THAI NGUYEN UNIVERSITY
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TEACHING GEOMETRY IN SENIOR GRADES OF LOWER SECONDARY SCHOOLS THROUGH AN INTEGRATED APPROACH

Major: Theory and Methodology of Mathematics Teaching
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DISSERTATION SUMMARY

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THE AUTHOR'S PUBLICATIONS
RELATED TO THE DISSERTATION TOPIC

International Publications (02)

1. Tran Viet Cuong, Dao Tam and Pham Van Hieu (2020), *"Designing and Using Geometry Case Studies in the Last Grade at Secondary Schools by Integrated Teaching Method in Vietnam"* Universal Journal of Educational Research, Vol. 8, No. 12, pp. 6620 - 6634, 2020. DOI: 10.13189/ujer.2020.081226.
2. Cuong, T. V., Tam, D., & Hieu, P. V. (2021), *Testing the effectiveness of the designing and applying process with certain circumstances in geometry teaching*, Linguistics and Culture.

National Publications in the country (04)

1. Dao Tam & Pham Van Hieu (2018), *Teaching geometry in senior grades of lower secondary schools in the approach of strengthening the exploitation of the relationships within mathematics, with other subjects and with reality*, Journal of Education, No. 434 (Term II - 7/2018) pp.54-58.
2. Dao Tam, Tran Viet Cuong & Pham Van Hieu (2019), *Preparing teachers with knowledge and practical skills to meet the needs of math teaching in lower secondary schools in an integrated teaching approach, Journal of Educational Sciences*, No. 17 (May 2019) pp.77-82.
3. Dao Tam, Tran Viet Cuong & Pham Van Hieu (2020), *The current situation of teaching Mathematics in the integrated teaching approach in senior grades of lower secondary schools in Hai Phong city*, Journal of Education, No. 474 (Term II - 3/2020) p.39.
4. Pham Van Hieu (2021), *Designing math teaching situations in the integrated teaching approach in lower secondary schools*, Journal of Education, special issue of May 2021.pp. 29.

Research Projects (01)

The PhD student participated in 01 university-level science and technology project.

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INTRODUCTION

1. Reason for choosing the research topic

The viewpoint of integrated teaching is interested in many countries around the world as a general education strategy such as Japan, Russia, and Australia. This viewpoint is concretized in such aspects as exploiting Maths teaching in the direction of inculcating the internal relationships between different chapters; exploiting Maths teaching according to interdisciplinary relationships; teaching in the direction of relating Maths to practice.

The educational goals of the subjects of the general education program and the goals of Maths education at all levels have emphasized the viewpoint of integrated teaching, orienting the teaching of Maths in high schools in general, and in lower secondary schools in particular, into integrated teaching. However, to implement integrated teaching in secondary schools, it is necessary to prepare the potential for teachers to be ready to meet the set goals.

Currently, the issue of integrated teaching in lower secondary schools has only been implemented in grade 6 for the school year 2021-2022 but has not been implemented widely. The problem of combining educational contents of some subjects according to certain principles to form an integrated subject in Vietnam is also done within the framework of a ministerial-level research project.

The outstanding difficulty in the study of integrating subjects is that the teachers have not been prepared ideologically as well as intellectually; they have not been trained and fostered synchronously to be ready to meet the set goals in the current educational innovation. Teachers have not paid attention to studying, designing, and using situations to organize activities for students to connect knowledge within Maths, connect Maths with other sciences and connect Maths knowledge with practice in general, Geometry in lower secondary school in particular.

The researcher chose the research topic for the thesis as: "Teaching Geometry in senior grades of lower secondary schools in an integrated approach".

2. Research aim

To realize integrated teaching through typical situations in teaching Geometry in senior grades in lower secondary schools in the direction of exploiting the internal relationships between Maths contents, interdisciplinary relationships, and relate Maths with practice.

This realization is demonstrated through the following stages:

- Prepare knowledge and skills for teachers to meet the requirements of integrated teaching and innovation in Maths education in lower secondary schools.

- Overcome the main difficulties of teachers in designing integrated teaching situations and organizing integrated teaching.

- Specify integrated teaching into some Geometry teaching situations in senior grades of lower secondary schools through exploiting the design and application process.

3. Research tasks

- Study the theory and practice of integrated teaching in the country and the world in general, integrated teaching in Geometry in senior grades of lower secondary schools in particular.

- Study and exploit the role of teaching Geometry in senior grades in an integrated approach.

- Propose a method of teaching Geometry in senior grades in lower secondary schools in the integrated teaching approach.

4. Research subject and object

- Research subject: The process of teaching Geometry in senior grades of lower secondary schools in the integrated teaching approach.

- Research object: prepare knowledge and skills for Maths teachers of lower secondary schools to build and use Geometry teaching situations in senior grades of lower secondary schools in the direction of organizing activities for students to implement integrated teaching.

5. Scientific hypothesis

After studying the types and levels of integrated teaching, studying the potential of Geometry textbooks for senior grades of the current lower secondary school, studying the viewpoints of renewing the goals of the Geometry teaching program of senior grades of lower secondary school, the researcher believes that if teachers are prepared with knowledge and skills to implement integrated teaching when teaching Geometry in senior grades of lower secondary schools, they can design teaching situations to organize practice activities for students to implement integrated teaching.

6. Research Methods

The thesis used the following research methods: Theoretical research method; Method of investigation and survey; Expert Method; Case study; Pedagogical experiment.

7. Arguments to defend

- It is necessary to equip teachers with some epistemological issues of integrated teaching to overcome difficulties in orienting, studying, and

designing teaching situations, and provide step-by-step procedures for organizing integrated teaching with these situations.

- Students learn effectively through interaction with integrated teaching situations designed and used by teachers in the teaching process.

