INITIATION

1. REASONS FOR THEMES

1. In Vietnam, the orientation of innovating education basically and comprehensively in the current period is "... transfering the process of education from mainly providing knowledge to developing capacity and quality of learners comprehensively. Hands-on learning; theoretical along with practical...".

2. Based on the regulations of organization and operation of gifted high schools, the purpose of gifted high schools is detecting the student with private intelligence and excellent results in the learning, then developing their abilities about a number of subjects on the basis of ensuring the comprehensive education; educating them with patriotism, spirit of overcoming difficulties, national pride; capability of self-learning, scientific research and innovation; good health in order to be the human resources required to meet the country's long-term development.

3. Inquiry is an activity for students to figure out and acquire knowledge. There are many ways to inquiry as observers, by summing up the experience of the individual and humanity, or by deploying scientific research process. Thus, scientific research is a mean of exploring based on the model scientific project implementation and scientific research is a form of inquiry activity. There are some teaching methods in this term and teaching inquiry is a truly effective measure. Inquiry-based teaching is *to teach how to learn, how to do science, how to think in the way of a scientific researcher.*

Based on those reasons above, we started to research topic: **Teaching inquiry the genetic basis section at Biology-gifted class of high school.**

II. RESEARCH PURPOSES

Based on the theory and practice of inquiry-based teaching, building procedures of designing scientific topics and inquiry-based teaching through science topic in Genetic Basis section for Biology-gifted students in high schools in order to train scientific research capacity.

III. RESEARCH SCOPES

Research is restricted in organizing inquiry-based teaching of Genetic basis section for students in Biology-gifted class of high school through scientific topics.

IV. SUBJECTS AND OBJECTS OF RESEARCH

4.1. Research subjects

Organizing the teaching inquiry in Genetic basis section for gifted students of high school.

4.2. Research Objects

The procedure of teaching inquiry in Genetic basis section for gifted students of high school through scientific topics.

V. HYPOTHESIS OF RESEARCH

If the process of buiding scientific topics in Genetic basis section is designed successfully and organizing inquiry-based teaching activities through scientific topics following the scientific research procedure is suitable, the scientific research capacity of students will be developed.

VI. RESEARCH TASKS

1. Selecting and systematizing theoretical basis related to topics including teaching inquiry, scientific research capacity.
2. Investigating the situation of acknowledging about inquiry-based teaching, organizing inquiry-based teaching and training scientific research capacity ai gifted high schools.
3. Analyzing contents of Genetic basis section at high schools to determine core knowledge in order to design scientific topics.
4. Determining structure of scientific research capacity.
5. Proposing design process of scientific topics and applying process to design scientific topics related to Genetic basis section.
6. Building inquiry-based teaching process through scientific topics following scientific research procedure in order to develop scientific research capacity for students.
7. Designing criteria to assess scientific research capacity for Biology-gifted high school students.
8. Experimenting pedagogy in order to assess the feasibility and effectiveness of the hypothesis raised.

VII. RESEARCH METHODS

1. Theoretical research
2. Basic investigation
3. Method expert
4. Experimenting pedagogy (TNSP).

VIII. NEW PROPOSED CONTRIBUTION OF THEMES

8.1. Systemizing the practical and theoretical basis of inquiry-based teaching in order to propose the definition of inquiry-based teaching

8.2. Systemizing practical and theoretical basis of research competency in order to propose definition, structure of research competency, constructing criteria and tools to assess the research competency of high school students.

8.3. On the basis of analyzing the Fundamentals of Genetics part in high school biology curriculum and the procedure of designing the scientific topic in order to construct the system of scientific topics to be used in inquiry-based teaching for biology – specialized students

8.4. Propose the process of inquiry-based teaching via scientific topic in the Fundamentals of Genetics for high school biology – specialized students.

8.5. Propose the process of inquiry-based teaching via scientific topic in the Fundamentals of Genetics for high school biology – specialized students to improve their research capability.

RESEARCH RESULTS

Chapter 1

THEORETICAL AND PRACTICAL BASIS OF THEMES

1.1. Inquiry-based teaching and scientific research capacity

1.1.1. Inquiry-based teaching

Around the world, there are many studies about inquiry-based teaching. Inquiry-based teaching pattern stems from observations about how human learn. From the beginning of the century, the ideas of Herbart (1901) about teaching started with the interest of students in the natural world and in the interacting with others. Later, many authors as Piaget (1975), Suchman (1962) also developed the idea about inquiry-based teaching. In the second half of the 20th century, inquiry-based teaching developed more, particularly in Canada and the United States of America.

In Vietnam, some authors as Le Vo Binh, Pho Duc Hoa, Trinh Nguyen Giao… also had studies about inquiry-based teaching. Based on the document-overview, we introduced the concept of inquiry-based teaching that Inquiry-based teaching via research topic can be understood as a method of organizing in which the learner experience research activities under the instruction of teacher in order to discover original knowledge and practise their scientific research skill.

Although there are many studies about inquiry-based teaching, those studies only finished at applying this method to improve the quality of teaching without any study on the subject of gifted students as well as the purpose of developing the scientific research capacity for students.

1.1.2. Scientific research capacity

Around the world, there are one author exposing concept of scientific research capacity (A. Šeberová) and some studies about the structure of scientific research capacity (Möller, Grube, & Mayer, 2008; Möller, Grube, Hartmann, & Mayer, 2009).

