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TEACHING CALCULUS IN GRADE 11 IN THE LAO PEOPLE'S DEMOCRATIC REPUBLIC IN THE DIRECTION OF DEVELOPING STUDENTS' MATHEMATICAL PROBLEM-SOLVING COMPETENCE

Speciality: Theory and Methodology of Mathematics Teaching
Code: 9140111

DISSERTATION SUMMRY

THAI NGUYEN - 2025

The dissertation was finished at:
Thai Nguyen University - University of Education

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The dissertation will be defended in the University committee:

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At …... hours, on the ……. day of ……..., 2025

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INTRODUCTION

1. Reasons for choosing the topic

1.1. The Lao People's Democratic Republic is currently in a period of strong innovation in many areas, in which education is given special attention. To meet the needs of national development, the Lao education sector needs to implement comprehensive reforms to train high-quality human resources with adequate knowledge, skills, creative thinking and good moral qualities.

1.2. Mathematics in high school is a fundamental subject, highly abstract and general.

1.3. However, the current state of education in the Lao People's Democratic Republic, especially the teaching of Mathematics, still has many limitations. The process of imparting knowledge is still mainly in the traditional way, students have few opportunities to participate in research, observation, experimentation, creativity and application of knowledge into practice (Pathoumma & Trinh, 2024). This situation is especially evident at the junior high and high school levels, where teaching methods still lean towards theory and memorization, making students lack the ability to apply knowledge to real-life situations. This limits the formation and full development of students' problem-solving ability, especially when they are faced with problems that require creative thinking. Therefore, innovating the teaching method of Mathematics to promote students' positivity and creativity is an urgent need to improve the quality of mathematics education in Laos.

1.4. The Lao People's Democratic Republic's Grade 11 Mathematics Program sets out specific goals to develop students' mathematical competencies, including: (1) being able to ask and answer questions appropriately when reasoning and solving problems; (2) being proficient in using reasoning methods such as induction and deduction; (3) building mathematical models from practical situations and coming up with appropriate solutions; (4) implementing, presenting and evaluating solutions to problems; and (5) effectively using tools, especially Information Technology, in learning, exploring and solving mathematical problems (Ministry of Education and Sports of Laos, 2015). These requirements ensure that grade 11 students are

equipped with a solid foundation of mathematical knowledge and skills, helping them to be ready to solve learning problems at higher levels of education as well as in real life.

Based on the above reasons, I chose to research the topic: ***"Teaching Calculus in Grade 11 in the Lao People's Democratic Republic in the direction of developing students' mathematical problem-solving competence".***

2. Research purpose

The purpose of the thesis is to clarify the theoretical and practical basis related to the development of problem-solving capacity for high school students. On that basis, the thesis proposes specific pedagogical measures to organize 11th grade Analysis teaching in the Lao People's Democratic Republic in the direction of developing problem-solving capacity for students, contributing to improving the quality of teaching 11th grade Analysis in the Lao People's Democratic Republic .

3. Research questions

(1) What are the specific components and manifestations of problem-solving ability in teaching 11th grade Analysis?

(2) What is the current status of developing problem-solving skills for students in teaching 11th grade analysis in Laos? What are the causes of these limitations?

(3) What pedagogical measures should be used to effectively develop problem-solving skills for students in teaching 11th grade Analysis in Laos?

4. Research tasks

- Theoretical basis research: Clarifying the concept and determining the components of problem-solving capacity in teaching Calculus grade 11; Determining the problem-solving capacity framework and describing in detail the specific manifestations of this capacity in teaching Calculus grade 11 at high schools in the Lao People's Democratic Republic .

- Assessing the current situation: Surveying the current situation of problem-solving capacity development of grade 11 students in the Lao People's Democratic Republic through research tools such as survey forms, in-depth interviews and classroom observations; Analyzing and evaluating the causes leading to limitations in developing students' problem-solving capacity, including factors from teachers, students,

educational programs and actual teaching and learning environment conditions in Laos.

- Proposing pedagogical measures: Develop and propose specific pedagogical measures to effectively organize teaching activities of Analysis subject for grade 11 in the direction of developing problem-solving capacity for students, focusing on building practical problem situations and encouraging students to actively participate in solving them. Design illustrative teaching activities and specific lesson plans suitable to the characteristics of the general education program in the People's Democratic Republic. Laos, using information technology as a tool to support teaching and learning organization.

- Pedagogical experiment: Implement pedagogical experiments to test the proposed pedagogical measures in the actual teaching environment at selected high schools in Laos; Analyze and evaluate the effectiveness of pedagogical measures through learning outcomes, indicators measuring the level of students' capacity development, and collect feedback from teachers and students to confirm the feasibility and effectiveness of the applied measures.

The above research tasks will contribute to clarifying the research problem and creating a practical basis for improving the quality of mathematics education, especially problem-solving ability for high school students in the Lao People's Democratic Republic .

5. Research object and subject

5.1. Research object: The process of teaching calculus grade 11 in the direction of developing problem-solving capacity at high schools in the Democratic Republic of Vietnam. Laos.

5.2. Research object: Pedagogical measures to develop problem-solving capacity of grade 11 students at Xaysomboun high school, Xaysomboun province, Lao People's Democratic Republic .

6. Scientific hypothesis

If appropriate pedagogical measures are developed and applied to organize the teaching of 11th grade Analysis in the direction of developing problem-solving capacity for high school students in the Lao People's Democratic Republic, it will contribute to improving students' problem-solving capacity and improving the quality of teaching Mathematics in general and 11th grade Analysis in particular.