- Methods of teaching geometry in the final grades of lower secondary schools in the direction of integrated teaching confirm its effectiveness through an analysis of pre and post pedagogical experimental results.

8. Contributions of the thesis

8.1. Theoretical contributions: The thesis has synthesized theoretical issues on integration, and integrated teaching in Vietnam and in the world to draw out the necessary contents for overcoming teachers' difficulties in orienting and exploring situations and organize integrated teaching for students through interaction with the designed situations to improve the efficiency of students' knowledge acquisition in the integrated teaching approach; proposed the process of designing and applying integrated teaching situations to contribute to improving the quality of Geometry teaching in senior grades of lower secondary schools.

8.2. Practical contributions: The thesis contributes to realizing the integrated teaching approach through some typical situations in teaching Geometry in senior grades of lower secondary school.

9. Thesis structure

In addition to the introduction, conclusion, recommendations, list of references, and appendices, the thesis includes 4 main chapters: *Chapter 1:* Theoretical basis. *Chapter 2:* Practical basis. *Chapter 3:* Designing and organizing Geometry teaching situations in senior grades of lower secondary schools in the integrated teaching approach. *Chapter 4:* Pedagogical experiment.

CHAPTER 1. THEORETICAL BASIS

1.1. Overview of research on integrated teaching

1.1.1. Foreign research works

Since the 60s of the twentieth century, many countries around the world, especially advanced countries, have built and developed programs and textbooks from an integrated teaching viewpoint.

Nowadays, many countries around the world consider integration and interdisciplinary as a basic viewpoint in implementing subject curricula from elementary school to lower secondary school and high school. A fairly common trend is the integration of traditional subjects such as Physics,

Chemistry, and Biology to form a new subject of natural science through interdisciplinary integration and cross-disciplinary integration.

Through the study of educational programs of many countries around the world, it is shown that integration is one of the educational perspectives that has become a trend in determining the content of teaching in high schools and in building subject curricula.

Thus, countries around the world have integrated knowledge related to the two fields of natural sciences and social sciences into integrated subjects.

Thus, integration in teaching has been studied by many scholars around the world, who have proposed different forms and levels of integration. In the development of educational programs in many countries around the world, integrated teaching is the core in determining the content of teaching in schools and in building the subject curricula.

1.1.2. Research works in Vietnam

In recent years, there have been many studies on the issues of integrated teaching from the perspective of teaching theory in general and subject teaching theory in particular, among which the issue of interest among researchers is the development of curricula and textbooks from an integrated teaching viewpoint. In middle and high schools, subject integration is still being studied and implemented in the junior grades but has not yet been implemented on a large scale.

The trend of integrated teaching in Vietnam aims to shorten the time to present knowledge of many subjects and focus on training students on how to apply integrated knowledge into practice. To solve a practical problem, it is often necessary to mobilize knowledge from many subjects - teaching each subject separately will bring systematic academic knowledge but is difficult to apply in practice.

In the General Education Program 2018, the overall program specifies the view that "The general education program ensures the development of learners' qualities and competencies through educational content with basic, practical, modern knowledge; harmonize virtue, wisdom, health, and beauty; focus on practice and applying knowledge to solve problems in study and life; highly integrated in the lower classes, gradually differentiated in the upper classes; use appropriate methods and forms of educational organization to promote the initiative and potential of each student; apply proper methods of testing and assessment in accordance with educational goals and educational methods to achieve the set goals".

1.1.3. Some remarks on domestic and foreign studies

Integrated teaching is a trend in modern teaching in developed countries and is the goal of current and future education, to solve the contradiction between the requirements of general education, students' acquisition levels, and the vast body of human knowledge, which is increasing day by day. The integrated approach allows us to look at things holistically. Teaching from an integrated perspective has many advantages. Through integrated teaching, learners save learning time and still achieve cognitive efficiency.

Integrated teaching helps to overcome the isolated and separate manifestations of each aspect of knowledge, and at the same time, it develops in learners dialectical thinking, the ability to understand and apply knowledge flexibly in different practical situations of the subject. Integration helps students combine knowledge of specific subjects and sub-disciplines in the curriculum in many different ways; as a result, the understanding of knowledge will be deeper, more systematic and sustainable.

In the above-mentioned studies, scholars have presented the concept of integrated teaching, the levels of integration, how to build integrated teaching topics, and the use of appropriate teaching forms to develop the competence of learners. However, no research work proposes to teach Geometry in senior grades of lower secondary school in an integrated approach.

To facilitate the application of integrated teaching by teachers in lower secondary schools, we consider it necessary to continue studying integrated teaching and the process of Geometry teaching in senior grades of lower secondary schools in the integrated teaching approach.

1.2. Overview of integrated teaching

1.2.1. Integration

Scholars have given many definitions of integration, which all have one point in common: integration is a dialectical combination of systematic and basic characteristics of different components to lead to a new object as a unified whole, merging the nature of the object components rather than the mechanical aggregation of the components' properties.

According to the researcher, *integration is the combination of knowledge and skills from different chapters in a subject or of different subjects to acquire a content of knowledge or solve a practical problem.*

1.2.2. Integrated teaching

1.2.2.1. The concept of integrated teaching.

Based on the theory of integrated teaching and the perspectives of integrated teaching in the world and in Vietnam, the researcher proposed

the following concept of integrated teaching in Maths: *Integrated teaching in Maths in lower secondary schools is a type of teaching where students acquire knowledge and skills based on interacting with teaching situations that satisfy the following requirements:*

- The situation is designed by teachers from known internal knowledge of Maths, knowledge of other related subjects or practical situations, which can be exploited to form, consolidate and deepen mathematical knowledge.

