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**TEACHING THE TOPIC EQUATIONS AND
INEQUALITIES IN HIGH SCHOOLS IN THE LAO
PEOPLE'S DEMOCRATIC REPUBLIC TOWARDS
DEVELOPING CRITICAL THINKING
AND CREATIVE THINKING FOR STUDENTS**

Major: Theory and Methodology of Mathematics Teaching

Code: 9140111

DISSERTATION SUMMARY

THAI NGUYEN - 2025

The dissertation was finished at:
UNIVERSITY OF EDUCATION - THAI NGUYEN UNIVERSITY

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Reviewer 1:.....

Reviewer 2:.....

Reviewer 3:.....

The dissertation will be defended in the university committee:
UNIVERSITY OF EDUCATION - THAI NGUYEN UNIVERSITY
Time: Date:

- The dissertation can be read at:**
- National library of Vietnam;
 - Digital Center - Thai Nguyen University;
 - Library of Education.

THE RESEARCHER'S PUBLICATIONS RELATED TO THE DISSERTATION TOPIC

1. Thongdeng Pathoumma, Do Thi Trinh (2024), *Fostering Critical and Creative Thinking through Mathematics Instruction in High Schools in the Lao People's Democratic Republic*, Pakistan Journal of Life and Social Sciences www.pjlss.edu.pk. Pak. j. life soc. Sci. (2024), 22(2): 20475-20485 E-ISSN: 2221-7630; P-ISSN: 1727-4915
<https://doi.org/10.57239/PJLSS-2024-22.2.00155>
2. Thongdeng Pathoumma, Do Thi Trinh (2024), *Teaching equations and inequalities in secondary schools in the Lao People's Democratic Republic with a focus on developing critical thinking skills in students*, Journal of Educational Management, 2024, Vol. 16, No. 8, August 2024, pp. 124-134. DOI: 10.53750/jem24.v16.n8.124
3. Thongdeng Pathoumma, Do Thi Trinh. (2025), *Teaching equations and inequalities in high schools of the Lao People's Democratic Republic with a focus on developing critical and creative thinking for students*, Journal of Educational Management, Vol. 17, No. 6, June 2025, pp. 182-188. DOI: 10.53750/jem25.v17.n6.182

INTRODUCTION

1. Reason for choosing the topic

The Party and State of the Lao People's Democratic Republic identify education as a key driving force for sustainable national development. The Resolution of the 11th Congress and the Law on Education (2015) both emphasize the role of education in forming a team of citizens with ethics and scientific and technical capacity to meet the requirements of the new era. In particular, training critical thinking and creative thinking for students is an important task to improve the quality of human resources.

However, current teaching practices in Lao general schools show that the development of thinking – especially critical thinking and creative thinking – is still lacking in systematization. The main reason is that teachers do not have appropriate pedagogical measures to integrate thinking training into specific content. In the high school mathematics program, the topic of equations and inequalities is the core content, with logic and great potential for developing thinking through diverse problems, rich in opportunities for reasoning, criticism and creativity.

From the requirements of educational innovation and the characteristics of Mathematics, the topic ***“Teaching the topic “Equations and inequalities” in high schools in the Lao People's Democratic Republic towards developing critical thinking and creative thinking for students”*** was chosen to contribute to improving the quality of teaching and developing thinking ability for students in a practical and effective way.

2. Overview of the research problem

2.1. Overview of research in countries around the world on critical thinking and creative thinking

2.2. Overview of research in Vietnam and Laos

2.3. General assessment

From the synthesis of domestic and foreign research works, the following conclusions can be drawn:

1. Many studies have focused on developing critical thinking and creative thinking in mathematics teaching, bringing practical results with high application value.

2. However, there has been no work proposing measures to teach a specific mathematical content in the direction of combining the simultaneous development of critical thinking and creative thinking for high school students, especially in the Lao People's Democratic Republic.

3. In Laos, research on developing thinking in teaching is still limited, affecting the quality of education. Therefore, research on developing critical thinking and creative thinking in teaching equations and inequalities is necessary and suitable for the requirements of educational innovation.

4. On that basis, the thesis aims to establish a theoretical and practical basis for developing critical thinking and creative thinking, proposing corresponding and integrated measures to simultaneously develop two types of thinking in teaching the topics of equations and inequalities, contributing to improving the quality and effectiveness of education in the Lao People's Democratic Republic.

3. Research purpose

Contribute to clarifying the theoretical and practical basis of critical thinking and creative thinking; point out the relationship between critical thinking and creative thinking , thereby proposing some measures to teach the topic of equations and inequalities in the direction of developing each type of thinking; serve as a foundation to propose an integrated approach, aiming at teaching the topic of equations and inequalities in the direction of simultaneously developing both critical thinking and creative thinking. for high school students of the Lao People's Democratic Republic.

4. Research tasks

4.1. Research the theoretical basis of critical thinking and creative thinking, the structure and manifestations of critical thinking and creative thinking, the relationship between critical thinking and creative thinking.

4.2. Study the current status of teaching the topic of equations and inequalities towards developing critical thinking and creative thinking for high school students in some high schools in the Lao People's Democratic Republic.

4.3. Proposing some teaching measures for the topic of equations and inequalities in the direction of developing each type of thinking; as a foundation for proposing an integrated approach, aiming at teaching the topic of equations and inequalities in the direction of simultaneously developing both critical and creative thinking. for high school students of the Lao People's Democratic Republic.

4.4. Pedagogical experiments to evaluate the correctness of scientific hypotheses; evaluate the effectiveness of Teaching methods proposed in the thesis.

