THAI NGUYEN UNIVERSITY
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APPYLING PROJECT-BASED LEARNING TO DEVELOP SCIENTIFIC RESEARCH COMPETENCIES FOR HIGH SCHOOL STUDENTS IN TEACHING ECOLOGY

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LIST OF PUBLISHED SCIENTIFIC WORKS RELATED TO THE THESIS

1. Vu Thi Thanh Thuy and Nguyen Van Hong (2017), "Project-based teaching and capacity development of Scientific research for students in teaching Ecology in high school", *Journal of Science and Technology - Thai Nguyen University*, Volume 167, Episode 07 (Page 79-83).
2. Vu Thi Thanh Thuy and Nguyen Van Hong (2018), "Orientations for developing scientific research capacity for students in teaching the "Ecology" of biology 12", *Journal of Education - Ministry of Education and Training,* Volume 425, pp 54-56
3. Vu Thi Thanh Thuy and Nguyen Van Hong (2018), *Report of scientific conference "Formation and development of scientific research skills for students in teaching Biology at high school, 1st National Science Conference"*, Hue University Publishing House, page 169-176.
4. Vu Thi Thanh Thuy and Nguyen Van Hong (2018), "Process of developing a learning project according to orientation of developing scientific research capacity for high school students*", Journal of Education - Ministry of Education and Training*, Volume 464, page 60-54

INTRODUCTION

1. Rationale of the study

1.1. The study is originated from the goal of education and training renovation in our country in the current period.

It is believed that the current educational objectives do not stop at imparting the knowledge and skills available to students, but also fostering them with necessary competencies such as creative thinking, problem solving self-study and research skills. Promoting activeness, initiative and creativity for learners to develop competencies is one of the orientations which is emphasized in the educational development strategy in our country in recent years.

The Resolution of the 8th plenum of the Party Central Committee emphasizes the need to shift from teaching knowledge to forming and developing capacity for learners: "Developing education and training means improving people's knowledge, training human resources, fostering talents. Vigorously shifting the educational process from providing knowledge to comprehensively developing learners' capabilities and qualities. Educational activities must be conducted on the principles of learning coupled with practice; theories closely linked to reality; education at school combined with education in the family and in the society." [13]

Article 5 of our country's Education Law [28] has clearly stated: "Methods of education must bring into full play the activeness, the consciousness, the self-motivation, and the creative thinking of learners; foster the self-study ability, the practical ability, the learning eagerness and the will to advance forward."

The official announcement of the 12th Party Congress clearly states that it is necessary to "Comprehensively and synchronously renovate objectives, curricula, contents, methods and forms of education and training in the extent to which educational development attaches much importance to learners' capacity and qualities". On the basis of precisely identifying and gaining the goal of education and training reforms, publicizing the objectives, "input" and "outcome" standards for each educational level, subject, program, major, and training specialty, the following step is to renovate the curriculum framework and contents of the subjects in

the direction of developing learners' capabilities and qualities, ensuring harmony among virtue, intellect, physicality and beauty; adequately implementing new motto: Teaching people, providing knowledge, and developing vocational training (formerly providing knowledge, teaching people, developing vocational training) [14].

Innovating teaching methods in high schools is one of the highly important tasks. Currently, the issue of renovating teaching methods (including innovating teaching methods in Biology) has been institutionalized in the Education Law of the Socialist Republic of Vietnam: "The methods of general education are to promote the activeness, consciousness, initiatives and creativeness of students; to be appropriate to the characteristics of each grade and subject; to nurture the methods of self-study and the ability to work in team, to drill the ability of applying learned knowledge into practice; to have impact on students' emotional development, to bring them joy and pleasure of learning."[13]

Thus, we recognize that these documents and regulations reflect the need to renovate educational methods to resolve the conflict between the need to train brand-new people and the general backward situation of teaching methodology in our country in the present day. This renovation sets new requirements for the education system, i.e., along with changes in contents, there should be radical innovations in teaching methodology with key thoughts and ideas expressed in different forms, such as "positiveness promotion", "positive teaching methods", "positive learning activities" or "learner activation".