- The situation aims to solve a math problem through modeling of phenomena in other subjects or in practice.

- The situation can be explained by known Mathematical knowledge or knowledge of other related subjects; the situation allows connecting math knowledge with knowledge of other sciences.

- In solving situations, students grasp the meaning of mathematical knowledge to be taught.

The researcher concretizes the definition of integrated teaching in Maths into integrated teaching in Geometry in lower secondary schools with the following expectations:

(1) Increase visualization when designing and using situations because geometric knowledge is abstract for students.

(2) The selected situations need to focus on elements of space geometry and quantitative relationships in Geometry.

1.2.2.2. Theoretical basis of integrated teaching

a) Philosophical basis

b) Psychological basis

c) Basis of teaching theory

1.2.2.3. The goal of integrated teaching.

Integrated teaching has four basic goals:

1) Integrated teaching aims to develop learners' competencies.

2) Integrated teaching makes learning processes meaningful.

3) Make connections between the knowledge, skills and methods of the subjects.

4) Streamlining knowledge, avoiding repetition of knowledge content in subjects.

1.2.2.4. The basic manifestations of integrated teaching.

Integrated teaching has the following characteristics:

- Establish relationships according to a certain logic between different knowledge and skills to perform a complex activity.

- Select the information, knowledge and skills necessary for students to perform practical activities in learning situations, and daily life, and

integrate students into the world of life.

- Make the learning process purposeful.

- Teachers do not give priority to imparting knowledge and single information; instead, they help students develop the competency to search, manage, organize and use knowledge to solve problems in meaningful situations.

- Overcome the habit of imparting and absorbing discrete knowledge and skills that make people "functionally illiterate", meaning that they can be crammed with a lot of information, but cannot use it.

1.2.2.5 Forms of integrated teaching. Based on the analysis of the theoretical basis of integrated teaching and research on the ways of classifying integrated teaching by scholars in the world and in Vietnam, in this research, the researcher focuses on teaching Geometry in senior grades of lower secondary schools in an integrated approach through exploiting the following contents:

(1) Exploit the internal relationship between the Geometry contents in senior grades of lower secondary schools.

(2) Exploit the interdisciplinary relationship of Geometry with other subjects.

(3) Exploit the relationship between teaching Geometry in senior grades of lower secondary schools with practice.

1.3. The significance of the Methodology of mathematical cognition for integrated teaching

1.3.1. The main viewpoints of the methodology of mathematical cognition

1.3.2. The significance of the methodology of mathematical cognition for the integrated teaching of Maths

Teaching Maths is essentially teaching the relationships within Maths, teaching Maths in relation to other subjects and to practice. The thought of teaching Maths according to relationships contributes to illuminating the integrated teaching perspective.

The consideration of modeling as the method of cognition is especially important in cases where direct understanding of the subject matter is difficult or even impossible. In this case, some model of the subject matter is created. That model ensures the intuitiveness of the experiment and the ease of the research. However, with a certain degree of accuracy in replicating the properties of the original, the properties of the model are of primary interest to the researcher and they have many advantages compared to studying the original.

1.4. Integration in teaching Geometry in senior grades of lower secondary schools

1.4.1. Possibility to develop different approaches to solving problems within Maths

This relationship is shown through the systematization of the knowledge in the Geometry program structure, in which the previous knowledge is the basis for forming the following knowledge and the relationship between the different chapters of the Geometry content.

1.4.2. The role of Geometry in senior grades of lower secondary schools in other subjects

Mathematical knowledge in senior grades of lower secondary schools will help students have a basis to learn other science subjects from which they can understand the laws of the objective world; help students explain things and phenomena following the truth; at the same time, immediately determine the students' attitudes towards things and phenomena; for the phenomenon being studied, and depending on the requirements of the program, train students to know how to affect that object or phenomenon.

The interdisciplinary relationship between subjects aims to connect the content circuit in the subjects as much as possible to avoid duplication; the knowledge and skills of one discipline help to clarify the knowledge and skills of the other; help students apply the knowledge and skills of each subject to solve the problems posed in the subjects.

Maths in schools plays the role of an instrumental subject because the language of Maths, knowledge of Maths, and thinking of mathematical methods are necessary for life, for learning other sciences, especially Physics, Chemistry, Technology, etc; for the training of scientific manners. Students know how to pose problems, analyze, solve problems and assess the solutions; know how to recognize the essence, and classify cases; from individual problems, they can draw general conclusions; know how to apply general reasoning to specific situations; know how to reason concisely and accurately; know how to present, express clearly and coherently...

1.4.3. The possibility to connect Geometry of senior grades of lower secondary schools with practice

From the viewpoint of mathematical methodology, this relationship is expressed through the methodology of mathematical cognition in general and the geometrical perception method of the phenomena of objective reality in particular. This is an important part of the methodology of mathematical cognition. To perceive the classes of phenomena of the

objective reality by mathematical methods, people use mathematical models for those classes of phenomena. In essence, it is using symbols and Maths language to describe the above-mentioned classes of phenomena of the objective reality.

The analysis of the above relationships and the practice of teaching Geometry in senior grades of lower secondary schools reveal that the study of internal relationships, interdisciplinary relationships, and the relationship of Geometry teaching with practice needs to be concretized to contribute to clarifying the methodological significance of Geometrical cognition, and to clarify the role of geometrical knowledge in practical activities through designing and using teaching situations to inculcate the roles of the relationships discussed above.

1.5. The potential of the Geometry textbook program for senior grades of lower secondary schools for integrated teaching

In the Maths curriculum of senior grades of lower secondary schools, there is a lot of Geometry knowledge that is internally related and has interdisciplinary relationships with other subjects such as Physics, Technology, etc. and related to reality. Many objects around us have geometric shapes: circles, squares, rectangular boxes, cones, spheres... Calculating distances, surface areas, cross-sections of objects shapes; calculating volumes of polyhedrons, and rotating blocks... are geometric problems related to reality.