5. Objects, research objects, research scope

5.1. Research object: Math teaching process in high school.

5.2. Research subjects: teaching methods for the topic of equations and inequalities towards developing critical thinking and creative thinking for high school students in the Lao People's Democratic Republic.

5.3. Research scope: The thesis focuses on studying the typical manifestations of critical thinking and creative thinking of high school students in learning Mathematics and some pedagogical measures in teaching Mathematics towards developing critical thinking and creative thinking for high school students.

6. Scientific hypothesis

If we can identify the manifestations of critical thinking and creative thinking of students in teaching equations and inequalities, and at the same time apply and exploit teaching methods in the direction of developing critical thinking and creative thinking for students through teaching equations and inequalities, it will contribute to developing critical thinking and creative thinking for high school students in the Lao People's Democratic Republic.

7. Research methods

To carry out the research tasks set out in the thesis, we use four main groups of methods: theoretical research methods, practical research methods, pedagogical experimental methods, and expert methods.

7.1. Theoretical research method

Theoretical research methods are applied to collect, analyze and systematize documents and scientific viewpoints related to critical thinking and creative thinking skills. This is to clarify the theoretical basis for developing and training these skills in teaching Mathematics at high school level. The results of theoretical research will be the foundation for building pedagogical measures to improve critical thinking and creative thinking skills for students through teaching equations and inequalities in the Lao People's Democratic Republic.

7.2. Practical research methods: Practical research is conducted through methods such as interviews, questionnaire surveys and pedagogical observations. The objective is to assess the current situation of teaching equations and inequalities in high schools in the Lao People's Democratic Republic, and to determine the level of training and development of students' critical thinking and creative thinking skills through these lessons. The results will be a practical basis for proposing and perfecting appropriate pedagogical measures.

7.3. Pedagogical experimental method: To evaluate the effectiveness of the proposed pedagogical measures, especially the training and development of critical thinking and creative thinking skills for students through teaching equations and inequalities in high schools in the Lao People's Democratic Republic, we will organize the implementation of teaching situations into practice to adjust and evaluate them as important impacts in the research process.

7.4. Expert method: Seek opinions from experts who are scientists specializing in the field of Theory and Methodology of Teaching Mathematics, including researchers and mathematics lecturers working at a number of research institutes and a number of Pedagogical Universities in the Socialist Republic of Vietnam and the Lao People's Democratic Republic, especially teachers who are directly teaching Mathematics in a number of high schools in the Lao People's Democratic Republic, by interviewing, discussing directly or distributing opinion forms.

8. Defensive arguments

8.1. Teaching Mathematics in high schools in the Lao People's Democratic Republic in the direction of training and developing critical thinking and creative thinking for students is necessary and has important significance in implementing educational innovation towards the educational goals of the 21st century in the Lao People's Democratic Republic.

8.2. The measures for teaching high school mathematics in the direction of developing critical thinking and creative thinking for students proposed in the thesis are feasible and effective. If these measures are implemented synchronously, systematically, regularly, compatible with the lesson content and suitable for the cognitive characteristics of students, they will contribute to developing students' thinking and improving the quality of mathematics education in high schools in the Lao People's Democratic Republic .

9. New contributions of the dissertation

9.1. Theoretical contributions

- Identify the components and levels of expression of critical thinking and creative thinking, and at the same time point out the relationship between critical thinking and creative thinking in teaching equations and inequalities.

9.2. Practical contributions

- Survey and analyze the current status of developing critical thinking and creative thinking for students in teaching equations and

inequalities in the Lao People's Democratic Republic.

- Organize the implementation of a number of measures to teach equations and inequalities in high schools in the direction of developing critical thinking and creative thinking for students, in accordance with school practice, on the basis of inheriting international lessons, in the condition of respecting the current Mathematics program and textbooks of the Lao People's Democratic Republic.

10. The detailed structure of the dissertation

In addition to the Introduction and Conclusion, the content of the thesis is presented in three chapters:

Chapter 1: Theoretical and practical basis.

Chapter 2: Methods of teaching equations and inequalities in high schools in the Lao People's Democratic Republic towards developing critical thinking and creative thinking for students.

Chapter 3: Pedagogical practice.

CHAPTER 1. THEORETICAL AND PRACTICAL BASIS

1.1. Some issues on critical thinking and creative thinking

1.1.1. Critical thinking

1.1.1.1. Concept of critical thinking

1.1.1.2. Some typical manifestations of critical thinking

1.1.1.3. Some manifestations of critical thinking in teaching mathematics to high school students

1.1.1.4. Expression of students' critical thinking in teaching Equations and Inequalities

1.1.2. Creative thinking

1.1.2.1. Concept of creative thinking

1.1.2.2. Basic characteristics of creative thinking

1.1.2.3. Some typical manifestations of creative thinking in mathematics learning of high school students

1.1.2.4. Expression of students' creative thinking in teaching Equations and Inequalities

1.1.3. The relationship between critical thinking and creative thinking

1.1.4. Expressions and levels of critical thinking and creative thinking

1.2. Teaching towards developing critical thinking and creative thinking

Teaching towards developing critical and creative thinking;
Specific teaching methods to develop critical and creative thinking ;

Assessment of students' critical and creative thinking; Teaching opportunities to develop critical and creative thinking for Lao high school students through the content of Equations and Inequalities

1.2.1. Teaching towards developing critical thinking and creative thinking

1.2.2. Specific teaching methods to develop critical thinking and creative thinking

1.2.3. Assessing students' critical and creative thinking

1.2.4. Teaching opportunities to develop critical and creative thinking for Lao high school students through the content of Equations and Inequalities

1.2.4.1. *Psychological and cognitive characteristics of high school students in the Lao People's Democratic Republic*

1.2.4.2. *Content of Equations and Inequalities in Mathematics Curriculum and Textbooks in High Schools of Lao People's Democratic Republic*

1.2.4.3. *Opportunities to develop critical thinking and creative thinking for students through teaching Equations and Inequalities in High School*

1.3. Current status of teaching Mathematics towards developing critical thinking and creative thinking for high school students in the Lao People's Democratic Republic

1.3.1. Description of the investigation and survey process

+ **Purpose:** To survey the current situation of teaching Mathematics in the direction of developing critical thinking and creative thinking for high school students, and at the same time initially evaluate some manifestations of these two types of thinking in the learning process.