1.2. *The study is originated from the superiority of project-based learning (PBL)*

In recent years, a number of academic research have clearly shown that project-based learning aims to direct learners to take the initiative in acquiring knowledge and building necessary skills and competencies through an active process of exploring and solving problems raised by teachers or both teachers and students [4]; [9] [8].

In project-based learning, learners often work in groups to perform a complex learning task that closely follows the curriculum and is associated with reality, has a range of interdisciplinary knowledge, and combines theory with practice. Studies have also shown that project-based learning has a positive influence on the

formation and development of learners' competencies, strengthens learners' competencies whether high- or low-caliber ones can, at all different levels, acquire 5 critical thinking behaviors (Synthesis, Prediction, Analysis, Evaluation, Feedback) and 5 social skills (teamwork, initiating ideas in groups, management, recognizing ideas from other groups, initiating ideas from other groups). Project tasks are done by learners with a high degree of self-reliance in the whole learning process. Therefore, project based learning is considered to have met the requirements of renewing training objectives and teaching methods, making a positive contribution to actualizing the contents of the Resolution No. 29 / NQ-TN issued by the 8th plenum of the 11th Party Central Committee.

1.3. The study is originated from requirements and current situations of developing scientific research capacities for high school students in our country

The development of scientific research competencies for students can help them be active, proactive and creative in order to equip themselves with the fundamental knowledge and skills for their lives in today's era.

Promoting scientific research capacities for students can help shorten the gap between general education and higher education. Besides, building scientific research capacities for students also contributes to forming and fostering the significant qualities of advanced employees, i.e., perseverance, patience, willpower to overcome challenges, creativity, objectivity, and accuracy. Strengthening students' competencies in science research is a new and crucial issue. This is apparently claimed in the Resolution No. 29 / NQ-TN issued by the 8th plenum of the 11th Party Central Committee [13].

However at present, in Vietnam, there seems to be gaps that need to be bridged in research on the implementation of project-based learning to establish scientific research capabilities for students in teaching Biology, especially when there is no author studying the application of project-based learning to flourish scientific research competencies for students in the teaching of Ecology.

The reasons mentioned above created an urge for us to choose the research thesis, namely **"Applying project-based learning to**

develop scientific research competencies for high school students in teaching Ecology".

2. Objectives of the study

Building learning projects in the form of scientific research topics; forming the process of organizing project-based learning approach in teaching Ecology to develop scientific research competencies for high school students.

3. Scientific hypothesis

If the leaning projects are developed in the form of scientific research topics which are used to organize teaching Ecology according to the scientific research process, it will both improve ecological knowledge and develop scientific research competencies for high school students.

4. Subject, object and scope of the study

4.1. *Study subjects*: Learning projects; Process of organizing project-based learning and teaching

4.2. *Study object*: Process of teaching Ecology at High Schools

4.3. *Scope of the study*: Applying project-based learning in teaching Ecology to develop scientific research competencies for high school students. Especially building important skills, such as detecting research problems; describing the name of the research topic; proposing research hypotheses; introducing research proposal; planning the implementation of research projects; collecting and processing research data; writing and making reports on the findings of the study.

5. Research content

5.1. Studying theories on projects, project-based learning approach and teaching Biology through the use of project-based learning, capacity and scientific research capacity as a theoretical basis for the study.

5.2. Understanding the reality of teaching Biology in general and teaching Biology through project-based learning in particular as well as the feasibility to implement project-based learning in teaching Biology to students in high schools in the current time.

5.3. Analyzing the content structure of the Ecology session - High Schools to identify content topics that can be developed into learning

projects and applying project-based learning to strengthen scientific research competencies for students.

5.4. Building principles and process of designing learning projects in the form of a scientific research topic.

5.5. Proposing a system of learning projects and applying project-based learning to develop scientific research capacities for students in teaching Ecology - High School Module.

5.6. Establishing assessment criteria to evaluate the results of applying project-based learning to develop scientific research capacities for students in teaching Ecology - High School Module.

5.7. Conducting pedagogical experiments to verify and evaluate the effectiveness of project-based learning implementation to develop scientific research capacities for high school students in teaching Ecology.