Based on the real teaching in Vietnam, we would like to propose the concept and structure of scientific research capacity as follows:

- Scientific research capacity of high school students is to master the system of scientific knowledge, scientific research skills, scientific attitudes and operate them in a reasonable manner for the successful implementation of the tasks of research to create products in the learning process at schools.
- The elemental skills of scientific research capacity includes: asking research questions, forming hypotheses, building implementation plan, analyzing results, drawing conclusions, writing report, and reporting.

1.2. Current situation of teaching inquiry and training scientific research capacity for students in teaching Biology at high schools

We conducted a survey with 79 Biology teachers at gifted high school about: 1) The essence and role of inquiry-based teaching; 2) The role of scientific research; 3) Knowledge level of teachers about scientific research methods; 4) The training-quality about scientific research capacity of teachers for students; 5) Reasons impacting the situation of training scientific research capacity in teaching Biology at gifted high schools. Additionally, we conducted investigation at 161 gifted students at high schools about the role of scientific research capacity and check their capacity.

The survey results showed that although the majority of teachers are aware of the role and the importance of inquiry-based teaching for students, in fact this work is implemented extremely limited because teachers do not fully understand about inquiry-based teaching as well as measures to train scientific research capacity for students. This once again confirms our themes to be meaningful and meet the demand of teachers about currently renovating teaching methods at high schools.

Chapter 2:
INQUIRY-BASED TEACHING IN THE FUNDAMENTALS OF GENETICS TO IMPROVING THE RESEARCH SKILLS OF SPECIALIZED HIGH SCHOOL STUDENTS

2.1. Analysis of the curriculum of the fundamentals of genetics section in specialized high school.

2.1.1. The position of the fundamentals of genetics in the biology curriculum in specialized high schools

By analyzing the time and position of fundamentals of genetics teaching, it is shown that the fundamentals of genetics holds important positions in program content and evaluation in biology in both general and specialized high schools. The content of fundamentals of genetics in specialized classes.

2.1.2. By analyzing the content of the program, we found that the fundamentals of genetics has the following basic characteristics

- Inherite and develop like extending concentric manner
- Most scientific knowledge drawn from experimental research.
- Logical content development.
- There are favorable conditions for students to practice theoretical and empirical thinking.

2.2. The content of of fundamentals of genetics selected to build scientific subjects for specialized students

2.2.1. Principles of content selection program to build scientific topics

- Knowledge of natural principles, as the basis to acquire new knowledge.
- Knowledge related to situations in real life.
- Knowledge is selected to represent a typical scientific concepts or applicable and long-lasting theoretical interpretations.

- Knowledge is selected to suit the level of awareness of students, meaning that it must be within the zone of proximal development.

2.2.2. The content of of fundamentals of genetics selected to build scientific subjects to explore the inquiry-based teaching

Based on the principles above, almost all content of of fundamentals of genetics can be used to deploy the inquiry-based teaching via scientific researches. However, to increase teaching effectiveness teachers should choose the following content: The genetic laws of Menden; Facilities, genetic mechanism at the molecular and cellular level; The disease, a genetic disability and disease symptoms; Application of genetics in breeding.

2.3. Design science topics to teach fundamentals of genetics for specialized high school students

2.3.1. Design principles of scientific topics to explore teaching institutions

- Sticking to the purposes, ensuring the implementation time.
- Ensuring the accuracy of the content of scientific knowledge and methods of knowledge.
- Promoting the positiveness and creativity for students.
- Ensuring the systematic .
- Ensuring the realistic.
- Bringing scientific specificity, selectivity to scientific content of the program.
- Requiring students to expand the content integration sensibly.

2.3.2. Process of forming research themes

We developed the process of designing research topics including 7 steps

Step 1: Choosing the research themes; Step 2: Determination of research context; Step 3: Determination of the topic name; Step 4: Determination of the aim of the research; Step 5: Determination of scientific hypotheses; Step 6: Determination of research content, methodology and phases; Step 7: Predicting the result.

Analyzing process:

Step 1: Select the content to build scientific topics.

First we have to analyze the content of the program, determine what content knowledge can be used to build the research themes (which has been presented in detail in section 2.2). The selected content can be all theory, exercises, projects, ...

Step 2: Determination of research context

The selected content needs to be included in a specific context. The context can be derived from the theory or practice. For example, the local genetic diseases, sexual deviant phenomena or issues related to the origin of the life-world ... When putting content in context, students will apply the knowledge, skills and attitude to solve the practical problems posed; thereby not only accumulate the knowledge but also contributes to forming and developing the capacity of the learner; while also making content more meaningful. To determine the context, all the conditions and

circumstances that have impacts of students need to be considered.

Step 3: Determination of the topic name

The scientific project named correctly is very important because the name specifies the purpose, subject, scope of research, and also research-oriented approach to scientific learners. To determine the name of scientific topics, students can follow these steps: Utilizing the known knowledge about the phenomena → Define the relationship between the known knowledge and the object to be studied → Determine the purpose of the research → proposing methods to study the object → Generalizing the topic name.

Step 4: Determination of the aim of the research

When building science topics, students need to clearly define the objectives of scientific topics, solving whether practical or theoretical problems. To do this, students must first analyze the overall objective of the program and the specific objectives of the lesson or seminar (knowledge, skills, ability to achieve).

Step 5: Determination of scientific hypotheses

The scientific hypothesis is the preliminary assessment and judgment about the nature of the problem that need to be proven. To form scientific hypothesis, we need to consider the causal relationship between the known issues with the issues that need to be learned, to make a preliminary assessment and judgment on the issue of research, which will be the proof of study results.