+ **Survey subjects:** Math teachers and 10th grade students at some high schools in Champasak province, Lao People's Democratic Republic.

+ **Survey content:** Teachers' and students' awareness of critical thinking and creative thinking; activities and methods of organizing Math teaching in the direction of developing thinking; assessment measures that contribute to promoting students' thinking.

+ **Survey form:** Distribute survey forms to teachers and students; directly interview a number of teachers at selected high schools using a predetermined interview script.

Survey time: **Teachers:** Survey in April 2023 at 4 high schools in Champasak province, including: Pakse, NguaDeng, PakSong, PhonThong and some teachers in BaChiang and PaThoumPhon districts. Distribute and collect enough 56 questionnaires. **Students:** Survey at the beginning of the 2022-2023

school year at Pakse, NguaDeng, PakSong, PhonThong high schools. Distribute and collect enough 200 questionnaires.

Reason for choosing survey location: Representativeness: Champasak is a large province in southern Laos, with a diverse high school system that reflects relatively fully the general education practice of the whole country; **Feasibility:** The locality has favorable conditions for implementing the survey, receiving active cooperation from educational institutions; **Generalizability:** Although the survey was only conducted in one province, the results are generalizable thanks to the general education program being unified nationwide.

Result processing: Survey data is processed using Microsoft Excel software.

1.3.2. Investigation and survey results

* On the teacher's side

a) Results of questionnaire survey

We collected and analyzed the survey forms and obtained the following results: *Teachers' perceptions of the manifestations of critical thinking and creative thinking in high school students during the mathematics learning process; activities, organizational forms and teaching techniques that can support the development of critical thinking and creative thinking for students ; along with some measures that can be applied in the process of assessment to promote the development of these two thinking abilities.*

The results show that the majority of mathematics teachers have basic awareness of methods to develop critical and creative thinking for students . However, there is still a significant difference in the level of understanding and application among teachers. In particular, activities such as group discussions, assignment of learning projects, development of self-assessment skills and application of information technology have not been widely implemented, which are issues that need more attention in the future.

b) Through teacher interviews

Through interviews, we found that many teachers do not fully understand the manifestations of critical thinking and creative thinking in students during the learning of Mathematics. As a result, students have few opportunities to demonstrate and practice these abilities, largely because teachers are not proactive or do not have a clear direction in organizing appropriate learning activities to develop critical thinking and creative thinking.

* For students

a) Through questionnaire survey

Students self-assess their performance of critical and creative thinking as well as the learning activities they regularly engage in during their studies.

This result shows that the organization of learning activities to develop critical thinking and creative thinking skills for students in current mathematics teaching is still limited. Teachers have not really created conditions for students to participate in activities that require the application of these skills regularly and effectively. Meanwhile, according to the opinion survey, many teachers said that they have implemented these activities regularly, but the reality of feedback from students shows that it is not consistent.

b) Through student interviews

The interview results showed that students showed some signs of critical thinking and creative thinking. However, they were not yet proactive in learning and did not know how to creatively apply mathematical knowledge to solve new problems as well as practical problems. The main reason came from the fact that teachers did not regularly organize learning activities to promote these two types of thinking, and at the same time did not effectively apply appropriate teaching methods, organizational forms and pedagogical techniques to encourage students to develop critical thinking and creative thinking abilities.

1.3.3. Conclusion on the current status of developing critical thinking and creative thinking in teaching high school mathematics in the Lao People's Democratic Republic

Chapter 1 Conclusion

Chapter 1 presented the theoretical basis of critical thinking and creative thinking, affirming that these are two abilities that can be trained through teaching Mathematics, especially when students participate in appropriate learning tasks. However, the current situation of teaching Mathematics in high schools in the Lao People's Democratic Republic shows that the development of critical thinking and creative thinking is still limited, lacking clear direction, teachers are still confused in organizing activities and lacking specific guidance documents. From there, it is necessary to develop feasible pedagogical measures, suitable for the current program, to develop these two abilities for students in an effective and sustainable way. Chapter 2 will present a system of proposed measures.

CHAPTER 2. TEACHING METHODS OF EQUATIONS AND INEQUALITIES TO DEVELOP CRITICAL THINKING AND REASONING CREATIVITY FOR STUDENTS

2.1. Orientation to develop teaching methods towards developing critical thinking and creative thinking for students

In researching and proposing pedagogical measures to develop critical thinking and creative thinking (C&C) for students in teaching equations and inequalities in high schools. We have proposed the following directions:

- **Orientation 1:** Pedagogical measures must be based on students' mathematical knowledge foundation, ensuring the teaching objectives of Mathematics in the general education program, training and developing critical thinking and creative thinking for high school students.

- **Orientation 2:** Pedagogical measures need to be structured in a certain scientific order, ensuring systematic consistency of all components of the learning capacity development process, contributing to training students' math problem solving skills.