Geometry content in senior grades of lower secondary schools, teaching methods of Geometry are still controversial with many problems. For example, Geometry content can not create interest and motivation for students to enjoy learning Geometry; the content is still academic; teachers have not been able to integrate the different chapters in Geometry or solve the interdisciplinary relationships between the subject of Geometry and other subjects; Geometry content has little relation to the practice.

1.6. Cognitive characteristics of lower secondary school students

1.6.1. Characteristics of students' learning activities in lower secondary schools

1.6.2. Characteristics of the intellectual development of lower secondary school students

1.6.3. Characteristics of Geometric cognition of lower secondary school students

CHAPTER 2. PRACTICAL BASIS

2.1. Survey purpose

- Investigate teachers' perceptions of integration in teaching in general and integration in teaching Maths in particular to reveal their cognitive advantages and disadvantages and to orient the research to overcome the weaknesses discovered from the survey.

- Investigate teachers' understanding of the design and organization of integrated teaching situations in teaching Maths; identify major difficulties when designing situations taken from real life around and from knowledge of other sciences when forming mathematical knowledge, consolidating and deepening knowledge when solving a Maths problem and applying it to practice.

- Investigate the level of application of integrated teaching by teachers in lower secondary schools in the process of teaching Geometry in sen grades of lower secondary school.

- Investigate the extent to which students apply Geometry knowledge of senior grades of lower secondary school to understand other knowledge and Maths knowledge implicit in practice, as well as learn how to solve a Maths problem by using internal relationships, interdisciplinary relationships, and relating Maths to practice. Especially clarify the difficulties of students with the issues being investigated above.

2.2. Survey content

2.2.1. For teachers

We surveyed the perception of some Maths teachers teaching senior grades of lower secondary schools at some schools in the districts of Hai Phong city about integrated teaching, the scientific basis of integrated teaching, the roles and goals of integrated teaching as well as the difficulties of teachers in organizing integrated teaching in Maths in general and in Geometry in particular in lower secondary schools.

2.2.2. For students

The content of the survey is presented in 8 situations in written form. We focus on assessing students' ability to mobilize knowledge and experience, identify key knowledge in problem-solving, search for new knowledge, and recognize the need to mobilize knowledge within Maths as well as knowledge in other scientific subjects to overcome conflicts and overcome difficulties when the existing knowledge and experience is not enough to solve the problem set out.

2.3. Survey method

2.3.1. Design the survey questionnaire

The survey questionnaire includes the following sections: Introduction to the survey objectives, questions about teaching Geometry in senior grades of lower secondary schools in an integrated approach, and personal information of the respondents. There are two types of survey questionnaires: Survey questionnaires for Maths teachers in senior grades of lower secondary schools and survey questionnaires for students in senior grades of lower secondary schools. The content of the survey: Perceptions and evaluation of administrators, teachers and lower secondary school students about teaching Geometry in senior grades of lower secondary schools in an integrated approach.

2.3.2. Data collection and processing

The questionnaires were distributed to teachers and students on the spot and returned to the investigator. The results were processed by mathematical-statistical methods.

2.4. Survey participants

2.4.1. Teachers

Survey 55 teachers who are teaching Maths at 9 lower secondary schools located in Hai Phong city.

2.4.2 Students

Survey 90 students studying at 6 lower secondary schools in the districts of Hong Bang, Kien An, Duong Kinh and Vinh Bao, which are located in Hai Phong city.

2.5. Survey instruments

- Administer a survey questionnaire consisting of 15 multiple-choice questions for teachers.
- Observe Geometry lessons in senior grades of lower secondary schools.
- Consult experts and experienced teachers.
- Survey students on how to solve integrated situations and problems with integrated content using questionnaires for groups of students.

2.6. Survey methods

- Observe students in discussions; investigate students' behavior towards the situations they approach. In case students have difficulty, there will be necessary instructions.
- When observing classrooms, there is a plan for observing content related to teaching in an integrated approach.
- Participate in teacher discussions on integrated teaching situations.

2.7. System of multiple-choice questions

The system of multiple-choice questions has the following contents: Survey objectives, survey contents to clarify the shortcomings of teachers that still need to be overcome, which will be studied in chapter 3.

2.8. Survey results analysis

2.8.1. Analysis of teacher survey results

The survey results are mainly analyzed qualitatively and quantitatively through the evaluation of the answers to the groups of survey questions given and the results obtained.

1) Question group 1: ***Investigate teachers' perceptions of integrated teaching concepts in general and integrated teaching in teaching Maths in lower secondary schools in particular.*** After evaluating the answers to questions in group 1 given by 55 Maths teachers, we obtained the following results of the posterior analysis:

- The concept of integration. The survey results show that teachers understood some aspects of integration; there were no complete answers. The reason for this is that teachers have not been trained in integrated teaching to prepare knowledge and skills to meet the requirements of teaching innovation in the current curriculum.

- The concept of integrated teaching. The percentage of teachers who understood integrated teaching is only 36%. This figure reflects the limited knowledge of teachers about integrated teaching. In fact, 36% of these teachers only have experiential knowledge about creating motivation for students to get involved in activities in Maths teaching: creating initial motivation, creating intermediate motivation, creating motivation for accomplishment to form, consolidate and exploit the applications of Mathematical knowledge. These teachers also know the significance of assessing students' ability based on PISA as well as the role of teaching to inculcate the meaning of knowledge.