Step 6: Determination of research content, methodology and phases.

To find the scientific basis for judgments about the nature of the phenomena mentioned in the scientific hypothesis, it is necessary to define the main points that need to be researched, use which methods to study each point and how to perform them.

Step 7: Predicting the result

Before proceeding to implement the project scientists, researchers need to predict the study results by each research content; thus helping people self-assess with reasonable adjustments in the implementation process.

2.3.3. The scientific themes to explore the fundamentals of genetics for specialized students

2.3.3.1. With the extensive level of knowledge mobilization

The general knowledge is mobilized using multiple sources of knowledge, nature inference, reasoning and judgment. With this criteria, the fundamentals of genetics can be exploited to build the following three scientific themes: *Defining the role of the genetic material of the organism; Assess the impact of the Menden inherited rules on the awareness and development of post-mendenlian genetic rule; study the genetics of disease in people born deaf mute using pedigree method through investigation in the situation of some Vietnamese schools.*

2.3.3.2. With the narrow level of knowledge mobilization

The knowledge is mobilized with lower level of generalization, reasoning and

judgment. With these criteria, the fundamentals of genetics can be exploited to build the several research topics within one research theme (Chapter). Example: With the theme of discovery the genetic mechanisms at the molecular level, the following research topic can be implemented: Define the integrity and diversity of biota at the molecular level by exploring the structure of nucleic acids; Understand the role of nucleic acids in the genetic phenomenon and variation at the molecular level.

2.4. The process of inquiry-based teaching through scientific topics

2.4.1. The general process of inquiry-based teaching through scientific topics

The process of inquiry-based teaching through scientific topics is a process of students conducting research under teachers' guidance, ie training students in scientific research process according to the different degree of self-directed ability of students. This process including 7 steps: *Step 1. Formation of research ideas; Step 2. Determination of research name; Step 3. Determination of research purpose; Step 4. Formation of scientific hypothesis; Step 5. Research planning; Step 6. Research performance; Step 7. Result reporting.*

Process are specified as follows:

- *Step* 1: Formation of research ideas

Every research was started from the formation of research ideas. The idea of the study can be considered as key orientations for scientific research and also decide the value of a science project. Research idea usually comes from observations, problems associated with the real life that need to be solved, analyzing problems that can detect knowledge gaps that need additional knowledge or conflicts need to be resolved, then base on prior knowledge to find the link between the issues. Therefore, to help students conceive research topic, teachers need to create the context for students to get experience.

* Teachers' activities:

+ Analysis of program content, define the units of knowledge that can be used to build a research idea; selection of appropriate context for students to experience.

* Students' activities: Experience under the guidance of teachers.

- *Step 2*: Determine the name of scientific topics

The purpose of this step is to indicate the content of study expressed in the name of scientific topics.

* Teachers' activities:

+ Guide students to mobilize the knowledge that they already know about the phenomena to find a relationship between them, determine research objectives, indicate the means to achieve that goal and generalize all the information on the name of scientific topics.

* Students' activities:

+ Mobilize knowledge, analyze, connect and generalize the name of scientific topics.

- *Step 3*: Define the goals of scientific topics

* Purpose: Students must understand the goals and identify the structure of scientific topics.
* Teachers' activities:
+ Student orientation with the following questions: What's the goals of scientific topics: the purpose and object of study, method to study, time of the study, analysis of the research results, conclusion from the research results, material sources.
* Students' activities: Discuss to answer questions; define goals scientific topics.
- *Step 4*: To form a scientific hypothesis
* Purpose: Students should give a preliminary assessment of the nature of the phenomena; give answers or explanations about research problems.
* Teachers' activities:
+ Ask students to consider the nature of the phenomena based on known knowledge about that phenomenon.
+ Give the preliminary judgment or prediction about research problems.
* Students' activities: Discuss in groups to make scientific hypotheses.
- *Step 5*: Planning Research

In this step, students need to plan the research. To orient the work of students, teachers can pose the questions about: Contents of research, study methodology, the execution time of each content, the order of research, time of finishing ... Students discuss in groups to answer questions and from there, build a research plan.
- *Step 6*: Conduct research
* Objective: Conduct data collection or conduct models designing, testing, and adjusting to prove scientific theories. At the same time, handle the research data collected, presenting the relationship between data, analysis a causal relationship to draw regularity, interpretation and synthesis of data models using the advanced scientific concepts, offering valuable conclusions from the research results obtained.
* Teachers' activities: Orientation and organization for student activities.
* Students' activities: Conduct research in group.
- *Step 7:* Reporting Results
* Purpose: Students present the entire operation and results obtained in the course of scientific research into a report using the completed method of scientific research.
* Activities of teachers and students: Students outline a scientific report → Arrange the data obtained and the use of language, scientific style to write a complete report → Presentation report → Discussion → Teachers summarize discussions, students learn from experience.
- *Step 8:* Review
* Objective: Evaluate the skill improvement of scientific research ability for the purpose of adjusting the process of teaching and learning.
* Activities of teachers and students:
+ Teachers and students re-evaluate students' progress in scientific research

capability, analyze what have been achieved and not achieved when implementing scientific research process. Teachers can use an objective multiple choice questions or questions to examine the scientific knowledge obtained, and construction of screening forms (planning, academic record) attached for the assessment of student skills.
+ Review, draw experiences to train scientific research capacity through the following scientific topics.