7. Research methods

The thesis uses a combination of the following research methods:

7.1. Theoretical research methods

7.2. Survey investigation method

7.3. Pedagogical experimental method

8. Arguments put forward in defense

The thesis defends the following main arguments:

8.1. The problem-solving capacity of high school students has a clear structure and can be assessed: The thesis determines that the problem-solving capacity of high school students is not only the ability to solve problematic situations but also includes the flexible mobilization of knowledge, skills, attitudes and experiences to achieve effective results in learning and life. The components and levels of expression of this capacity are clarified by the thesis, in accordance with the practical educational conditions in high schools in the Lao People's Democratic Republic .

8.2. The pedagogical measures proposed in the thesis are feasible and effective in developing problem-solving skills for students in teaching 11th grade analysis. The thesis defends the thesis that designing problem situations in teaching 11th grade analysis, combined with active teaching methods, applying information technology and organizing learning activities suitable to the educational context of Laos, are feasible and effective measures. The results of pedagogical experiments have demonstrated that these measures contribute significantly to developing students' problem-solving skills, while improving the quality of teaching 11th grade mathematics in the Lao People's Democratic Republic .

9. Contributions of the thesis

9.1. In theory

The thesis clarifies the concept of problem-solving capacity of high school students; analyzes the characteristics and nature of teaching in the direction of developing problem-solving capacity through teaching activities of 11th grade Analysis. At the same time, the thesis has identified and described in detail the components as well as the levels of expression of problem-solving capacity, contributing to the theoretical basis for the formation, fostering and assessment of this capacity in high school students.

9.2. In practice

The thesis proposes specific and feasible pedagogical measures to organize the teaching of Mathematics (Analysis grade 11) in the Lao People's Democratic Republic in the direction of developing problem-solving capacity for students, thereby improving the effectiveness of teaching Mathematics in high schools.

The thesis builds a system of exercises and problematic situations closely related to practice, providing a useful source of reference materials for high school mathematics teachers in the Lao People's Democratic Republic, helping teachers more conveniently apply the proposed pedagogical measures in the teaching and learning process.

10. Structure of the thesis

In addition to the Introduction, Conclusion, References and Appendices, the thesis is structured into 5 specific chapters as follows:

Chapter 1: Research Overview

Chapter 2: Theoretical basis

Chapter 3: Practical basis

Chapter 4: Some pedagogical measures to organize the teaching of Analysis in grade 11 towards developing problem-solving ability for students in the Lao People's Democratic Republic

Chapter 5: Pedagogical experiment

Chapter 1: RESEARCH OVERVIEW

1.1. Overview of studies on problem-solving capacity development

1.1.1. Overview of studies discussing the concept and importance of problem-solving ability in teaching mathematics

1.1.2. Overview of research on developing problem-solving skills in mathematics

1.1.3. Some discussions and proposals

Developing problem-solving skills for students is a difficult but feasible task if there is synchronization between the program, teachers, students and the assessment system. Research in Laos has only stopped at the level of proposing measures, and has not yet built a theoretical framework and standardized assessment tools. Therefore, the thesis will inherit and continue to develop in this direction: building a problem-solving capacity framework in teaching Calculus 11, designing a system of assessment tasks, and proposing measures to organize

classes suitable for the context of the Lao People's Democratic Republic .

1.2. Overview of research on problem-solving teaching

1.2.1. Overview of research on the concept of problem-solving teaching

1.2.2. Overview of research on teaching methods and models towards developing problem-solving capacity

1.2.3. Overview of studies on the current situation and challenges in teaching towards developing problem-solving skills

1.2.4. Some discussions and proposals

It can be seen that teaching mathematics in the direction of developing problem-solving ability is an inevitable and promising trend. However, to successfully apply it in a specific educational environment (like in Laos), specific research is needed to find the most suitable model and measures for the students, teacher conditions and facilities there. This is the task that the author of the thesis will focus on in the following chapters of the thesis, aiming to propose feasible measures to organize the teaching of the 11th grade Analysis program in Laos in the direction of developing problem-solving ability for students.

1.3. Overview of research on teaching 11th grade analysis towards developing students' problem-solving ability

The research overview shows that there are many positive results in teaching mathematics to develop problem-solving skills for students, but in Laos this is still a new and unexploited direction. In particular, teaching Calculus 11 - with important contents such as functions and derivatives - in the direction of problem-solving skills for Lao students has never been systematically studied. This confirms the urgency and significance of the thesis topic. The overview results also suggest to the thesis author valuable ideas and experiences to apply in the research process: from designing problem situations, choosing appropriate practical problems, to organizing group activities, using supporting technology or methods to assess students' abilities. Lessons from previous studies will be distilled and developed in the following chapters, aiming to build a teaching model for Calculus 11 suitable for Lao reality, contributing to improving the quality of mathematics teaching and developing problem-solving skills for students.

1.4. Conclusion of Chapter 1

From an overview of domestic and foreign research, the following main conclusions can be drawn:

(1) The ability to solve mathematical problems has been affirmed as an essential goal of modern mathematics education.

(2) Regarding teaching methods, problem-solving teaching is an effective method to achieve the above goal.

(3). Previous studies have achieved many experimental results in teaching mathematics to develop problem-solving skills , especially at high school level.

Based on the above conclusions, the author of the thesis determines the key task of the thesis as: Building and experimenting with teaching methods for Calculus 11 in Laos in the direction of developing problem-solving capacity for students. The analysis in Chapter 1 has created a foundation for the author of the thesis to confidently implement the next research steps, hoping to contribute a new approach to improving the quality of mathematics teaching in the Lao People's Democratic Republic.