- **Orientation 3:** Pedagogical measures need to ensure feasibility and effectiveness in practice.

- **Orientation 4:** Pedagogical measures must highlight the focus on teaching equations and inequalities in high schools towards developing critical thinking and creative thinking for students.

2.2. Some measures for teaching equations and inequalities towards developing critical thinking and creative thinking for students

2.2.1. Measure 1: Create opportunities for students to make judgments and debate

2.2.1.1. Purpose of the measure

2.2.1.2. Scientific basis of the measure

2.2.1.3. How to implement the measure

Step 0: Teacher prepares the problem/situation/issue

Step 1: Give a problem or situation that requires students to make initial predictions.

Step 2: Ask students to discuss in groups, debate and defend their personal opinions using logical arguments to come up with ideas and judgments to solve the problem.

Step 3: Organize students to present different ideas/solutions and analyze the advantages and disadvantages of each method, and unify the problem.

Step 4: Conclusion.

Example 2.1. After completing the quadratic equation lesson, teachers can reinforce and deepen students' understanding of how to solve and exploit problems effectively. Teachers can use the method of organizing debates, encouraging students to make judgments about the solution of the equation without using available formulas, and thereby leading students to the most reasonable and fastest solution methods. Specifically.

2.2.2. Measure 2: Encourage students to share positive doubts through situations containing difficulties and mistakes.

2.2.2.1. Purpose of the measure

2.2.2.2. Scientific basis of the measure

2.2.2.3. How to implement the measure

Step 0: The teacher prepares a problem/situation containing difficulties and mistakes.

Step 1: Determine the objective of the activity

Step 2: Teachers select and present situations containing difficulties and mistakes that are appropriate to the lesson content, including opportunities for students to actively question.

Step 3: Organize students to actively discuss to discover, overcome and find solutions.

Step 4: Comment, evaluate, systematize and classify problems according to error groups.

Example 2.4: During the practice session on "Real-life problems" for students, teachers can organize activities as follows:

2.2.3 . Measure 3: Develop creative thinking for students through activities that comprehensively review the problem and the problem-solving methods that have been implemented, thereby finding new ways to solve the problem.

2.2.3.1. Purpose of the measure

2.2.3.2. Scientific basis of the measure

2.2.3.3. How to implement the measure

Step 0: Teacher prepares problem/situation

Step 1: The teacher presents a situation/problem and asks students to come up with a solution.

Step 2: After giving a solution, ask students to re-evaluate the entire problem-solving process, from making assumptions to reasoning and checking results.

Step 3: Guide students to find out the limitations in the old solution and propose other solutions.

Step 4: Synthesize opinions and draw lessons.

Example 2.7. After teaching the theorem “Quadratic trinomial sign” (grade 10 textbook) to students, teachers can organize consolidation activities to help students understand and apply the theorem as follows:

2.2.4. Measure 4: Develop creative thinking for students through activities that consider a problem from many different perspectives.

2.2.4.1. Purpose of the measure

2.2.4.2. Scientific basis of the measure

2.2.4.3. How to implement the measure

Step 0: Prepare the situation/problem

Step 1: The teacher gives a situation/problem that can be solved in many ways.

Step 2: Organize students to work in groups/individually to propose solutions.

Step 3: Create opportunities for students to present their ideas to the class and comment on each other, analyzing the advantages and disadvantages of each option.

Step 4. Conclusion, summarize knowledge and expand the problem (if any)

Example 2.9: After teaching students how to solve irrational equations of the form $f(x) = \sqrt{g(x)}$, teachers can organize consolidation and application activities as follows:

2.2.5. Measure 5: Organize teaching of concepts, theorems, and rules through the content of equations and inequalities in the direction of developing critical thinking and creative thinking for students.

2.2.5.1. Purpose of the measure

2.2.5.2. Scientific basis of the measure

2.2.5.3. Content and method of implementing measures

a) Teaching concepts towards developing critical and creative thinking

+ To implement this measure, teachers can organize for students as follows:

Activity 1: Experiencing the concept approach

Activity 2: Forming and expressing concepts

Activity 3: Concept reinforcement

Activity 4: Applying the concept

Example 2.12. When teaching the concept of "Exponential equation" (textbook 11, Lesson 16) to students with the *knowledge goal*:

b) Teaching theorems towards developing critical thinking and creative thinking

+ To implement this measure, teachers can organize for students as follows:

Activity 1. Warm up

Activity 2. Forming theorems

Activity 3. Prove the theorem

Activity 4. Consolidating the theorem

Activity 5. Applying the theorem

Example 2.13. When teaching Viet's theorem for quadratic equations (textbook 11, Lesson 13)

c) Teaching rules towards developing critical thinking and creative thinking

+ To implement this measure, teachers can organize for students as follows:

Activity 1: Experience

Activity 2: Explain and prove the rule

Activity 3: Ask questions and argue

Activity 4: Application

Example 2.15. Teaching the rule for solving quadratic equations (Math 10 textbook, Lesson 13):

Chapter 2 Conclusion

Based on the theory and practice presented in Chapter 1, Chapter 2 proposed five measures to train and develop critical thinking and creative thinking for high school students in teaching Mathematics, especially the content of equations and inequalities. The measures include: creating opportunities for students to judge and debate; encouraging active sharing of doubts; developing creative thinking through reflective activities and finding new solutions; examining problems from multiple perspectives; and organizing the teaching of concepts, theorems, and rules in the direction of developing thinking.

Each measure is presented in a clear structure, with specific illustrative examples, suitable for the current high school mathematics program in the Lao People's Democratic Republic, contributing to improving the quality of teaching and developing comprehensive thinking capacity for students.