2.4.2. Methods of inquiry-based teaching through scientific topics

Methods of inquiry-based teaching consist of two stages shown in Figure 2.3.

Figure 2.3. Methods of inquiry-based teaching through scientific topics

2.4.1.1. Phase 1

This is the first stage of the inquiry-based teaching process through research. The timing of this phase usually lasts 2-3 lessons and is done before the students learn a subject or when students enter the 10th grade. This phase consists of two steps:

- *Step 1*: Teachers train and guide students through the process of building and deploying a scientific topic

Purpose: To help students with basic knowledge about scientific research methods.

* Teachers' activities:

+ Introduce the role of scientific research and the steps of the scientific

research process.
+ Explain each step of the process of scientific research.
* Students' activities: Listen to teachers' introduction of the role of scientific research and to the guidance of the implementation process of scientific research.
Step 2: The teachers introduce a scientific topic and follow the steps.
Purpose: Students understand each step in the scientific research process to perform effectively.
* Teachers' activities: Introduction of scientific topics; Perform scientific projects step by step.
* Students' activities:
+ Observe teachers perform scientific research process steps in a specific scientific topic.
+ Discuss to understand the meaning of each step in the process of scientific research.
2.4.1.2. Phase 2: Formation of scientific research capacity through scientific research activities at different levels

After the students have certain acknowledgement of scientific research and observe a process of modeling, teachers train student to explore scientific topics for their development of scientific research capability. During this period, students experience scientific research activities through a science project. Depending on the level of participation of teachers and the self-direction levels of students in the teaching process, we carry through 4 teaching degree as follows:

➢ *Level 1:* Teachers perform the first 5 steps of the process of scientific research to develop a research plan, students perform from step 6 onwards.

At this level, teachers implement the first 5 steps of the process of scientific research, planning detailed studies. Students observe and carry out research, report the results and evaluation. This is the level required of least student self-direction and most teacher assistance.
Teachers can organize the training for students following these steps:
+ Step 1.1: Teachers perform the first 5 steps of the process of scientific research to develop a full plan, detailing the work to carry out a scientific project. Students observe and remember the events of the steps for critical thinking. In the research plan, teachers need to specify the required primary research content, method of implementation of each content, the order of execution of work, set the time to complete, ...
+ Step 1.2: Teachers assign research responsibility to students. The assignment for students can be done before the new lesson; or can be done to students during class or as homework can after finishing the lesson.

To perform the study plan, teachers divide students into groups of 5-8 members, with the leader, a secretary and members. The division should be based on the group needs and the students level and should ensure a relatively equal level between groups.

+ Step 1.3: Teachers help student in research plan implementation.

In this process, students use the research methods specified in the plan to collect data. Students self-seek information from various sources, in different ways such as experiments, conducted surveys, interviews, …, and then analyze and synthesize the data collected, creating logical reasoning to draw the conclusion proving the scientific hypothesis. The teacher acts as the organizer, orienting, supporting and supervising so that students can perform their best in assigned tasks.

+ Step 1.4: Teachers help students in result reporting.

After students finish writing the report, the teachers hold scientific seminars, in which the students will report their entire research process. In the seminar, the group appoints their representative to present their study. Teachers hold student exchanges, discussions, comments and conclusions of science. Based on the critical opinions, comments of classmates, students can edit to create the most complete product. In addition, students can share research results on the forums to absorb the opinions of experts and friends in order to improve their scientific research.

+ Step 1.5: Teachers guide students in evaluating the results.

To evaluate how the students develop and implement scientific projects, teachers need to evaluate the research process and research results, in which the process of research to create products need to be paid more attention. The students' performance during the implementation of scientific projects can be assessed. Teachers assess through products, tests, records research, learning attitude of students.

In addition to the teacher assessments, teachers also guide the students in self-assessment in their groups during the whole process to based on specific criteria and clearly.

➢ *Level 2*: Teachers determine the name of scientific topics and research goals. Students perform the remaining steps.

This level is used when the students has relatively strong awareness of the scientific research process, can carry more than one step. The process of teaching at this level can follow these steps:

+ Step 2.1: Teachers build a science project with full name and the specific and obvious research goals.

+ Step 2.2: Teachers assign the project implementation to students

In this process, students should be active in dividing the class into groups to

perform the project. Students self-perform all the remaining steps of the process of scientific research, based on the knowledge of scientific research have been equipped by teachers and while observing teacher performance. At this level of training, teachers can organize for student discussion to identify what is already known, what it should be learnt and causal relationships between them to form a scientific hypothesis.

➢ *Level 3:* Teachers conceive the study ideas, students determine the research project name and perform the remaining steps.

This level is used when the students have solid awareness of scientific research process, can conduct their activities following the learning process steps of scientific research; simultaneously using scientific research skills competently. At this level, students can identify the scientific name of the project, the purpose of research. Then, with known skills, students perform research to create products. To form research ideas for a science project, teachers should first study the whole curriculum, the overall objective curriculum, and then the target of the research topics, the knowledge and skills that should be achieved. Teachers predict the content of the subject/lesson can used to form research ideas for a science project to organize teaching activities for students to discover.

After forming and launching the idea of the study, teachers organize students to discuss to indicate prior knowledge related to this issue. Through discussion, students figure out the relationship between research issues and the objective to be achieved in order to determine the name and objectives of the subject.

Once identifying the name and purpose of scientific topics, students actively perform the remaining steps of the process of scientific research under the supervision of teachers.