Chapter 2
THEORETICAL BASIS

2.1. Some basic concepts in the thesis

2.1.1. Problems and problematic situations

2.1.1.1. Problem

In this thesis, the concept of "problem" in teaching mathematics is understood as a challenging task, requiring students to overcome obstacles by thinking creatively and applying knowledge flexibly. It is not only an assessment tool but also a means to develop comprehensive mathematical competence. The effective use of problems can help students develop critical and creative thinking, thereby improving the quality of teaching.

2.1.1.2. Problem solving

Based on the above views, "problem solving" in mathematics teaching can be defined as follows: *"Problem solving" is a complex cognitive process in which students use knowledge, skills and creative*

thinking to find ways to solve mathematical tasks for which they do not have a clear solution. This process includes problem identification, planning to solve, implementing the plan and evaluating the results, and requires a combination of cognitive skills, metacognition and emotional factors such as motivation and beliefs.

2.1.1.3. Problematic situations

The author of the thesis defines "problematic situation" in mathematics teaching as follows: *"Problematic situation" is a pedagogical context intentionally created by the teacher, containing a mathematical task that students cannot solve immediately. This situation creates a cognitive contradiction, forcing students to think creatively, explore and flexibly apply existing knowledge and skills to find a solution. To put it more simply, a problematic situation is a combination of a situation (specific circumstances) and a problem (unsolved task). It is not just a difficult question, but also a learning experience that stimulates curiosity and urges learners to act to overcome obstacles.*

2.1.1.4. Common ways to create problem situations

2.1.2. Mathematical problem solving ability

2.1.2.1. Capacity

In this thesis, the author believes that: "Competence is the ability of an individual to mobilize and effectively apply knowledge, skills, attitudes and experience to successfully solve tasks in specific situations".

2.1.2.2. Mathematical problem solving ability

In this study, problem-solving ability is understood as the ability of students to effectively and creatively apply knowledge, skills, attitudes, values and personal motivation to solve new and complex mathematical situations, contributing to the development of logical thinking, creativity and the ability to apply mathematics in practice.

2.1.2.3. Teaching and learning oriented towards developing problem-solving skills

From the above analysis, the thesis defines: *Teaching with the orientation of developing problem-solving capacity is the process of organizing learning activities in which students are placed in situations with practical or academic problems, requiring the mobilization of knowledge, skills and attitudes to analyze, propose and*

implement appropriate solutions, thereby comprehensively developing the capacity to think, act and adapt to reality.

Therefore, although the way each author divides the stages may be different, the general nature still emphasizes the active process of the learner in facing, analyzing, proposing hypotheses and testing solutions to find the most suitable solution. The classic problem-solving model proposed by Polya (1957) with four steps: (1) understanding the problem, (2) planning the solution, (3) implementing the plan and (4) checking, still retains its fundamental value in mathematics education. This model was later extended by authors such as Schoenfeld (1985), Mayer (1992), and Jonassen (2000) into teaching stages to develop students' higher-order thinking . In Vietnam, many authors also emphasize the role of the problem-solving process as the basis for organizing teaching activities to develop capacity (Nguyen Ba Kim, 2003; Nguyen Cong Khanh, 2016; Vu Duong Thao, 2022). From the analysis of the concept of Problem-Solving Capacity, it is possible to build a corresponding teaching process to systematically develop this capacity.

Step 1: Identify and understand the problem. In this step, students are exposed to a situation with a practical problem or one related to the mathematical content they are learning. Students have the task of identifying the problem that needs to be solved, clarifying the requirements of the problem, and thereby discovering the connection between the problem and the knowledge they have learned. This is the first step in developing the component capacity - recognizing and discovering problems that need to be solved using mathematics (Polya, 1957; Vu Duong Thao, 2022).

Step 2: Propose and select solutions. After understanding the problem, students think, discuss and propose possible solutions. This process requires students to flexibly mobilize knowledge, experience and reasoning skills. Teachers play a guiding role, asking open-ended questions so that students can evaluate the feasibility of the solutions and choose a reasonable solution. This is the basis for developing the second component capacity - selecting and proposing solutions (Jonassen, 2000; Nguyen Cong Khanh, 2016).

Step 3: Implement and present the solution. Students implement the solution according to the chosen plan, ensuring

logic, accuracy and clarity in the presentation. The use of supporting tools such as mathematical software, mind maps or illustrations can also be encouraged to increase visualization. This step aims to develop the third component competency - implementing and presenting the problem-solving solution (Schoenfeld, 1985).

Step 4: Evaluation, generalization and application. Students evaluate the solution: compare it with other options, detect errors (if any), make corrections and draw lessons. At the same time, students are encouraged to generalize the solution, and then apply it to similar situations or other practical situations. This is the stage of developing the fourth component capacity - testing, evaluation, generalization and practical application (Mayer, 1992; Nguyen Ba Kim, 2003).

Thus, teaching with the orientation of developing problem-solving capacity not only helps students acquire knowledge, but also contributes to forming creative thinking skills, the ability to solve practical problems, creating a foundation for self-study and sustainable self-development.

2.2. Problem-solving ability in teaching Analysis

2.2.1. Components of mathematical problem-solving ability

This thesis proposes a framework of mathematical problem-solving competencies in high school with four main components:

- Recognize and discover problems that can be solved using mathematics: Identify situations that contain problems; collect, organize and evaluate relevant information; share understanding with others.

- Select and propose methods and solutions to solve problems: Select appropriate solution methods; establish a concise and optimal problem-solving process.

- Implement and present problem-solving solutions: Implement problem-solving steps logically and accurately; present solutions clearly and appropriately to the audience.

- Testing, evaluating, generalizing and applying in practice: Analyze and evaluate the effectiveness of solutions; generalize and apply solutions to similar or practical problems.