CHAPTER 3. PEDAGOGICAL EXPERIENCE

3.1. Experimental purpose

The main purpose of pedagogical experiment is:

- + Initial survey and assessment of the ability to carry out activities to develop critical thinking and creative thinking (CTH and CTH) of 11th grade students of high schools in the Lao People's Democratic Republic.
- + Is it possible to evaluate students through testing?
- + Illustrate and initially test the feasibility and effectiveness of the pedagogical measures proposed in chapter 2 .
- + Serve as a basis for testing the experimental hypothesis of the thesis .

3.2. Experimental tasks

- + Determine the content and method of the experiment, select the subjects and location to organize the experiment.
- + Compile experimental documents, guide teachers on how to prepare and conduct experimental lessons, prepare lesson plans, teaching aids and discuss with experimental teachers about teaching methods, experimental lesson plans, and assessment tools.
- + Plan and conduct experiments according to plan: The experimental round aims to explore and gain experience. Formal experiments, observe and collect information reflecting the process and evaluate experimental results related to the feasibility and effectiveness of proposed measures.
- + Analyze and process experimental data using statistical methods to evaluate students' critical thinking and creative thinking.
- + Evaluate experimental results in two aspects: feasibility and effectiveness of proposed pedagogical measures.

3.3. Experimental organization and content

3.3.1. Experimental organization

In the 2023-2024 school year, from March 20, 2024 to April 20, 2024, teaching will be conducted simultaneously at the experimental facility. During the experimental period, there will be 24 lessons: the first 4 lessons will introduce the research content and conduct a pre-experimental test, 18 experimental teaching lessons, and the last 2 lessons will conduct a post-experimental test.

Subjects: Teachers we selected to teach the experimental classes in each school in the experimental and control classes all had equivalent professional qualifications and skills.

3.3.2. Experimental procedure

3.3.3. Develop evaluation methods and criteria

3.3.3.1. Methods and criteria for qualitative assessment

3.3.3.2. Methods and criteria for quantitative assessment

3.3.4. Experimental content

We choose the following topics and situations related to the topic to compile the pedagogical experimental content: Math textbook program for grade 11:

I. Chapter 4: Exponential Functions

§16: Methods for solving exponential equations and inequalities
(09 sessions)

II. Chapter 5: Logarithmic functions

§23: Methods for solving logarithmic equations and inequalities
(04 periods)

3.3.4.1. *Some perspectives on selecting experimental content*

3.3.4.2. *Experimental teaching program*

3.3.4.3. *Experimental teaching lesson plan*

3.3.5. Instructions for teachers to teach experimentally

Designing problem situations with pedagogical intentions related to equations and inequalities is a key issue of pedagogical experimental content. In addition to designing more detailed tests, in addition to problem situations or practical situations, we add theory and practical application problems.

3.4. Experimental results

experimental subjects, analyzed from information collected through post- experimental survey forms and direct discussions with teachers and students.

3.4.1. Effectiveness and feasibility of measures

The survey data results were processed by average value, classified according to the following rating scale: Average score from $1 \leq \bar{x} \leq 1,79$ is not feasible; Average score from $1,80 \leq \bar{x} \leq 2,59$ is average; Average score from $2,60 \leq \bar{x} \leq 3,39$ is feasible; Average score from $3,40 \leq \bar{x} \leq 4,00$ is very feasible.

Below is a table of results of opinions assessing the feasibility of the measures.

Table 3.2. Results of opinions assessing the feasibility of measures

Evaluation criteria	Quantity/Ratio	Level				Mean score
		Not feasible	Medium	Possible	Very feasible	
Measure 1	Quantity	2	4	10	4	2.80
	Ratio %	10%	20%	50%	20%	
Measure 2	Quantity	1	3	12	4	2.95
	Ratio %	5%	15%	60%	20%	

Evaluation criteria	Quantity/Ratio	Level				Mean score
		Not feasible	Medium	Possible	Very feasible	
Measure 3	Quantity	0	4	8	8	3.20
	Ratio %	0%	20%	40%	40%	
Measure 4	Quantity	2	3	9	6	2.95
	Ratio %	10%	15%	45%	30%	
Measure 5	Quantity	1	3	12	4	2.95
	Ratio %	10%	15%	60%	20%	

Thus, the data in Table 3.2 shows that the measures are evaluated at the most feasible level, in which the measures "Developing the elements of critical thinking and creative thinking " such as: Measure 1; Measure 2; Measure 3; Measure 4 and Measure 5 are evaluated at the fairly feasible level, with an average score in the range from 2.80 to 3.20. This shows that teachers pay great attention to students' practical activities, with the development of the elements of critical thinking and creative thinking. Through those problems, students love to learn; identify and clarify information, arrange and handle problematic situations, arouse their passion for exploration and discovery. Reflect on thinking in the process of teaching solving equations and inequalities for students in the direction of developing the elements of critical thinking and creative thinking for students.

From the survey results and analysis to evaluate the effectiveness and feasibility of the proposed measures to develop the elements of critical thinking and creative thinking for high school students, teachers need to pay attention to the organization and implementation of the measures.

3.4.2. Analysis of Students' critical thinking and creative thinking abilities

a) Analysis of teacher's assessment

Below is a summary table of the results of the assessment of critical thinking and creative thinking abilities of experimental class students at two schools through problem-solving activities designed during the experimental teaching process.