➢ *Level 4*: Teachers create context, student proposed research ideas and implement the remaining steps.

This is the highest level in the level of teaching discoveries through scientific projects, requires a high degree of self-directed student teachers also play a role only to create the context for student formation research ideas as the organization and supervision of orientation for student activities.

Context is expected to generate research ideas and also guide students to the course objectives, so requires teachers to carefully study program content, course objectives, content selection can develop into research ideas meet course objectives.

After the student has experience in the context of creating, organizing for student teachers need to use the core question to approach the problem that got the idea to study in student. The core question is often used in the phrase "what is", "how" and "why" for a phenomenon occurring and human destiny - the "if ... then...”

In addition, teachers also play an important role in guiding students to identify, choose the questions. Teachers can organize for student discussion groups to choose questions aims of the course.

Thus, through the experience with these activities under the scientific research discoveries, the scientific research skills capacity will be formed and developed in students.

2.4.2. Illustrative examples of the application of the process of inquiry-based teaching through scientific topics

* Organize inquiry-based teaching topics. Identify unity and diversity nature of biota at the molecular level by exploring the structure of nucleic acids form at level 1.

Step 1: Teachers will perform the first step of the process to set up a research plan. Students will observe, ponder and discuss the actions that teachers make.

- Teachers build scientific hypothesis: the determination of the structure of nucleic acids in biological groups will demonstrate the unity and diversity of biota at the molecular level. Then teachers will plan the research with specific content as follows:

N^0	Content of Science Discovery	Research Methodology	Execution time	Who performed
1	Learn the nucleic acid structures form in living groups	Collect, aggregate materials	2-3 days	
2	Find similarities and differences between the structure of nucleic acids form in groups of organisms	Analysis, synthesis, comparison	2 days	
3	Explain the similarities and differences between the nucleic acid structures form in groups of organisms. Learn sense in terms of evolution: the unity and diversity.	Explain, inference, generalized	1 day	

Step 2: Teachers assign research responsibility for students to do.

Since students have been equipped with the basic knowledge of nucleic acids from 9th grade, so the subject can be made before a new lesson. First, teachers divide the class into groups and assign tasks among members: team leader, secretary, ... Teachers assigned research plan to the leader, the group discusses and assign specific tasks to each students to carry out the research content. Teachers can ask each group to submit 1 research plan to track, monitor and adjust.

Step 3: Teachers help students in research plan implementation.

After 2-3 days, the group has collected data for research tasks 1, the teacher asks the group leaders to report implementation results. Based on the information collected in task 1, the group will analyze, summarize, generalize

and find connection between information to perform the task 2. During the remaining process, teachers ask team leader to report the research progress via email.

Step 4: The teacher organizes the student result reporting.

Teachers require document preparation from groups to report, including: assigning tasks, implementation, group meeting, workbook, manual data storage (probably online book), and task performance (in the form of PowerPoint). Teachers ask the representative of each group to present the results; then other groups of students pose questions, suggestions and discussion.

Step 5: Teachers guide students to evaluate the results.

Teachers provide evaluation criteria for each group, students discuss in groups to evaluate the remaining groups.

2.5. The assessment of research competency of high school students in biology

2.5.1. Criteria for evaluating scientific research capacity

Table 2. 1. Ladders assessment of the research capacity of high school students

Level / Skills	Level 1 (Start) (M_0) (1-3 points)	Level 2 (Developmen) (M_1) (3-7 points)	Level 3 (Pattern) (M_2) (7-10 points)	Maximum score
Research Question	Choose study questions from the pool of questions that teachers suggest	Set research questions from the analysis of a given subject or real-life situation.	Set research question from the self-proposed idea or topic	10
Scientific hypothesis formation	No self-formed scientific hypothesis that should be based on scientific theory that teachers make.	Scientific hypothesis that is not very explicit, which can be proven by scientific research.	Explicit scientific hypothesis that can be proven by scientific research.	10
Planning and implementation	Launching a number of research methods but not in line with the objectives and content of research. Offering a number of solutions to test a hypothesis. Dividing the progress for each asset, not a detailed time for each point.	Launching a number of research methods appropriate to the objectives and contents of the study, but incomplete. Offering a number of solutions and implementation to test a hypothesis. Dividing progress but not enough	Choosing the right research methods appropriate to the objectives and content of research. Offering effective solutions to test a hypothesis. Time split in research process to fully implement the content.	10

	Being able to collect some information, but limited resources in terms of both timeliness and reliability.	content. Gather as much information related to the research topic as possible, but timeliness and reliability is not high.	Collect all information relating to research topics from a variety of different channels, updated and highly reliable.	
Processing the results and draw conclusions	Using the results that are not relevant to the hypothesis and has not brought about the conclusion or result in simpler form.	Using the results related to the theory, but not really complete; analysis, synthesis, generalization to draw conclusions but not explicit.	Full use of the results related to the theory; integrated analysis, generalization to draw conclusions thorough, accurate and explicit.	10
Writing report	Writing report but unclear and incorrect or correct layout but allocated unreasonable portions Having multiple errors when using scientific style.	Report writing with correct layout and allocation of a reasonable portion but do not have detailed content Use not really accurate scientific style, express also shaky.	Report writing with correct layout and reasonable allocation of parts. Use the scientific style, express understandable.	10

From a total score of scientific research, we provided a 4-level system of constituent skills capacity in scientific research of students (table 2.2).