- The concept of integrated teaching in Maths. 64% of teachers responded to the concept of integrated teaching in Maths. Many teachers answered this question correctly because teachers are equipped with cognitive activities and learning activities in teaching Maths. In cognitive activities and learning activities, special attention is paid to activities of practicing and applying knowledge into practice. Especially when solving a math problem, teachers are equipped with methodological knowledge, mobilizing many different types of knowledge, through which teachers can see the inner relationship between mathematical knowledge. On the other hand, lower secondary school teachers have received interdisciplinary training in pedagogical institutions such as Maths - Physics; Maths - Technology; Maths -

Informatics; Maths – Chemistry, etc. The above characteristics are a favorable basis for answering the questions posed.

- The concept of integrated teaching in Geometry in senior grades of lower secondary schools. 13% of teachers answered correctly about the concept of integrated teaching in Geometry in senior grades of lower secondary school. This result reflects that the majority of teachers have not yet paid attention to the idea of integrated teaching when teaching Geometry in lower secondary schools. Teachers understood the general concept of integrated teaching in Maths but they did not know how to actualize it in detail when teaching Geometry.

- The concept of integration in teaching Maths and integrated teaching of natural sciences. There were 51% of teachers who answered this question correctly for the following reasons:

+ Lower secondary school teachers received interdisciplinary training in pedagogical institutions, so they understand the relationship between knowledge of Maths and knowledge of other sciences.

+ When teaching according to the method of problem discovery and solving or teaching from a constructivist perspective, problems and situations created for students to judge are usually taken from practical situations or situations in other sciences; therefore, the teacher is aware of the relationship between Maths and other sciences.

2) Question group 2: ***Investigate teachers' perceptions of the scientific basis of integrated teaching.*** After evaluating the answers to the questions in group 2 given by 55 Maths teachers, we obtained the following results of the posterior analysis:

- The concept of the philosophical basis of integrated teaching in teaching Maths. The reason why the number of teachers who answered correctly is still low is that teachers do not practice applying the view of the common relationships in Maths education. Most of the teachers do not apply the philosophical perspective in life as well as in the practice of teaching Maths. Few teachers understood the philosophical basis of integrated teaching mainly; instead, they relate to other aspects such as the relationship between Algebra and Geometry, the relationship of natural sciences with Teaching Math, and assessing Maths understanding according to PISA. Most teachers have not studied deeply the philosophical basis of integrated teaching.

- The concept of the methodological basis of Maths for integrated teaching in Maths. Most teachers only answered correctly in some aspects of the methodological basis of integrated teaching. Most of them understood that the basis for connecting Maths teaching with practice is to build mathematical models of classes of phenomena in practice to mathematize real situations,

thereby explaining real phenomena with mathematical knowledge. Few teachers realized the subject matter of Maths. Meanwhile, realizing the subject matter of Maths and the characteristics of Maths is the basis for exploring practical situations associated with teaching Maths in schools.

3) Question group 3: ***Investigate teachers' perceptions of the roles and goals of integrated teaching.*** After evaluating the answers to the questions in group 3 given by 55 Maths teachers, we obtained the following results of the posterior analysis: On average, 35% of teachers answered correctly on important aspects of the goals of integrated teaching. These results are consistent with our priori analysis results.

4) Question group 4: ***Investigate the difficulties of teachers in organizing integrated teaching in Maths in general and Geometry in particular in lower secondary schools.*** The posterior analysis was carried out according to the questions regarding the above-mentioned difficulties. Through a posterior analysis, we can determine if the priori difficulties of teachers mentioned in the priori analysis are valid; if they are true according to the current difficult situation of teachers.

+) Assess the difficulties in designing integrated situations in general and practical situations in particular. These difficulties are covered in questions 10 to 13. The results are as follows:

66% of the teachers surveyed mentioned difficulties in designing situations that contain the knowledge to be taught, which is meaningful for integrated teaching. This status has been shown in the priori analysis. The rest of the teachers have not paid attention to this issue because in practice they have not experienced exploring practical situations in order for students to interact, form, consolidate and deepen their knowledge.

+) Assess the difficulties in preparing knowledge for teachers to have orientation in integrated teaching situations.

These difficulties are reflected in questions 12 to 14. The results are as follows: 44% of the teachers claimed that they had difficulty in preparing knowledge and promoting exploration of integrated situations. This is also quite consistent with the difficulties outlined in our priori analysis.

+ Assess the current situation of teachers' difficulties in preparing for an integrated teaching organization.

These difficulties are outlined in questions 10; 11; 13; 15. The survey results show that many teachers are not aware of the methodological knowledge related to the subject matters of Maths, the characteristics of Maths, the relationship between different chapters in Maths, the relationship between Maths and other sciences, and the relationship between Maths and

practice. Teachers have not paid attention to the common relationships in dialectical materialist philosophy to guide the exploration of integrated situations. As a result, 40% of teachers stated that they were aware of the difficulties. More or less, teachers understood the necessary knowledge to adjust and prepare integrated situations for students to interact with.

+) Assess teachers' difficulties in preparing intensive knowledge of many subjects to approach integrated teaching. These difficulties are explored in questions 12 and 15 in Appendix 1.

The survey results show that many teachers did not understand the nature of integrated teaching; therefore, they did not understand this difficulty. The major difficulty is that the same problem of Maths in general and Geometry in senior grades of lower secondary schools in particular is considered and solved from an integrated viewpoint. Multiple sources of knowledge in the same subject or knowledge of other sciences as well as practical knowledge cause difficulties for many teachers. Few teachers selected this difficulty because they were initially aware of the idea of integrated teaching through self-study of documents, doing research or exploiting many integrated issues in solving math problems.