6. Research methodology

6.1. Theoretical research methods

Studying official documents of the Party, State and Ministry of Education and Training on renovating teaching methods; methodology of teaching Ecology, project-based learning; fostering scientific research capacity for students; studies on competency and capacity development for students ... to serve as a basis for building the theoretical basis of the study.

6.2. Practical research methods

• Methods of investigation and survey

- Clarifying the reality of project-based learning implementation in teaching Biology through questionnaires for teachers, students and teachers' lesson plans in some high schools in the northern mountainous region;

- Learning about the real context of training scientific research capacity for students in teaching Biology through questionnaires and direct interviews with teachers, students, learners' products, and teachers' lesson plans.

• Expert method: meeting, exchanging and consulting experts about issues related to the research topic.

• Pedagogical experiment method: Conducting pedagogical experiments to test the effectiveness and feasibility of the scientific hypotheses.

6.3. Statistic method: Using M. Excel software for experimental data processing.

7. Contribution of the thesis

- Clarify the theoretical and practical basis on project-based learning in general and its application in teaching Ecology in particular to develop scientific research capacities.

- Determining the structure of scientific research capacity, criteria for evaluating scientific research capacity.

- Develop a system of learning projects and project-based learning implementation to strengthen scientific research capabilities for high school students in teaching Ecology- High School Module.

- Building principles and processes of applying project-based learning to develop scientific research capabilities for students in teaching Ecology - High School Module.

- Develop a set of criteria for evaluating the results of project-based learning implementation to strengthen scientific research capabilities for students in teaching Ecology - High School Module.

8. Arguments for protection

The implementation of project-based learning is an effective method in supporting students to dominate scientific knowledge in a proactive and positive manner, thereby helping them to form and develop scientific research capacities.

9. Structure of the thesis

In addition to "Introduction", "Conclusion", "References" and "Appendices", the main content of the thesis consists of three chapters:

Chapter 1. Theoretical and practical basis.

Chapter 2. Implementation of project-based learning to develop scientific research capacity for high school students in teaching Ecology.

Chapter 3. Experimental pedagogy

DEVELOPMENT

CHAPTER 1
THEORETICAL AND PRACTICAL BASIS

1.1. Literature review
1.1.1. In the world
1.1.2. In Vietnam
1.2. Rationale
1.2.1. Orientation for innovating teaching methods
1.2.2. Capacity and scientific research capacity
1.2.3. Project-based learning
1.3. Practical basis
1.3.1. Reality of developing scientific research capacity in high schools
1.3.2. General situation of implementing pedagogical approaches in teaching Biology in high schools

CONCLUSION OF CHAPTER 1

The above research results allow us to draw some conclusions as follows:

- Competency - based learning approach is a general trend of education in the new era and has been announced in many highly legal documents of our Party and State, in which the new Advanced Education Program specifically recognizes this issue. To accomplish these announcements and recognitions, it is inevitable to make changes in teaching methods.

- Competencies include core competencies and specialized competencies, or role-specific ones, which are believed to be a combination of knowledge, skills and attitudes to perform a specific task in a specific context. To assess competencies, it is necessary to assess each of its structural components.

- Project-based learning has existed for a long time and, in the area of research and applications in teaching, has been paid much attention to by many educators in the world and in our country.

- The core issue of project-based learning is to build a series of learning projects. A learning project is a learning task associated with the lesson/ topic content and linked to practice. This is also a

distinctive characteristic of project-based learning compared to some other teaching methods, such as problem-solving, research- based and situation-based learning approaches.

- Project-based learning has an effect in forming and developing a wide range of different competencies for students including scientific research competencies. However, the reality of teaching Biology in general and teaching the Ecology - High School Module in particular to develop scientific research capacity for students have not been taken into appropriate consideration.