Table 3.3. Analysis and assessment of capabilities critical thinking and creative thinking of experimental class students

No.	Component skills	Experimental class students at NguaDeng High School		Experimental class students at Phonthong High School	
		N=40	Ratio %	N=42	Ratio %
1	Understand - identify the problem situation	35	87.5%	35	83.33%
2	Organize and process information	32	80%	34	80.95%
3	Imagine possibilities and connect ideas	29	72.5%	31	73.8%
4	Review and expand on known actions and ideas	26	65%	27	64.28%
5	Find solutions and turn ideas into action	24	60%	23	54.76%
6	Thinking about critical thinking and creative thinking	21	52.5%	20	47.61%
7	Reflecting on the solution process	17	42.5%	18	42.85%
8	Transfer knowledge into new contexts.	14	35%	13	30.95%
9	Identify, consider, and evaluate the logic and reasoning behind choices	9	22.5%	10	23.8%
10	Draw conclusions and design a course of action	5	12.5%	6	14.28%
11	Evaluate ideas, methods and results against criteria	3	7.5%	4	9.52%

According to Table 3.3, students' critical thinking and creative thinking abilities of students at the two schools are still limited. Although about 72.5% and 73.8% of students can imagine and connect ideas, only 60% and 54.76% can find solutions and turn ideas into actions, and less than 50% of students know how to think, reflect or apply thinking in solving problems. In particular, advanced skills such as transferring knowledge to new contexts (35% and 30.95%), evaluating logic (22.5% and 23.8%), drawing conclusions and designing solutions (12.5% and 14.28%), and evaluating results according to criteria (7.5% and 9.52%) are all at very low levels. This shows that it is necessary to strengthen the training of critical thinking and creative thinking in a more systematic way.

b) Analysis and evaluation of experimental class students

We asked for opinions from students in the experimental class using a questionnaire with 4 levels of evaluation: 1- Poor; 2- Average; 3- Good; 4- Very good.

The following table shows the results of the assessment of critical thinking and creative thinking abilities of experimental class students after experimental teaching.

Table 3.4. Assessment of critical thinking and creative thinking abilities of students after the experiment

Component capabilities	Experimental class students	Level				Mean score
		1	2	3	4	
		Number of students/ Ratio	Number of students/ Ratio	Number of students/ Ratio	Number of students/ Ratio	
The ability to research, identify, explore, and organize information and ideas	NguaDeng High School	12	20	6	2	1.95
	Phonthong High School	11	22	5	4	2.04
Ability to generate ideas, possibilities and actions	NguaDeng High School	8	21	9	2	2.12
	Phonthong High School	6	23	10	3	2.23
Ability to reflect on thinking and solution processes	NguaDeng High School	7	19	12	2	2.22
	Phonthong High School	5	21	14	2	2.30
Ability to analyze, synthesize, evaluate theories and solution processes	NguaDeng High School	6	24	6	4	2.00
	Phonthong High School	9	20	8	5	2.21

Through the results shown in the table above, it can be seen that the majority of students asked about the level of critical thinking and creative thinking ability of the two schools are at an average level as follows:

- NguaDeng High School: There are 20 students who have the ability to research, identify, explore and organize information and ideas, achieving an average score of 1.95. For 21 students who have achieved

the ability to generate ideas, the ability and implementation of problem solutions, achieving an average score of 2.12. Of these, 19 students can reflect on their thinking and implement the solution process, achieving an average score of 2.22. And the majority of 24 students, who believe that they have the ability to analyze, synthesize, evaluate theories and solution processes, achieving an average score of 2.00.

- Phonthong High School: There are 22 students who are able to research, identify, explore and organize information and ideas, achieving an average score of 2.04. For 23 students who are able to generate ideas, the ability and implementation of problem solutions, achieving an average score of 2.23. Of these, 21 students can reflect on their thinking and implement the solution process, achieving an average score of 2.30. And the majority of 20 students, who believe that they are able to analyze, synthesize, evaluate theories and solution processes, achieving an average score of 2.21.

3.4.3. Analysis of experimental results

3.4.3.1. 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 author of the thesis to process and evaluate. Table 3.5 is the data on the results of the tests that we have surveyed.

Table 3.5. Frequency distribution The results of the experimental class and the control class test

No.	NguaDeng High School				Phonthong High School			
	Experimental class		Control class		Experimental class		Control class	
Score	Frequency of occurrence	Total score	Frequency of occurrence	Total score	Frequency of occurrence	Total score	Frequency of occurrence	Total score
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	2	6	0	0	5	15
4	4	16	8	32	5	20	8	32
5	13	65	15	75	14	70	12	60
6	10	60	8	48	9	54	10	60
7	6	42	7	49	9	63	6	42
8	5	40	3	24	4	32	3	24
9	2	18	0	0	1	9	0	0
10	0	0	0	0	0	0	0	0
Total	40 (students)	241 (Points)	43 (students)	234 (Points)	42 (students)	248 (Points)	44 (students)	233 (Points)

No.	NguaDeng High School				Phonthong High School			
	Experimental class		Control class		Experimental class		Control class	
Mean score	6.02		5.44		5.9		5.29	
Sample variance	1.87		1.68		1.64		1.98	
Standard deviation	1.36		1.29		1.28		1.40	

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

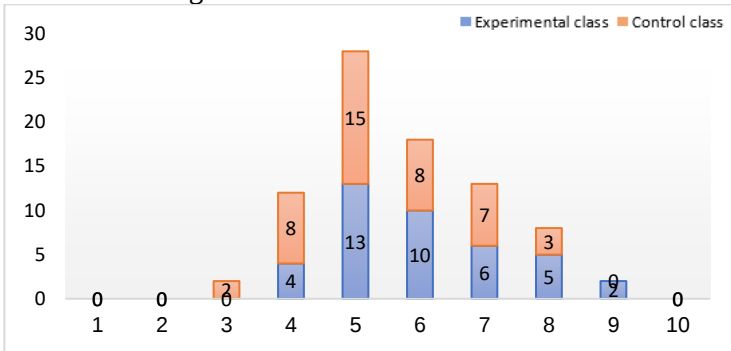


Figure 3.4. Frequency distribution of test scores of experimental class and control class of NguaDeng high school