Table 2.2. Grading of scientific research capacity of students

N^0	Research capacity level	Total score	Conditions
1	Level 1	From 40 to 50 points	No skills below 7 points
2	Level 2	From 31 points to 39 points	No skills below 5 points
3	Level 3	From 21 points to 30 points	Skilled research question to reach 5 points or more
4	Level 4	Less than 20 points	

2.5.2. The tool is used to assess the capacity of Scientific Research

Table 2.3. Appropriate tools to assess the capacity of Scientific Research

Skills	Assessment tools		
	Questions, essay assignments	Questions, objective tests	Research Handbook
Reseach questions	x	x	
Hypothesis formation	x	x	
Planning and implementation	x		x
Processing the results and drawing conclusions	x	x	x
Writing a report			x

Chapter 3
PEDAGOGIC EXPERIMENT

3.1. Experimental purposes

In order to test the feasibility and effectiveness of the scientific hypothesis that projects set out: if we build design process for scientific topics and inquiry-based teaching through those topics following the nscientific research procedure in teaching Genetic basis section, it will develop scientific research capacity about Biology for students.

3.2. Experimental content

We conduct teaching inquiry with 4 lesson plans at experimental schools as follows: 1. Determine the unity and diversity of biota at the molecular level by exploring the structure forms of nucleic acids (Level 1); 2. Identify the genetic laws of a pair of alleles and genes not allele (Level 2); 3. The study of gender deviant at adolescents in the present and determine the cause of those sexual deviant (level 3); Studying the genetics of congenital deafness and dumb in humans by pedigree method through investigation the situation in some schools in Vietnam (Level 4).

3.3. Experimental methods

3.3.1. Select experimental teacher

Selecting teachers who are interested in developing scientific research capacity and have at least 3 years experience teaching Genetic basis section.

3.3.2. Choose experimental objects

We conducted experiemtal pedagogy in 5 gifted high schools in year 2014-2015 as in detail: Vinh Phuc gifted high school – Vinh Phuc; Lao Cai gifted high school – Lao Cai; Le Hong Phong gifted high school – Nam Dinh; Nguyen Trai gifted high school – Hia Duong; Le Quy Don gifted high school – Da Nang. Total: 161 students.

3.3.3. Experimental procedure

- Communicate, agreed with the teachers about the purpose, methods and requirements in the experimental pedagogy.

- Transfer documents for teacher to research including basic content of scientific research, lesson plans, assessment tools.
- Before starting the experimental teaching, we ask teachers perform experimental phase 1:
+ Spend approximately 1 lesson to guide students in the experimental class about the steps in the process of scientific research.
+ Conduct modeling 1 of scientific topics in about 1-2 lessons.
- Then, continue to implement the 2nd phase of the teaching inquiry process through scientific topics:
+ Training scientific research capacity for students through 4 experimental lesson plans.
+ Measuring to evaluate experimental results.

3.4. Instruments, and methods of experimental measurements

To evaluate the skills of asking research question, hypothesis formation skills, skills in planning and implementation, data processing and drawing conclusions, we built four test subjects with the duration of 45 minutes experimental measurement all students in 5 classes. Additionally, we will send summary of design process for scientific topics and teaching inquiry through topics, assessment tools of scientific research capacity for teachers at gifted high schools in order to get feedback.

3.5. Experimental results

Note: $\mathbf{M_0}$ (from 0 to 3 points); $\mathbf{M_1}$ (from over 3 to 7 points); $\mathbf{M_2}$ (from 7 to 10 points)

3.5.1. Quantitative analysis of experimental results

3.5.1.1. Skill of asking research questions

**** Testing of the difference between the average score of tests in the experimental classes (T-test to verify independently)***

Table 3.1. Student structure divided by the level of skill of asking research questions

Time tracking	**No. of students**	Level attainment of skills of asking research questions			Statistics			
		$\mathbf{M_0}$	$\mathbf{M_1}$	$\mathbf{M_2}$	**Average score**	Mean	Mode	SD
Test 1	161	53 (32,9%)	101 (62,7%)	7 (4,3%)	4,5	1,7	4	4
Test 2	161	9 (5,6%)	119 (73,9%)	33 (20,5%)	6,4	1,3	7	7
Test 3	161	0 (0,0%)	126 (78,3%)	35 (21,7%)	6,9	0,9	7	7
Test 4	161	0 (0,0%)	66 (41,0%)	95 (59,0%)	7,9	0,8	8	7

Data in Table 3.1 shows that in every test, the percentage of students reaching M_0 decreased while the figure for students reaching M_2 increased.

To test the significance of the difference in the average score of the test in the same group of experiments, we used T-test in pairs (Compare Mean/Paired Sample T-test in SPSS) to accredite. Results are presented in Table 3.2.

Table 3.2. Test results the difference in the average score (Sktb) between the tests of the same experimental group

Pair of test	**Sktb**	**t**	**df**	**p**
test 2-1	1,9	12,7	160	0,00
test 3-2	0,5	5,3	160	0,00
test 4-3	1,0	13,6	160	0,00

The results shown in Table 3.2 shows the difference in the average point between the tests of the experimental group which was 1.9, 0.5 and 1.0 respectively with p-values less than 0.05; there are statistically significant.

Table 3.3. Results of Chi-squared test (χ^2) about the difference in test scores between the experimental school

Test	χ^2	**df**	**p**
test 1	0,38	8	0,000
test 2	0,60	8	0,000
test 3	0,12	4	0,019
test 4	0,17	4	0,002

The results shown in Table 3.3 shows the difference in test scores between schools with p values less than 0.05 was statistically significant.