Thus, the four components of mathematical problem-solving competence are identified based on the inheritance and development of

international theoretical frameworks (Pólya, PISA, NCTM, TIMSS) and educational orientation in Laos, and are concretized into observable and assessable actions in the classroom. This competence framework reflects a seamless process from problem recognition to testing, generalization and application, ensuring both scientificity and suitability to the context of teaching Calculus in Lao high schools.

2.2.2. Level of mathematical problem solving ability

On that basis, this thesis divides three levels for each component of mathematical problem-solving ability, including: Basic - Achieved - Proficient. The selection of three levels is to ensure feasibility in assessment , avoid complexity when dividing too many levels, and at the same time still enough to reflect the differences and development process of students' abilities . In which:

- Basic Level: Students are just in the capacity formation stage, performing tasks is still confused, incomplete, inaccurate or unstable.
- Attainment Level: Students complete the basic requirements of the task, are able to apply knowledge and skills relatively effectively, but are limited in terms of optimization, flexibility or coherence in presentation.
- Proficiency Level: Students can perform tasks independently, accurately, logically, know how to check and adjust the process, and have the ability to generalize and apply to new situations.

Through analysis, it can be seen that Student A is assessed as proficient in elements 1 and 3, but only achieved elements 2 and 4. Thus, the level of development of his problem-solving ability is not uniform among the elements. This result provides important information for teachers: it is necessary to focus on further training the ability to explain solution choices (element 2) and check and evaluate results (element 4). This demonstrates the feasibility and practical value of Table 2.3, because the table not only classifies according to the overall level but also allows to determine the specific advantages and disadvantages of each element of problem-solving ability.

2.2.3. Demonstration of students' problem-solving ability in teaching 11th grade analysis in Lao PDR

2.2.3.1. Requirements to be achieved in the 11th grade analysis program of the Lao People's Democratic Republic

In teaching Calculus for the second semester in the Grade 11 Math textbook of the general education program of the Lao People's Democratic Republic, there are 8 lessons. The content, requirements and time allocation of the lessons are shown in Table 2.3 . Table 2.3 1Content of the Calculus lessons in the Grade 11 Math textbook of the Lao People's Democratic Republic

2.2.3.2. Demonstration of students' problem-solving ability in teaching 11th grade Analysis in the Lao People's Democratic Republic

Based on the proposed problem-solving competency framework and the content of the 11th grade Analysis program in the Lao People's Democratic Republic , the specific manifestations of each component competency in the teaching context are constructed as follows: ***Table 2.4. Expression of problem-solving ability of students in learning Calculus grade 11 in the Democratic Republic of Vietnam Laos***

Illustrative examples for each component competency in teaching Analysis grade 11 in Lao People's Democratic Republic . Consider the following real-life problem:

A manufacturing company wants to maximize profits. The function representing production costs as a function of the number of units produced is:$C(x) = x^3 - 6x^2 + 9x + 4$ and the revenue function according to the number of products is: $R(x) = 10x$. Determine the number of products $x$at which profit $\mathrm{P(x)} = \mathrm{R(x)} - \mathrm{C(x)}$reaches its maximum value.

Component capacity 1. Recognizing and detecting problems

Component capacity 2. Select and propose solutions

Component capacity 3. Implement and present solutions

Component capacity 4. Test, evaluate, generalize and apply

2.3. Assessment of students ' problem-solving abilities

2.3.1. Objectives and contents of evaluating the manifestations of problem-solving ability in teaching calculus for grade 11 students in the Lao People's Democratic Republic

- Determine students' level of mastery of knowledge and skills in Calculus topics (limits, derivatives, function surveys, integration, etc.), thereby assessing their ability to apply them to solving practical and highly conceptual mathematical tasks.

- Identify strengths and weaknesses in mathematical thinking, the ability to select and implement problem-solving strategies, and the ability to self-assess, review, and draw conclusions from the problem-solving process.

- Create a basis for adjusting teaching methods and building personalized support plans to help students develop problem-solving skills.

- Contribute to the comprehensive development of students' capacities, including problem-solving capacity.

- Ensure transparency and objectivity in recognizing learning outcomes, thereby supporting the assessment, classification and career orientation of students according to individual abilities.

2.3.2. Methods and forms of assessment

To assess the manifestations of effective problem-solving skills, teachers should use a variety of assessment methods and forms such as:

- Observe students as they solve problems in class. For example, teachers observe how students perform the steps of examining functions, comment on how students plan and organize their thinking when solving problems about the extreme values of cubic functions.

- Research problem-solving products. For example, evaluate learning products such as written tests on limits and function survey reports to clearly determine each student's specific problem-solving ability.

- Question and answer and group discussion. For example: Teachers organize group discussions for students about the steps to solve problems of calculating limits of indeterminate functions, thereby assessing communication skills and critical thinking.

- Self-assessment and peer assessment. For example, students use a self-assessment chart to reflect on their own and their classmates' performance on limit and function problems, helping them to become more aware of their strengths and weaknesses.

2.3.4. Tools for assessing the manifestations of problem-solving ability

To assess the manifestations of problem-solving ability in teaching 11th grade Analytical Mathematics in Lao People's

Democratic Republic, this study used the rubric, a widely used tool in educational research to determine learners' achievement levels based on clear criteria and specific levels of description (Brookhart, 2018; Moskal, 2000).