2.8.2. Analyze student survey results

2.8.2.1. Priori analysis

2.8.2.2. Posterior analysis

2.8.2.3. Overall assessment of student survey results.

After having surveying students, and observing their activities and discussions, we found that students revealed the following behaviors:

Before organizing for the students to solve the designed situations, we informed them about the objectives of the given situations in the survey. We found out that they enthusiastically accessed information and in the process of solving the situations, they showed great interest. They also participated in the process of group discussion lively and actively. They have learned to switch from practical language to Mathematical language and initially knew how to convert practical models into Mathematical models.

In addition, we found that in the process of learning Geometry, students still had some limitations. For example, when facing a situation that requires new knowledge, students have difficulties due to insufficient knowledge of methods and knowledge of compatible things to access the new situations to solve the problem posed. The above difficulty is because students have not been able to exploit the intermediate knowledge gained from the knowledge development activities in the Geometry textbook program to integrate the required knowledge.

We also found that students still have difficulty when solving situations that need the integration of knowledge already in Geometry to solve situations that integrate algebraic knowledge such as situation 5.

In the object transformation activity, students are still limited in the thinking process to reveal the objects of the activity such as mathematical concepts, the rules of the relationship between mathematical objects...

Chapter 3
DESIGN AND APPLY GEOMETRY TEACHING SITUATIONS IN SENIOR GRADES OF LOWER SECONDARY SCHOOLS IN THE INTEGRATED TEACHING APPROACH

3.1. The process of designing and applying Geometry teaching situations in senior grades of lower secondary schools in the integrated teaching approach

3.1.1. The need for designing Geometry teaching situations in senior grades of lower secondary schools in the integrated teaching approach

3.1.2. The process of designing Geometry teaching situations in senior grades of lower secondary schools in the integrated teaching approach

Based on the theoretical studies presented in Chapter 1 and the results of the survey on the current status in Chapter 2, we propose a process with the following steps:

Step 1: Teachers study the contents and core objectives of the Geometry lesson to be taught.

Step 2: Explore and discover situations related to shapes quantitative factors such as length, area, volume and measurements of other geometrical quantities associated with the Geometry lesson content, taken from the subject of Geometry, associated with knowledge of other subjects or knowledge of practical situations.

Step 3: Organize seminars in professional groups and poll the opinions of experienced teachers directly or through the media.

Step 4: Examine students and groups of students through their interaction with situations to detect students' cognition levels.

Step 5: Finalize the situations after receiving feedback from students on levels of cognitive activities: Generalization, abstraction, modeling.

3.1.3. The process of applying the designed situations in teaching typical situations in Geometry in senior grades of lower secondary schools

Based on the theoretical studies presented in Chapter 1 and the actual situation survey results in Chapter 2, the steps of the process of applying integrated situations in teaching Geometry in senior grades of lower secondary schools are proposed as follows:

Step 1: Transfer cognitive tasks to students by providing integrated situations appropriate to the content and objectives of the Geometry topic to be taught.

Step 2: Organize for students to interact with the situations via the system of questions or teachers' orientation (in class, in groups or in extra-curricular learning activities depending on the requirements and cognitive level of the topic to be taught) to discover concepts, propositions; make predictions, hypotheses, and models of phenomena.

Step 3: Require students to make arguments to prove judgments, test hypotheses, and solve problems in the model.

Step 4: Require students to state the conclusions about the concepts, clarify the propositions and the meaning of the knowledge drawn from the mathematical models, and set the orientation for the development of new problems. The teacher confirms the above knowledge.

3.2. Concretize the process of designing and applying typical situations in teaching Geometry in senior grades of lower secondary schools in an integrated approach

3.2.1. Scenario of teaching Geometry concepts in the integrated teaching approach shown in the processes of designing and applying situations

3.2.2. Scenario of teaching students how to discover the theorems and the laws of Geometry in the integrated teaching approach shown in the processes of designing and applying situations.

3.2.3. Scenario of teaching students how to solve Maths problems in the integrated teaching approach shown in the process of designing and applying situations.

Chapter 4. PEDAGOGICAL EXPERIMENT

4.1. Purpose of pedagogical experiment

The purpose of the pedagogical experiment is to evaluate the feasibility and effectiveness of the process of designing Geometry teaching situations in senior grades of lower secondary schools in the integrated teaching approach and the process of applying the designed situations in teaching typical situations in Geometry in senior grades of lower secondary schools and the results of using the designed situations in teaching Geometry in senior grades of lower secondary schools in the integrated teaching approach.

4.2. Pedagogical experiment participants and data

4.2.1. Teachers

Teachers are experiment participants who have been equipped with the following knowledge:

- Knowledge of integrated teaching gained from the training sessions of the 2018 general education program implemented by the Ministry of Education and Training.

- Knowledge gained from studying documents to understand the content and role of integrated teaching deployed by the experiment organizers.

- Teachers have mastered the design process and the process of using integrated situations to teach Geometry. These processes were mentioned in chapter 3 of the thesis.

- Teachers have knowledge of integrated teaching: Organize integrated teaching, guide, control and use the processes for students to interact with the situations.

- Teachers were aware of teaching methods and had the opportunity to apply integrated teaching in teaching Geometry.

4.2.2. Students

Students have been equipped with the knowledge and skills to learn in an integrated approach:

- Students learn and practice problem-solving activities in teaching Geometry in different ways by examining the relationship between the problem to be solved and the existing knowledge. Since then, students have had many different ways to mobilize groups of knowledge as prerequisites to solve a problem. These knowledge and skills create opportunities for students to implement internal integration: mobilizing knowledge from different chapters in Maths to solve a certain problem.

- Students learn from a constructivist perspective; know how to use existing knowledge to make judgments, hypotheses about objects, mathematical relations in general, objects, and geometrical relationships in particular in different ways by investigating individual cases and special cases to generalize and make judgments as well as hypotheses.