3.5.1.2. Skill of forming hypothesis

Table 3.4. Student structure divided by the level of skill of hypothesis formation

Time tracking	**No. of students**	Level attainment of skills of hypothesis formation			Statistics			
		M_0	**M_1**	**M_2**	**Average score**	Mean	Mode	SD
Test 1	161	98 (60,9%)	63 (39,1%)	0 (0,0 %)	3,4	3	3	1,4
Test 2	161	6 (3,7%)	139 (80,9%)	16 (9,9%)	5,8	6	6	1,3
Test 3	161	2 (1,2%)	129 (80,1%)	30 (18,6%)	6,4	6	6	1,2
Test 4	161	0 (0,0%)	98 (60,9%)	63 (39,1%)	7,1	7	6	1,2

Data in Table 3.4 shows that in every test, the percentage of students reaching M_0 decreased while the figure for students reaching M_2 increased.

Table 3.5. Test results the difference in the average score (Sktb) between the tests of the same experimental group

Pair of test	**Sktb**	**t**	**df**	**p**
test 2-1	2,4	23,9	160	0,00
test 3-2	0,6	7,9	160	0,00
test 4-3	0,7	9,5	160	0,00

The results are shown in Table 3.5 shows the difference in the average point between the tests of the experimental group was 2.4, 0.6 and 0.7 respectively with p-values less than 0.05 which is statistically significant.

Table 3.6. Results of Chi-squared test (χ^2) about the difference in test scores between the experimental school

Test	χ^2	**df**	**p**
test 1	0,35	4	0,037
test 2	0,17	8	0,029
test 3	0,29	8	0,000
test 4	0,08	4	0,008

The results are shown in Table 3.6 shows the difference in test scores between schools with p values less than 0.05 is statistically significant.

3.5.1.3. *Skill of planning and implementing*

**** Testing of the difference between the average score of tests in the experimental classes (T-test to verify independently)***

Table 3.7 Student structure divided by the level of skill of planning and implementing

Time tracking	**No. of students**	Level attainment of skills of planning and implementing			Statistics			
		M_0	**M_1**	**M_2**	**Average score**	Mean	Mode	SD
Test 1	161	81 (50,3%)	75 (46,6%)	5 (3,1 %)	4,0	3	4	1,4
Test 2	161	28 (17,4%)	112 (69,6%)	21 (13%)	5,5	6	5	1,5
Test 3	161	16 (9,9%)	122 (75,8%)	23 (14,3%)	5,7	6	6	1,5
Test 4	161	12 (7,5%)	111 (68,9%)	38 (23,6%)	6,6	7	7	1,5

Data in Table 3.7 shows that in every test, the percentage of students reaching M_0 decreased while the figure for students reaching M_2 increased.

Table 3.8 . Test results the difference in the average score (Sktb) between the tests of the same experimental group

Pair of test	**Sktb**	**t**	**df**	**p**
test 2-1	1,5	14,7	160	0,000
test 3-2	0,2	3,3	160	0,001
test 4-3	0,9	8,2	160	0,000

The results shown in Table 3.8 shows the difference in the average point between the tests of experimental groups was respectively 1.5; 0.3 and 0.9 with p-values less than 0.05 which is statistically significant.

Table 3.9. Results of Chi-squared test (χ^2) about the difference in test scores between the experimental school

Test	χ^2	**df**	**p**
test 1	0,31	8	0,000
test 2	0,24	8	0,002
test 3	0,62	8	0,000
test 4	0,30	8	0,000

The result shown in the 3.9 shows the difference in test scores between schools with p values less than 0.05 is statistically significant.

3.5.1.4. Skill of analyzing results and drawing conclusions

**** Testing of the difference between the average score of tests in the experimental classes (T-test to verify independently)***

Table 3.10. Student structure divided by the level of skill of analyzing results and drawing conclusions

Time tracking	**No. of students**	Level attainment of skills of processing data and draw conlusions			Statistics			
		M_0	**M_1**	**M_2**	**Average score**	Mean	Mode	SD
Test 1	161	29 (18,0%)	113 (70,2%)	19 (11,8 %)	5,4	5	6	1,7
Test 2	161	13 (8,1%)	105 (65,2%)	43 (26,7%)	6,2	6	6	1,6
Test 3	161	11 (6,8%)	102 (63,4%)	48 (29,8%)	6,5	7	7	1,5
Test 4	161	1 (0,6%)	95 (59,0%)	65 (40,4%)	7,0	7	8	1,1

Data in Table 3.10 shows that in every test, the percentage of students reaching M_0 decreased while the figure for students reaching M_2 increased.

Table 3.11 . Test results the difference in the average score (Sktb) between the tests of the same experimental group

Pair of test	**Sktb**	**t**	**df**	**p**
test 2-1	0,9	6,6	160	0,000
test 3-2	0,3	2,3	160	0,022
test 4-3	0,5	5,7	160	0,000

The results shown in Table 3.11 shows the difference in the average point between the tests of the experimental group was respectively 0.9, 0.3 and 0.5 with p-values less than 0.05 is statistically meaningful. This result shows that skills in the students progress slowly. In our opinion, the cause could be because this skill is a difficult skill; therefore we need continue to organize training in the long run.