The rubric structure is designed according to the four components of problem-solving competence identified in the previous section: (1) Recognizing and detecting problems; (2) Selecting and proposing solutions; (3) Implementing and presenting solutions; (4) Checking, evaluating, generalizing and applying. Each component is divided into three levels: Basic (1 point), Achieved (2 points), Proficient (3 points), in accordance with the detailed description in Table 2.4. The determination of these three levels is based on the 3-level rubric scale, which is recommended in educational research to ensure simplicity, ease of observation and feasibility in classroom assessment (Jonsson & Svingby, 2007). The 1-3 scale was chosen because it directly reflects three levels of progress from low to high, while ensuring compatibility with the proficiency scale system in competency studies (Sadler, 2009).

2.4. Conclusion of Chapter 2

This chapter has systematically presented the theoretical foundations related to problems, problem solving, the concept of competence, and delved into the specific components of problem-solving competence in the context of teaching 11th grade Analysis. From the theoretical overview, the chapter has clarified the concept of "problem" as tasks or questions for which students do not have specific solutions immediately, requiring creative thinking and efforts to find suitable solutions.

Chapter 3: PRACTICAL BASIS

3.1. Survey purpose

The main purpose of the survey is to comprehensively, objectively and accurately assess the current situation of problem-solving ability of high school students as well as the current situation of fostering this ability in the process of teaching Mathematics, especially Analysis in grade 11. The survey aims to clearly identify the limitations and shortcomings in the teaching and learning process, and

at the same time find out the specific causes leading to these limitations. Based on the results obtained, the research aims to propose feasible SP solutions to overcome existing problems, contributing to improving the quality and effectiveness of innovative teaching methods.

3.2. The current situation of problem-solving ability of high school students in the Lao People's Democratic Republic in teaching 11th grade Analysis

3.2.1. Survey methods and tools

3.2.2. Survey subjects

3.2.3. Student survey results

3.2.3.1. Questionnaire survey results

a) On the level of problem-solving ability and problem-solving activities of students.

b) On the assessment of students' problem-solving abilities during the teaching and learning process

c) Factors affecting students' problem-solving ability

3.2.3.2. Survey results through test

3.2.4. Teacher survey results and field observations

a) Perception, methods and tools for assessing the manifestations of students' problem-solving ability in Mathematics

b) Observation results were conducted through observing teaching hours, reviewing lesson plans and analyzing student tests graded by math teachers.

3.3. Some conclusions drawn from the survey

3.3.1. Some advantages and limitations in problem-solving ability in Mathematics of high school students in the Lao People's Democratic Republic

Survey and observation results show that high school students' problem-solving ability in Mathematics has shown positive signs but there are still many limitations that need to be overcome.

In terms of advantages, students have initially formed a positive attitude towards tasks of discovering and solving problems; more than 70% of teachers participating in the survey said that students showed interest and good cooperation when participating in group discussion activities, solving practical problems, and at the same time had the ability to apply knowledge to solve similar exercises at a fairly good level. These figures demonstrate that the innovation in teaching methods has created

conditions for students to approach capacity development activities more naturally than before.

However, the limitations are also very clear. More than 60% of teachers noted that students still lack confidence when participating in problem solving, are often hesitant in open situations, rarely come up with different solutions and still depend on direct guidance from teachers. The results of the test analysis show that only 25% of the tests have detailed comments to help students recognize their strengths and weaknesses; the rest either have no comments or general comments, making students lack a basis for self-assessment and improving their abilities. The perspective from the students themselves in the self-assessment section also reflects this discrepancy: many students are confident in their ability to do the test but the actual results are not up to par, proving that they do not have specific criteria to objectively assess their abilities. Thus, while students have made progress in their attitudes and ability to apply knowledge at a basic level, the in-depth development of competency components such as problem recognition, analysis, evaluation and effective solution proposal is still limited, requiring systematic support from teachers and the learning environment.

3.3.2. Some advantages and difficulties in teaching Math for grade 11 in the direction of developing problem-solving ability for students in the Lao People's Democratic Republic

The survey showed that the teaching environment for Grade 11 Mathematics in the Lao People's Democratic Republic had certain favorable conditions for developing problem-solving skills, but there were also systematic difficulties.

On the positive side, the majority of teachers have clearly recognized the role of this ability: more than 80% affirmed that developing problem-solving ability is important in improving the quality of teaching Analysis, and 71.9% said that they have initially applied methods of detecting and solving problems, combined with group discussions and practical exercises in teaching. Many students also showed interest and excitement in applied problems, considering them as opportunities to apply knowledge in practice, which creates a positive psychological basis for implementing innovative measures.

However, the difficulty comes from the difference between the

perception and practice of teachers and students. Only about half of teachers are confident in organizing a system of problem situations, the number of people who regularly exploit students' incorrect or incomplete solutions is only about 20-25%, and the rate of using modern tools such as rubrics is very low. More than 56% of teachers reflect that the information technology infrastructure does not meet the requirements for organizing technology-supported activities, while most students are still familiar with traditional learning methods, lacking self-assessment and critical thinking skills. The lack of synchronization between teachers' perception and organizational capacity and students' ability to receive and respond leads to low efficiency in developing problem-solving skills.

3.3.3. Some causes of the current situation

After conducting a questionnaire survey to determine the current situation of problem-solving skills in teaching Mathematics in Laos, the study continued to conduct interviews with teachers to gain a deeper understanding of the causes leading to this situation. The causes presented below are the results of the analysis from the interview data, reflecting both objective and subjective factors in the teaching and learning process.

Regarding objective reasons, the current program is still heavy on theoretical knowledge, not paying due attention to training practical skills. The tight schedule puts pressure on teachers, making it difficult for them to spend more time on creative activities and capacity development. Factors such as professional training materials on teaching methods for capacity, facilities (computer rooms, teaching software) and other modern means are still lacking in some educational institutions. This creates a major barrier in implementing innovative teaching methods. Students are not familiar with self-assessment of their own abilities, leading to a lack of confidence and dependence on teachers. Students are still accustomed to passive learning methods, with little initiative in exploring and solving problems.