The results in the table above are from NguaDeng High School . shows that the average score of the output test of the experimental class is only higher than the average score of the control class (0.58 points higher), some students achieved quite high results of 8/10 points; the standard deviation of the control class test compared to the experimental class test is lower (decreased from 1.36 to 1.29). To confirm the above results, we conducted a hypothesis test H_0 that the output quality of the two classes is equivalent for the $\bar{x}_1 > \bar{x}_2$ significance level $\alpha = 0.05$

$$\text{We have: } |\theta_{TN}| = \frac{|6,02 - 5,44|}{\sqrt{\frac{1,87}{40} + \frac{1,68}{43}}} = 2,00 > 1,96 = \theta_{TB}$$

The above results allow to reject the hypothesis H_0 or in other words, teaching to develop critical thinking and creative thinking in the experimental class is effective and helps to improve students' learning outcomes better than the teaching method in the control class.

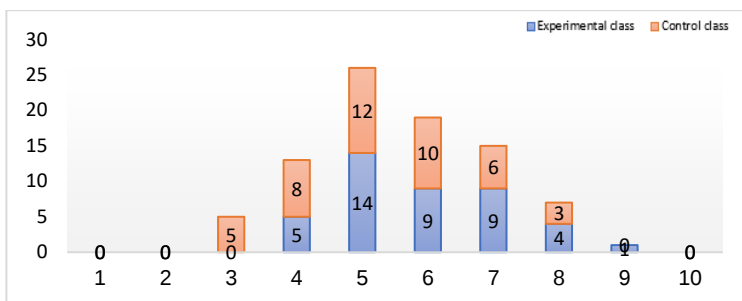


Figure 3.5. Frequency distribution of test scores of experimental class and control class of Phonthong high school

Still Phonthong High School, the results show that the average score of the output test of the experimental class is also higher than the average score of the control class (0.61 points higher), some students achieved quite high results of 8/10 points; the standard deviation of the test of the control class compared to the test of the experimental class is lower (reduced from 1.40 to 1.28). To confirm the above results, the author of the thesis conducted a hypothesis test H_0 that the output quality of the two classes is equivalent for the $\bar{x}_1 > \bar{x}_2$ significance level $\alpha = 0.05$.

$$\text{We have: } |\theta_{TN}| = \frac{|5,9 - 5,29|}{\sqrt{\frac{1,64}{42} + \frac{1,98}{44}}} = 2,17 > 1,96 = \theta_{TB}$$

The above results allow to reject the hypothesis H_0 or in other words, teaching to develop critical thinking and creative thinking in the experimental class is effective and helps to improve students' learning outcomes better than the teaching method in the control class.

Table 3.6. Frequency distribution (grouped) of test results of experimental class and control class

No.	Class	Number of students	Number of tests with corresponding scores and test score ratio		
			0-4	5-7	8-10
NguDeng High School	Experiment	40	4	29	7
			10%	72.5 %	17.5 %
	Control	43	10	30	3
			23.25 %	69.76 %	6.97 %
Phonthong High School	Experiment	42	5	32	5
			11.90 %	76.19 %	11.90 %
	Control	44	12	28	3
			27.27 %	63.63 %	6.81 %

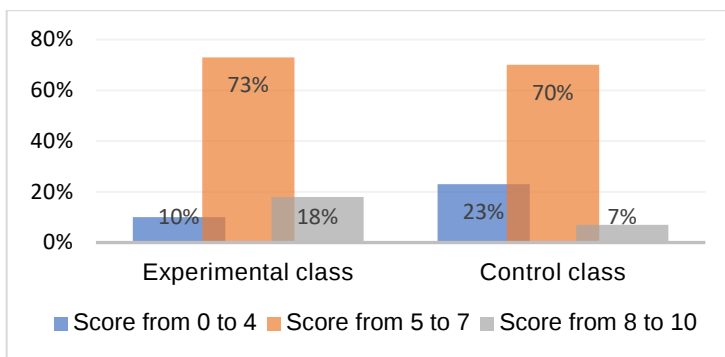


Figure 3.6. Frequency distribution of test scores of experimental class and control class of NguaDeng school

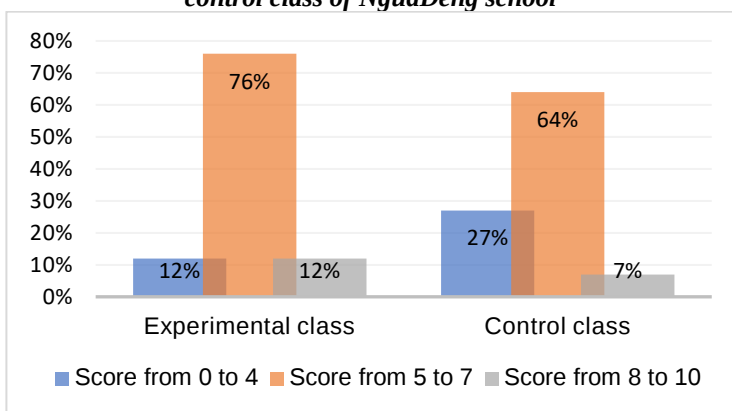


Figure 3.7. Frequency distribution of test scores of experimental class and control class of Phonthong school

The results of the experimental test showed that the students' critical thinking and creative thinking abilities, especially the ability to reflect on the process of solving equations and inequalities, were still at an average level. However, the average score of the experimental class at NguaDeng school was 2.74% higher than the control class, and at Phonthong school was about 13% higher. This shows that teaching in the direction of developing critical thinking and creative thinking initially brought positive results.