Table 3.12. Results of Chi-squared test (χ^2) about the difference in test scores between the experimental school

Test	χ^2	**df**	**p**
test 1	0,20	8	0,009
test 2	0,37	8	0,000
test 3	0,30	8	0,000
test 4	0,17	8	0,021

The results presented in the 3.12 shows the difference in test points between the school with p-values less than 0.05 is statistically significant.

3.5.1.5. Skill of writing report

**** Testing of the difference between the average score of tests in the experimental classes (T-test to verify independently)***

Table 3.13. Student structure divided by the level of skill of writing report

Time tracking	**No. of students**	Level attainment of skills of writing report			Statistics			
		M_0	**M_1**	**M_2**	**Average score**	Mean	Mode	SD
Test 1	161	29 (17,9%)	116 (71,6%)	16 (9,9%)	5,3	5	6	1,7
Test 2	161	13 (8,1%)	107 (66,5%)	41 (25,5%)	6,2	6	6	1,6
Test 3	161	10 (6,2%)	104 (64,6%)	47 (29,2%)	6,5	7	7	1,5
Test 4	161	1 (0,6%)	96 (58,5%)	66 (40,9%)	7,2	7	8	1,1

Data in Table 3.13 shows that in every test, the percentage of students reaching M_0 decreased while the figure for students reaching M_2 increased.

Table 3.14 . Test results the difference in the average score (Sktb) between the tests of the same experimental group

Pair of test	Sktb	t	df	p
test 2-1	0,9	7,6	160	0,000
test 3-2	0,3	2,6	160	0,009
test 4-3	0,7	5,8	160	0,000

The results shown in Table 3.14 shows the difference in the average point between the tests of the experimental group was 0.9, 0.3 and 0.7 respectively with p-values less than 0.05 which is statistically significant.

Table 3.15. Results of Chi-squared test (χ^2) about the difference in test scores between the experimental school

Test	χ^2	df	p
test 1	0,23	8	0,004
test 2	0,43	8	0,000
test 3	0,31	8	0,000
test 4	0,18	8	0,021

The results presented in the 3.15 shows the difference in test points between the school with p-values less than 0.05 is statistically significant.

Over time of pedagogical experiment, the level of knowledge mobilization capacity expanded and the level of organizing teaching inquiry through scientific topics enhanced, scientific research capacity of students is developed. In our opinion, the reason for this progress is that throughout 4 scientific topics, students were trained 4 times, to be deployed in scientific research activities 4 times not only in one but in many topics science, in many contexts, content research, different research methods and also different created products.

3.5.2. Qualitative analysis of experimental results

According to the information from the implementation of experimental pedagogy and exchanges with teachers of experimental pedagogy, we propose some following quantitative comments.

- All teachers agreed that teaching inquiry procedure through scientific topics which was built is useful, especially in fostering good students and will develop scientific research capacity in students if applied reasonably.
- Students are excited with scientific research, and the cooperation as well as self-learning abilities rase.

CONCLUSION AND RECOMMENDATION

1. Conclusion

After completing the thesis, we come to conclusions, as follows:

1.1. Thesis built the theoretical basis of teaching inquiry and identified the reality of teaching inquiry at gifted high schools.
1.2. Thesis identified the concept of teaching inquiry, in which teaching inquiry through topics is considered as a teaching method when learners experience throughout inquiry activities following the orientation of teachers in order to discover knowledge.
1.3. Thesis identified concept of scientific research capacity; as well as identified structure of scientific research capacity of high school students with 5 elemental skills: *1) asking research questions; 2) Forming hypothesis; 3) Planning and implementing; 4) Analyzing results and drawing conclusions; 5) Writing report* and expose quality level of each criteria.
1.4. Thesis identified the relation between inquiry and scientific research activities, in which scientific research activity is an inquiry mean following the model of deploying scientific topic.
1.5. Thesis proposed design process for teaching inquiry including 7 steps: 1) Selecting content to build scientific topic; 2) Determining context from content; 3) Determining name of scientific topic; 4) Determining purposes of scientific topics; 5) Determining sceintific hypothesis; 6) Predicting research plan; 7) Predicting obtained results.
1.6. Thesis proposed process of teaching inquiry through scientific topics including 8 steps: 1) Forming research idea; 2) Determining name of topic; 3) Determining topic'spurpose; 4) Forming hypothesis; 5) Research-planing; 6) Implementing plan; 7) Informing results; 8) Evaluation. Simultaneously, proposing solution using teaching inquiry procedure through scientific topics including 2 phases following the way of developing scientific research capacity for students with 4 levels. As can be seen from the experimental results, the procedure of inquiry-based teaching via scientific topic is a educational method to organize teaching with the purpose of improving the scientific research capability for biology – specialized in the teaching of the Fundamentals of Genetics.

2. RECOMMENDATIONS.

After researching thesis, we would like to have some recommendations as follows:
2.1. Continue to apply design process for scientific topics anf teaching inquiry procedure through scientific topics in teaching Genetic basis section for all high school students specializing in biology.
2.2. Continue to deploy system of questions, tasks, scientific topics as assessment tools for scientific research capacity of Biology-gifted students at high schools.

2.3. Should bring the content of design process for scientific topics anf teaching inquiry procedure through scientific topics to develop scientific research capacity of students into section of teaching methods of Biology at Bachelors program of Biology-teachers as well as regular fostering plan for Biology teachers at high schools.

2.4. Continue to carry out researches to propose the structure and standards of scientific research capacity of the Vietnamese high school students in the general education program in next years.

2.5. Continue to conduct researches to complete the assessment criteria and assessment tools for high school students' scientific research capacity.