On the teachers' side, many said they lacked confidence in organizing activities to develop problem-solving skills. for students, mainly due to lack of experience and inadequate training in competency-based teaching methods. The survey results from the questionnaire also demonstrate this: about 60% of teachers (38/64)

admitted to having difficulties in designing and organizing the problem situation system (Problem Situation), reflecting the limitations of modern pedagogical skills and practical experience.

To overcome these limitations, a comprehensive solution is needed: updating the curriculum to incorporate more problem-solving skills training activities; enhancing training and professional development for teachers in modern teaching methods; and investing in educational technology to support innovation in assessment and learning organization. These changes will not only contribute to improving students' problem-solving skills but also improve the quality of mathematics teaching in the Lao People's Democratic Republic.

3.4. Conclusion of Chapter 3

The study investigated the current situation of problem-solving capacity development through collecting and analyzing data from 64 mathematics teachers and 247 grade 11 students at high schools in Xaysomboun province. Through this survey, the research team made specific comments on the current situation of students' problem-solving capacity as well as the current situation of problem-solving capacity development in teaching mathematics at high schools today.

Chapter 4
SOME PEDAGOGICAL MEASURES TO ORGANIZATE MATH TEACHING GRADE 11 IN THE DIRECTION OF DEVELOPING PROBLEM-SOLVING ABILITY FOR STUDENTS IN THE LAOS PEOPLE'S DEMOCRATIC REPUBLIC

4.1. Orientation for building teaching methods for Calculus 11 towards developing problem-solving ability for students

In order to develop pedagogical measures to organize the teaching of Analysis subject in grade 11 towards developing problem-solving capacity for high school students in the Lao People's Democratic Republic, the author proposes the following basic orientations:

Orientation 1: Measures must be consistent with the current trend of educational innovation in the Lao People's Democratic Republic. According to the Lao Ministry of Education and Sports (2016), general education needs to shift from passive knowledge transfer to active, proactive development of learners' capacity (Lao Ministry of Education and Sports, 2016). Therefore, proposed measures need to focus on exploiting and constructing problematic situations, in order to form and develop students' mathematical problem-solving capacity throughout the entire teaching and learning process.

Orientation 2: Measures must be based on the program content and textbooks (Textbooks) Calculus Grade 11 currently being applied in the Lao People's Democratic Republic. According to Nguyen Ba Kim (2011), to develop problem-solving skills, it is necessary to choose knowledge content that has a lot of potential to promote thinking ability and apply mathematical knowledge into practice. Therefore, the proposed situations need to come from specific content in the current program, ensuring authenticity and applicability in teaching practice in high schools.

Orientation 3: Measures should be based on the principle of exploiting and collecting existing situations in current teaching materials, while expanding and improving those mathematical situations to suit diverse practical contexts. Bui Huy Ngoc (2000) believes that practical problems play an important role in helping students better understand the application of mathematics in life, thereby improving their creative thinking ability and problem-solving skills. Therefore, exploited situations should aim to connect mathematical knowledge with practical problems close to the lives of students in the Lao People's Democratic Republic.

Orientation 4: Measures to build situations need to impact each specific component of problem-solving ability. This is based on the research of Tran Vui (2014), which asserts that effective mathematical problem solving must focus on each component such as problem recognition, analysis and determination of solutions, selection of appropriate strategies and evaluation of results. Therefore, proposed

measures need to specify each teaching activity, focus on overcoming practical difficulties and obstacles that students often encounter, ensure feasibility and suitability with practical conditions in high schools of the Lao People's Democratic Republic.

4.2. Some pedagogical measures to develop problem-solving skills in teaching calculus grade 11 for students

4.2.1. Measure 1: Organize teaching using a system of problem situations to develop students' problem-solving skills through teaching calculus.

a) Objectives of the measure

- Develop students' problem-solving ability through approaching and solving problem situations (Problem situations) in the content of Calculus 11. Help students practice the components of problem-solving ability, focusing on 2 main components: problem recognition and choosing and proposing solutions.

- Overcoming the lack of problem situation systems and competency-oriented teaching materials. From there, develop students' mathematical problem-solving ability through organizing teaching based on problem situation systems suitable for the content of the 11th grade Calculus program.

b) Basis of measures

c) How to implement the measure

d) Example of implementing the measure

Example 4.1. *Teaching the concept of exponential functions*

Example 4.2. *Teaching monotonicity of exponential functions*

Example 4.3 *. Teaching how to solve derivative exercises: Application to finding extreme values*

Example 4.4 *. Teaching logarithms*

4.2.2. Measure 2: Exploiting solutions to problems containing errors or incompleteness to train students' problem-solving skills

a) Objectives of the measure

- Develop students' problem-solving skills through analyzing, evaluating, and correcting incorrect or incomplete solutions. Create conditions for students to identify and overcome typical errors in the problem-solving process, thereby improving the quality of learning Calculus 11.

- Helps students develop critical thinking, analytical skills and

self -evaluation of solutions. Contributes to the comprehensive development of problem-solving skills , especially the components: Implementation, presentation of solutions and testing, evaluation, and generalization.

b) Basis of measures

c) How to implement the measure

d) Example of implementing the measure

Example 4.5. *Teaching using theorems to calculate the limit of a sequence*

Example 4.6. *Teaching integral and antiderivative calculations of functions*

Example 4.7 *. Teaching how to solve logarithmic equations*

Example 4.8 *. Teaching of functions*

4.2.3. Measure 3: Organizing students to solve problematic situations with the support of information and communication technology in teaching calculus grade 11 in the Lao People's Democratic Republic

a) Objectives of the measure

Modern education needs to connect mathematical knowledge with real life and apply information and communication technology to enhance learning efficiency. This measure allows students to approach problems with supporting tools such as mathematical software, simulation presentations, digital data, etc. with specific purposes:

- Harness the power of technology to enhance the effectiveness of calculus teaching, helping students visualize knowledge, simulate and check solutions.

