of using diagrams and graphs to represent relationships and solutions of problems; and comparing mathematical models with reality is still weak.

4.5. Assessment of experimental results

4.5.1. Quantitative assessment

Frequency distribution table of test results of experimental class and control class

Experimental class			Control class		
Score	Frequency	Total score	Score	Frequency	Total score
1	0	0	1	0	0
2	0	0	2	5	10
3	4	12	3	7	21
4	4	16	4	8	32
5	18	90	5	13	65
6	9	54	6	8	48
7	7	49	7	6	42
8	3	24	8	1	8
9	0	0	9	0	0
10	0	0	10	0	0
Total	45 (students)	245 (scores)	Total	48 (students)	226 (scores)
Mean score	5,44		Mean score	4,70	
Sample variance	1,55		Sample variance	2,37	
Standard deviation	1,24		Standard deviation	1,53	

In the above table, we can see that the average score of the output test of the experimental class is only slightly higher than the average score of the control class (0.74 points higher), with some students achieving quite high results 8/10 points; standard deviation of the control class test compared with the experimental class test (reduced from 1.53 to 1.24). To confirm the above point, we test the hypothesis H_0 that the output quality of the two classes is equivalent for $\overline{x}_1 > \overline{x}_2$, with level of significance $\alpha = 0.05$.

We have: $$|\theta_{tn}| = \frac{|5.44 - 4.70|}{\sqrt{\frac{1.55}{45} + \frac{2.37}{48}}} = 2.56 > 1.96 = \theta_b$$

This allows to reject the hypothesis H_0 or in other words: the teaching method in the experimental class has a better progress and development than the teaching method in the control class.

4.5.2. Qualitative assessments

The assessment shows that students' mathematical modeling capacity is still limited, at first, students are not familiar with modeling activities in the process, do not understand the steps of the modeling process. mathematics, so when performing the stages, they are still confused and confused.

As the pedagogical experiment progresses, observe and carefully record students' activities. At the end of each lesson, we conduct a discussion to draw experience, listen to the students' sharing, especially the students' interest in learning in the experimental class.

Thus, qualitatively, the above shows the results of the regular lesson and the lesson according to the experimental lesson plan. The results show that students in the experimental class actively participate in asking questions and actively participate in learning activities.

4.6. Chapter 4 conclusion

Experimental results show that: With the teaching method of pedagogical experimental lesson plans, students of the pedagogical experiment class are more interested, because they are trained in skills to develop modeling capacity, so the capacity is developed. forward. The learning results of the experimental class showed that the students of the experimental class understood the lesson better than the control class, and demonstrated better problems when applying the modeling method to solve practical problems. From there, it shows the feasibility and effectiveness of the proposed lesson plans. The pedagogical experimental results partly demonstrate the feasibility of the content and the way of organizing teaching in the direction of developing modeling competence for students. The pedagogical experimental results show that the research purpose is correct. The pedagogical hypothesis is accepted and the research task is completed, the topic is completely feasible in the implementation of teaching mathematics for high schools.

CONCLUSION AND RECOMMENDATION

Conclusion:

The dissertation has obtained the following main results:

- An overview, analysis and synthesis of theoretical and practical issues related to modeling such as: Concepts of modeling, modeling capacity, modeling methods in teaching mathematics, suggestions modeling process in high school math teaching, proposing components and levels of modeling competence.

- Through the investigation of the current situation, the dissertation has clarified a number of current situations and limitations of students' modeling ability and proposed a teaching plan in the direction of developing modeling competence, contributing to overcoming some difficult problems to teach this method.

- Proposing some pedagogical measures to develop modeling capacity for high school students through teaching the content of algebra in the 10^{th} grade math textbook program of the Lao Peoples' Democratic Republic. The dissertation has presented examples to illustrate and clarify teaching methods and organization.

- The dissertation results have been tested through teaching experimental pedagogy and having a control class at PhaiLom high school and analyzing students' learning outcomes during the time period when teaching experimentally at the school.

From the above results, it can be concluded that: The scientific hypothesis of the dissertation is acceptable, the research task of the topic has been completed, the contributions of the dissertation can be deployed and applied in practice.

Recommendation:

- Research and apply modeling method in teaching some other content of Mathematics such as geometry, analysis, probability - statistics, etc. in high school of the Lao People's Democratic Republic.

- Research on the use of mathematical models in teaching mathematics in the direction associated with practical contexts.