- Students already know how to exploit knowledge in different directions through reviewing and consolidating knowledge and solve problems. In the Geometry program of senior grades of lower secondary schools, there are initially sections that focus on linking Geometry teaching with other science subjects such as Physics.

- Students in senior grades of lower secondary schools also know how to solve problems with practical content according to the PISA program.

- Students also practice modeling to explain phenomena in practice.

From the analysis of the experiment participants and data, we could choose experimental contents on a scientific basis.

4.3. Methods of pedagogical experiment

We conducted experiments as follows: Select content, conduct experiments and evaluate in the form of case studies for one or several groups of Maths teachers and students in senior grades of lower secondary school. In the case study, we focus on the forms of group research, discussion and debate, where the experimenters could observe the behaviors of students and teachers through activities corresponding to the experimental contents assigned to the selected groups. Experimental conductors gave questionnaires, gave instructions, observed, listened to and recorded the activities of each participant; recorded discussions and debates of teachers and students to gather data on their beliefs, attitudes, thinking activities, sharing ideas in groups and the conclusions of groups.

4.4. Experimental contents

4.4.1. For teachers

We conducted the experiment in the direction of concretizing the process of designing integrated teaching situations shown in teaching concepts, theorems and rules. Specifically, the experiments are presented as follows:

Experiment 1: The process of designing lesson plans for teaching the concept: "Two shapes are symmetrical through a line and the concept of shapes with axes of symmetry".

Experiment 2: The process of applying the situations to teach the concept: "Two shapes are symmetrical through a line and the concept of shapes axes of symmetry."

Experiment 3: Explore and design situations to apply the Pythagorean theorem in practice.

4.4.2. For students

When experimenting with teachers, we already investigated several activities that students need to conduct to make judgments, hypotheses, and activities to test judgments and hypotheses. These activities are conducted through teacher instructions and questionnaires. For the above reason, in the experiment for students, we only focused on students' activities through interacting with situations to explore and discover knowledge. The content of the experiment with students is as follows:

Experiment 1: Explain real-life situations through mathematical modeling activities.

Experiment 2: Use internal integration to form the theorem about inscribed quadrilaterals in circles.

4.5. Experimental instruments: Provide situations and questionnaires.

4.6. Survey form

- We surveyed 24 teachers during the period from August 2019 to October 2019 at three schools: Hong Bang lower secondary school; Nguyen Trai lower secondary school and Nguyen Binh Khiem lower secondary school.

- We surveyed 30 students in the period from May 2020 to July 2020 at three schools: Tran Phu lower secondary school; Nguyen Ba Ngoc lower secondary school and Nhan Hoa lower secondary school.

4.7. Survey organization

- Transfer context, and deliver questionnaires to groups of teachers and students to research and discuss to find solutions.

- The teacher in charge of the experiment observed the students' activities.

- Teachers recorded and videotaped some interactions between students and the situations; interactions between students and students; their sharing and discussing problem-solving ideas.

- The teacher recorded and videotaped the group's conclusions about knowledge discovery.

4.8. Experiment evaluation

We evaluated the experiment on two aspects:

4.8.1 Priori analysis

4.8.2 Posterior analysis

4.8.2.1 Posterior analysis of the results of the experimental situations for teachers

Experimental results are mainly evaluated qualitatively and quantitatively through the evaluation of answers to the experimental situations and the obtained results.

After observing and discussing with three groups of teachers in the seminar on experimental situation 1, we obtained the results of the posterior analysis as follows:

- The teachers have mastered the design process with 5 steps:

There are 92% of teachers who have mastered the process of designing Geometry teaching situations in senior grades of lower secondary schools in the integrated teaching approach.

There are 8% of teachers who still have difficulty in step 2, which is to explore situations chosen from relevant knowledge content, from other subject knowledge, or from practical situations containing knowledge related to the content to be taught. The reason is that this group of teachers are still inexperienced in teaching, with 2-4 years of working experience, so they do not have enough time and experience to accumulate knowledge or

relate knowledge and skills of Maths to other sciences; they can not exploit the practical situations implicitly containing mathematical knowledge related to the experimental situations.

During the experiment of situation 1, we found that 67% of teachers had difficulty in indicating that every point P on the semicircle (AMB) would have an image of P' on the semicircle (ANB), and vice versa, every point Q on the semicircle (ANB) has an image on the semicircle (AMB). This difficulty has been analyzed in the priori analysis section because most of the teachers did not care about the proposition that the axis symmetry is congruent.

In the experimental situation 2. In the process of discussing and taking notes of groups of teachers participating in experiment 2, we observed and found that 100% grasped the process of applying designed situations in typical Geometry teaching situations in senior grades of lower secondary school. Teachers discussed and examined the use of appropriate teaching methods and theories for each content to be taught in an integrated approach. The main methods used to implement integrated teaching situations in this thesis include teaching from the perspective of activity theory, teaching students how to discover and solve problems, cooperative teaching, and teaching from the viewpoint of constructivist theory. The thesis also illustrated the extent to which the above methods are used in the application process to clarify the main activities of teachers and students in the process of interacting with the integrated situations.

96% of teachers had a plan to transfer cognitive tasks to students by providing integrated situations that are appropriate to the content and goals of the Geometry topic of teaching situation 2.

4% of teachers still have difficulty in transferring tasks to students, which is understandable because although the teachers themselves have professional knowledge and master the process, they lack teaching experience. This lack of experience can be remedied in the future teaching process.

100% of teachers organized activities for students to interact with the situations through a system of questions or teacher orientation in groups, and students discovered concepts, propositions, made predictions, hypotheses, and models of phenomena as mentioned in the priori section. Students argued to prove judgments; reasoned to test hypotheses; solved problems in modeling situations; stated conclusions about concepts; clarified propositions and the meaning of knowledge drawn from mathematical models; set orientations for the development of new problems.