- Support learning in the process of discovering, analyzing and evaluating mathematical problems, thereby comprehensively developing problem-solving skills.

- To develop in students the skills to use technology as a tool to support thinking and problem solving in the subject.

b) Basis of measures

c) How to implement the measure

d) Example of implementing the measure

Example 4.7 *. Designing application situations in teaching exponential functions*

Example 4.9 . Designing problem situations in teaching the concept of

variation of exponential functions$f(x) = a^x$

4.3. Conclusion

In this chapter 4, the author has researched and proposed a number of pedagogical measures to develop problem-solving ability for students through teaching activities of Calculus grade 11 in high schools in the Lao People's Democratic Republic. The measures are built on the basis of the theory of mathematical problem-solving ability, based on the characteristics of the program content, the current situation of teaching Calculus grade 11 as well as the principles of active teaching to improve the effectiveness of current mathematics education in the Lao People's Democratic Republic .

Chapter 5: TEACHING PRACTICE

5.1. Experimental purpose

Pedagogical experiments were conducted to verify the correctness and reliability of the scientific hypothesis proposed in the thesis. Specifically, the pedagogical experiment aimed to verify the feasibility and effectiveness of the proposed pedagogical measures in the practice of teaching 11th grade Analysis at high schools in the Lao People's Democratic Republic . The implementation of the experiment not only simply confirmed the feasibility of the proposed measures but also clarified the role of these measures in equipping, fostering and developing problem-solving capacity for students.

5.2. Experimental tasks

Pedagogical experiments need to complete the following specific tasks:

First, compile and prepare complete documents for the experiment.

Second, conduct experimental teaching according to the proposed plan.

Third, collect and process data from experimental teaching activities using scientific and appropriate statistical methods.

Finally, comprehensively and objectively evaluate the experimental results.

5.3. Experimental organization and content

5.3.1. Experimental organization

The pedagogical experiment was carried out on the basis of

consensus and support from the Board of Directors of Xaysomboun High School (Anouvong District, Xaysomboun Province) and Nakhonxay High School (Khamkerd District, Borlykhamxay Province).

5.3.2. Experimental procedure

Step 1: Preparation

Step 2: Organize experimental teaching

Step 3: Evaluate experimental results

5.3.3. Experimental content

The topics in the 11th grade Mathematics textbook program of the Lao People's Democratic Republic selected to compile experimental content include:

- Lesson 19: Limits and derivatives of exponential functions (04 periods).

- Lesson 20: Integral of exponential functions (04 periods).

5.4. Experimental results

5.4.1. Assessment of the effectiveness and feasibility of measures

Below is a table of results of opinions evaluating the effectiveness and feasibility of the measures.

Table 5.3 1Results of opinions evaluating the effectiveness of measures

Evaluation criteria	Level				Average score
	Very effective	Medium	Less effective	inefficient	
BP1	3	8	6	1	2.72
BP 2	2	10	4	2	2.66
BP 3	5	8	5	0	3.27

The survey results confirm the effectiveness and feasibility of the proposed pedagogical measures , and at the same time help to

clearly identify the strengths and limitations for further adjustment and improvement, thereby creating a solid foundation for widespread application in teaching practice in high schools.

5.4.2. Assessment of students' manifestations of problem-solving ability

i) Teacher assessment

According to the data in Table 5.3, the problem-solving ability of students in the two schools is still limited, many students have not identified problematic situations and discovered problems that need to be solved. However, the percentage of students who can establish a way to solve the problem is 50% and 58.13%, but only 39.13% and 48.83% of students can implement a solution to the problem. In particular, the skill of explaining a problem-solving solution is about 32.6% and 39.53%, the evaluation of the implemented solution is only about 26.08% and 32.55% of students, the skill of generalizing the problem is at a low level with a rate of 19.56% and 23.25%, and the application in practice is still weak, only about 8.69% and 11.62% of students achieve it.

ii). Evaluation of experimental class students

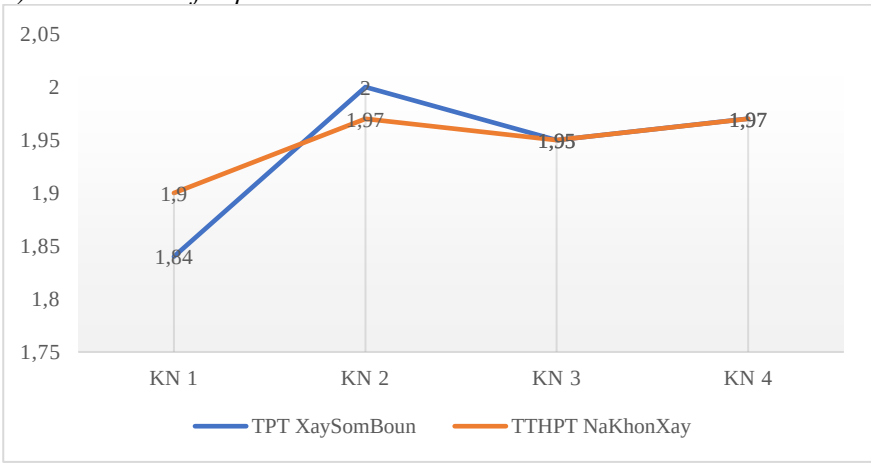

Figure 5.3 1Evaluation of the manifestations of students' problem-solving ability after the experiment

In there:

- Component capacity 1: Recognizing and detecting problems
- Component 2: Selecting and proposing solutions
- Component 3: Implement and present solutions
- Component 4: Testing, evaluating, generalizing and applying

Through the results shown in Chart 5.3 above, it can be seen that the majority of students asked for their opinions on the level of problem-solving competency components of the two schools are at an average level, such as: Xaysomboun High School with a rate from 47.82% to 54.37%, and Nakhonxay High School with a rate from 46.51% to 53.48%, it can be said that students of these two schools are still limited and have not performed well with the problem-solving competency components in the process of teaching and learning problem-solving.