Results from tables, charts and observations show that the experimental class, thanks to being trained in the direction of developing critical thinking and creative thinking, has significantly improved thinking skills compared to the control class - which has the same level

but learns using traditional methods. This confirms that organizing teaching in the direction of developing thinking helps students to be active, creative and apply knowledge well to solve practical problems. However, there are still some students in the experimental class who achieve low results, showing the need for additional individual support measures such as: assigning clear tasks, giving appropriate suggestions and closely following up during the learning process.

3.4.3.2. *Qualitative analysis*

- *Ability to learn, identify, explore, and organize information and ideas:* Before the experiment, it showed limitations in learning - identifying problematic situations; arranging and processing mathematical information and ideas; many students did not perform well. After the experiment, it showed that students achieved and performed learning - identifying problematic situations; arranging and processing mathematical information and ideas better. This shows that learning - identifying problematic situations; arranging and processing mathematical information and ideas need to be further trained in the process of solving problems.

- *Ability to generate ideas, abilities and actions:* Before the experiment, students initially knew how to connect and expand the mathematical ideas they had learned, but were still confused about finding solutions and converting ideas into specific problem-solving processes. After the experiment, many students were able to imagine, connect, expand ideas and proactively find solutions, thereby building appropriate problem-solving processes. The results showed that students had clearly formed and developed the ability to generate ideas, abilities and actions in solving mathematical problems.

- *Ability to reflect on thinking and the solution process:* Before the experiment, the limitations were only thinking about critical thinking and creative thinking, but the reflection on the solution process and transferring knowledge into new contexts were not done well. After the experiment, the difference was found in thinking about critical thinking and creative thinking, reflecting on the solution process and being able to transfer knowledge into solving other problems. This shows that students are interested in doing the activities of learning, exploring and applying to new problems and contexts.

- *Analytical, synthetic, and evaluative thinking abilities regarding theories and solution procedures:* Before the experiment, students were

still limited in analyzing, evaluating logic, reasons for selection, drawing conclusions and building action processes due to lack of practice. After the experiment, although the difference was not large, the number of students who were able to perform these operations increased, showing the initial formation of analytical, synthesizing and evaluating thinking skills in solving math problems.

- ***Regarding argumentation and criticism in practice:*** Before the experiment, students were still confused when arguing and criticizing in discussing practical issues. After the experiment, thanks to being encouraged to ask questions and analyze situations, they significantly improved their ability to think dialectically, to evaluate problems from multiple perspectives and to use real data to argue and criticize. Thereby, they not only studied Math well but also practiced logical thinking and presentation and defense skills.

- ***On creativity in solving practical problems:*** Before the experiment, many students were still confused when applying mathematical knowledge to practice. After applying teaching methods, students in the experimental class thought more flexibly, knew how to combine many approaches and come up with creative solutions. They made significant progress in reasoning, criticism and relating to solving real-life problems, showing that developing critical and creative thinking contributes to improving overall capacity and learning outcomes.

Chapter 3 Conclusion

The pedagogical experiment was conducted in the 2023-2024 school year at Phonthong High School and NguaDeng High School (Champasak Province, Lao People's Democratic Republic) to verify the feasibility and effectiveness of the combined application of the 5 proposed teaching methods. The experiment was conducted in two classes (1 experimental class, 1 control class) with corresponding teaching content.

The results show that students in the experimental class have a more positive attitude towards learning, actively participate in learning activities and discussions; suitable lesson plans help teachers easily organize teaching. In terms of knowledge, students in the experimental class grasp the lesson more deeply and sustainably and achieve higher results than the control class. Quantitative analysis confirms that the pedagogical hypothesis is well-founded, affirming the feasibility and initial effectiveness of the proposed measures.

CONCLUSION AND RECOMMENDATION

Conclusion:

The thesis has completed the proposed research tasks, with the following main results:

1. Theoretical basis: The thesis has systematized the viewpoints on critical thinking and creative thinking and corresponding abilities; clarified the relationship between the two types of thinking and affirmed the necessity of developing them in teaching Mathematics in high schools in the Lao People's Democratic Republic.

2. Regarding the system of measures: Based on theoretical foundations, international experience and educational practices in Laos, the thesis has proposed 5 measures to develop critical thinking and creative thinking through teaching the topic of equations and inequalities. The measures are closely related, need to be implemented synchronously, illustrated with specific examples, and consistent with the current program.

3. Regarding pedagogical experiments: Experiments at two high schools have shown that the proposed measures are feasible, clearly effective and consistent with the orientation of educational innovation in the Lao People's Democratic Republic. Students in the experimental class have made clear progress in attitude, learning outcomes and thinking ability.

From there, the following conclusions can be drawn: Developing thinking is the core goal of educational innovation, especially in teaching Mathematics; Training critical thinking and creative thinking for students through specific pedagogical measures is an effective and practical approach; The proposed system of measures is feasible, has a scientific and practical basis and can be applied in innovating Mathematics teaching in the Lao People's Democratic Republic.

The research results confirm the scientific hypothesis of the thesis, and at the same time contribute to the orientation for the development of Mathematics education according to the requirements of modern education in the 21st century.

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.