In experiment 3. We found that 100% of teachers observed and commented that the number of bricks counted on one side in Figure 4.8 equals the number of bricks counted on the diagonal and the number is 2. Similarly, the number of bricks counted on one side of Figure 4.9 is also equal to the number of bricks on the diagonal and the number is 3. In this experimental situation, most of the teachers can use geometrical knowledge to explain.

100% of the teachers have built a system of guiding questions for students to approach situations and model contexts in situations. This is also consistent with our priori analysis.

4.8.2.2 Posterior analysis of the results in experimental situations for students.

In experimental situation 1: among a total number of students in 3 groups tested in situation 1, 67% could model the situation when observing the movement of the lifting equipment. The students actively described the situation and modeled the situation as follows: Two iron bars of equal length are connected by an axis passing through their midpoint; when two iron bars move around the axis, the ends of the iron bars are always 4 vertices of a rectangle: A; B; C; D. The phenomenon of lifting and lowering of equipment can be modeled in Figure 4.19 and Figure 4.20 as follows: Two iron bars AC and BD are represented by two diagonals of the rectangle ABCD (see Figure 4.26). Then the nature of lifting the object is because the forces acting on the width BC decrease gradually while the forces on the length AB increase $AB \le AC$. When the two diagonals move, the shape of the rectangle changes; in fact, the length and width of the rectangle change according to the law. This law is described using the Pythagorean theorem: $AC^2 = AB^2 + BC^2$ (1). Since AC has a length unchanged due to the fixed length of the iron bar, from equality (1) it follows that the larger BC is, the smaller AB will be, which causes the device to lower the object. Conversely, the smaller BC is, the larger AB is, which causes the device to lift the object.

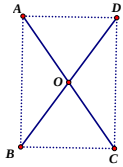

Figure 4.1

33% of the students had difficulty in modeling because they had difficulty understanding the idealization operation - iron bars are represented by straight lines. Students who are weak in applied thinking will solve practical phenomena by describing and using mathematical

languages. When they had access to the teacher's instructions, they actively described and modeled the situation.

In situation 2: Given square ABCD; rectangle ABCD, isosceles trapezoid ABCD with bases AD and BC

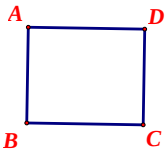

Figure 4.1

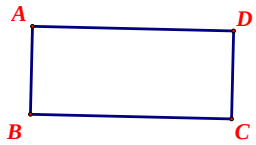

Figure 4.2

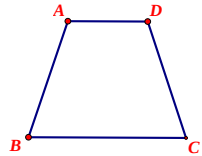

Figure 4 3

During the process of observing students and interviewing them, we found that 100% of the students could state the common characteristics of the 3 shapes: All of the three shapes can incircle a circle; The square and the rectangle can be inscribed in the minimum circle in one of the two methods of integrating the knowledge that has been learned.

- Method 1: Students applied the definition of a circle learned in grade 6 and pointed out the shapes that can be inscribed in a circle as follows: A square and a rectangle with equal diagonals intersecting each other at the midpoint O of each line and then in Figure 4.27 and Figure 4.28, it can be deduced that $OA=OB=OC=OD$. Since O is the center of the circumcircle of the square and the rectangle

- Method 2: The vertices B and D of the square and the rectangle both look at the two ends of the diagonal AC under a right angle. Therefore, the square and the rectangle are inscribed in a circle whose diameter is AC diagonal.

20% of the students found it difficult to demonstrate that an isosceles trapezoid can inscribe a circle when explaining that the perpendicular bisectors of sides AD and BC of trapezoid ABCD are congruent (see Figure 4.29). Let I be the intersection of the perpendicular bisector d' of side AB and the perpendicular bisector d of side AD. Then d is also perpendicular to BC at J as BC //AD. We can prove that the triangle ΔBIC is isosceles at I. Again, IJ is the altitude and the perpendicular bisector. Thus, the two perpendicular bisectors of AD and CB coincide.

100% of the surveyed students could point out that the sum of opposite angles of a quadrilateral is 180^0 and could state the concept of a quadrilateral inscribed in a circle.

CONCLUSION OF THE THESIS

The research results of the thesis allow the researcher to conclude some main issues as follows:

1. The thesis has synthesized several issues of integrated teaching theory in lower secondary schools; especially the thesis has tried to clarify the epistemological foundation of integrated teaching, including the basic issues of Mathematical methodology, and cognitive methodology to illuminate integrated teaching.

2. The thesis has provided an orientation basis for the design of integrated teaching situations following a 5-step process.

3. The thesis has provided a basis for orienting and designing the process of applying integrated teaching situations in teaching Geometry in senior grades of lower secondary school. The situations are also the foundation for preparing knowledge and skills for teachers and students to approach integrated teaching in teaching geometry in senior grades of lower secondary schools. In addition, the designed situations are the basis for orienting the practice of integrated teaching as well as organizing experiential activities for students to acquire new knowledge or apply knowledge into practice through exploiting the designed integrated teaching situations.

4. The thesis has deployed and applied the designed processes to teaching typical situations in an integrated teaching approach. The thesis has designed and applied several specific teaching situations: teaching concepts, theorems and teaching solving math problems. Situations are built and applied to show exploration through practical experience.

5. The results have been tested via the case study method and qualitative assessment organization. The research results of the thesis have opened up an integrated teaching approach in an interactive way with integrated teaching situations designed and applied in teaching geometry in senior grades of lower secondary school.

6. In the thesis, many typical examples are given, associated with reality and exploiting the relationship between Mathematics and other sciences.