5.4.3. Analysis of experimental results

5.4.3.1. Qualitative analysis

The thesis author evaluates that, for students in the experimental class of two high schools, students who were affected by the measures proposed by the thesis author in chapter 3 have seen the development of students in particular, and improved students' mathematics learning results in general.

5.4.3.2. Quantitative analysis

In addition to the qualitative assessment of the results of the tasks performed through the test in the experimental period of the experimental class and the control class, there are data for the thesis author to process and evaluate. Table 5.7 is the data on the results of the tests that the thesis author has surveyed.

Table 5.7 2Frequency distribution of test results of experimental class and control class

Serial number	**Xaysomboun High School**				**Na k hon x ay high school**			
	Experimental class		**Exchange class**		**Experimental class**		**Exchange class**	
Score	Frequency of occurre	Total score	Frequency of occurre	Total score	Frequency of occurre	Total score	Frequency of occurre	Total score

	nce		nce		nce		nce	
1	0	0	0	0	0	0	0	0
2	0	0	5	10	0	0	3	6
3	4	12	7	21	3	9	5	15
4	4	16	8	32	5	20	8	32
5	18	90	13	65	16	80	12	60
6	9	54	8	48	8	48	10	60
7	7	49	6	42	8	56	6	42
8	4	32	0	0	3	24	1	8
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
Total	46 (HS)	253 (Points)	47 (HS)	218 (Point)	43 (HS)	237 (Points)	45 (HS)	223 (Points)
Average score	5 , 50		4 , 63		5.51		4.95	
Sample variance	2.03		2.27		1.69		2.17	
Standard deviation	1.42		1.50		1.30		1.47	

The data can be visualized by the frequency distribution charts of the experimental class - control class of Xaysomboun high school and Nakhonxay high school as follows:

Through the results shown in the tables and charts above and the results of students' activities, it shows that in the experimental class, due to the training of problem-solving skills, the level of competence is clearly improved. Students in the control class have the same level as the experimental class, but the teaching method using conventional methods does not develop problem-solving competence for students in the process of understanding knowledge, applying knowledge to recognize and detect problems that need to be solved by mathematics, choosing and proposing methods and solutions to solve problems, implementing and presenting solutions to solve problems and testing, evaluating, generalizing and applying practical situations to build a system of problematic situations originating from practice or interdisciplinary topics and solving problems originating from practical situations. Thus, if teaching situations are organized using the problem-solving competency method in teaching activities, it will

develop students' active learning, helping them apply the knowledge they have learned to solve systematic problems from practice, thereby leading to students having higher learning results. However, the experimental class still has a number of students with low scores, which proves that although there is a new and effective method, the impact on these students has not reached the threshold, so the results of each individual have not changed much. Therefore, teachers need to have measures to overcome this: specific, lighter requirements, suggestions, orientation and teachers closely follow up during the teaching process.

5.5. Conclusion of Chapter 5

- Helping students develop problem-solving skills through teaching 11th grade Calculus has theoretical and practical significance.

- The pedagogical measures proposed in Chapter 3 are highly feasible and consistent with the theory of innovation in teaching methods.

- The results of the pedagogical experiment show that the proposed research objectives are correct; the scientific hypothesis is acceptable and the research task has been completed; the results of the topic are completely feasible in implementing the teaching of Analysis in the direction of developing problem-solving capacity for high school students of the Lao People's Democratic Republic.

CONCLUDE

The thesis obtained the following main results:

1. Systematize issues on problem solving process, problem solving teaching, problem solving capacity. Present concepts on problem solving process, problems, problematic situations, capacity, problem solving capacity and components of problem solving capacity.

2. Systematize studies on problem-solving capacity development, propose an understanding of problem-solving capacity and its characteristics. Systematize studies on teaching calculus grade 11 in the Lao People's Democratic Republic in the direction of developing problem-solving capacity.

3. Identifying the orientations for teaching calculus grade 11 in

the Lao People's Democratic Republic in the direction of developing problem-solving capacity. Building 3 measures for teaching calculus grade 11 in the Lao People's Democratic Republic in the direction of developing problem-solving capacity for students.

4. Organize experiments to illustrate the feasibility and effectiveness of the proposed pedagogical measures.

5. In school teaching, teaching problem solving must be carried out simultaneously with knowledge formation. Teaching problem solving is not a separate content, but solving them must take place naturally, along with the process of acquiring knowledge and skills. Problem solving needs to be taught through the teaching content in school.

Based on the results achieved, it can be affirmed that the research purpose has been achieved, the research task has been completed and the scientific hypothesis is acceptable. The thesis research has affirmed that problem-solving capacity for students is an extremely necessary task to help improve the effectiveness of teaching calculus grade 11 in particular, teaching mathematics in general and has a positive impact on the development of problem-solving capacity of students. This is a research direction to help students form a way of learning, a way of acquiring knowledge, a way of solving problems in an era of constantly increasing knowledge and is the right direction to meet the current educational trend of forming and developing capacity for students.