CHAPTER 2
APPLICATION OF PROJECT BASED LEARNING TO DEVELOP THE SCIENTIFIC RESEARCH COMPETENCIES FOR HIGH SCHOOL STUDENTS IN ECOLOGY TEACHING

2.1. Content structure of Ecology Module (Biology grade 12 - High school)

2.1.1. Content structure of Ecology Module Biology - Current grade 12)

2.1.2. Contents of the Ecology section in Biology - grade 12 (New high school education program - Biology 2018)

2.2. Composition of basic knowledge

2.3. Orientation on methods of teaching Biology in high schools

2.4. Principles and procedures of designing a learning project in the form of a scientific research topic

2.4.1. **Principles of designing a learning project in the form of a scientific research topic**

• Learning projects must be designed based on academic goals that are aligned with standards.

• Learning projects must be designed aiming to develop learners' scientific research competencies in particular and other required competencies in general.

• Learning projects must draw their attention to learners' interests, and learners are put at the centre of the learning process.

• Learning projects must ensure the agreement between theory and practice and between rationale and reality.

• Designed learning projects must be feasible.

• Learning projects must be designed based on the process of conducting the scientific research topic.

• The content of learning projects must be highly integrated.

2.4.2. Learning projects in the Ecology - High School Module

Based on the content of the lesson/ subject, we can restructure them into projects, and projects in different academic subjects are called Learning Projects (LP). A learning project must meet the following major criteria:

1) Be sticked to the curriculum, focusing on core and interdisciplinary knowledge;

2) Be associated with reality, topical, attractive and suitable for students;

3) Ensure skills development: teamwork; cooperation; communication; higher-order thinking; problem-solving; report performance and formation technology applications, etc.

4) May be limited within the classroom only and sometimes beyond the classroom;

5) Learning projects can last for a few periods, or a few weeks, even throughout the school year.

With the aim of improving the quality of teaching and develop scientific research competencies for students in teaching Ecology (Biology textbook 12 for high schools); based on the content of the Ecology section and the standards of a learning project, we propose some contents that can be conducted through project-based learning as follows (the nominated learning projects work as a model and a medium as a scientific research topic and can be done in different periods of times):

Table 2.1. Lists of learning projects that can be implemented in the Ecology curriculum

Ecology grade 12	Basic content in the textbook	Deployed content in project-based learning
Chapter 1 Individual ecology (individuals and environment)	- Concepts of habitats: environment, types of environment, ecological factors, groups of ecological factors. - The influence of infertile ecological factors on the organisms, forming adaptive characteristics. - The laws of interaction between organisms and environment. - The impact of organisms on the environment	-*Investigating microclimate in the Y area* - Assessing the impact of ecological factors (or groups of ecological factors) on living things - *Studying adaptive characteristics of species X in the Y area* - Studying the interaction between organisms and environment, accordingly proposing measures to improve and protect the environment of the Y area
Chapter 2 - Biological population	- Definition of population - Relationship among individuals in the population. - Basic characteristics of the population - Relationship between the population and environment, and the variation in the number of individuals in the population	- Investigating the populations present in the Y area - Studying the basic characteristics of population X in the Y area - Figuring out the relationship between population X and the environment in the Y area - Investigating the seasonal changes in numbers of population X in the Y area

Ecology grade 12	Basic content in the textbook	Deployed content in project-based learning
Chapter 3: Biomes	- Definition of biomes - Relationship among species in the community, rules of ecological pyramid. - Basic characteristics of biomes. -Ecological succession.	- Figuring out the basic components and relationships among species in the biome community in the Y area - *Studying the ecological succession in the Y area*
Chapter 4: Ecosystem, biosphere and ecology with natural resources management	- Concepts of Ecosystem and types of Ecosystem - Physical cycle and energy metabolism in the ecosystem, the law of ecological efficiency. - Concepts of Biosphere and biological zones. - Basic issues in management and use of natural resources	- Discovering the types of ecosystems in the Y area - Finding out the causes of environmental pollution (soil, water, air pollution), proposing measures to improve the environment in the Y area - Assessing the current situation of natural resources exploitation in the Y area and proposing remedial measures. -Assessing the biodiversity of population X in Y area

Note: - X is the name of a species; -Y is the local place where the school is located.

- Learning projects carried out within the classroom (In italics)
- Learning projects carried out outside the classroom (Vertical letters)

2.4.3. Process of designing learning projects

2.4.4. An example of the process

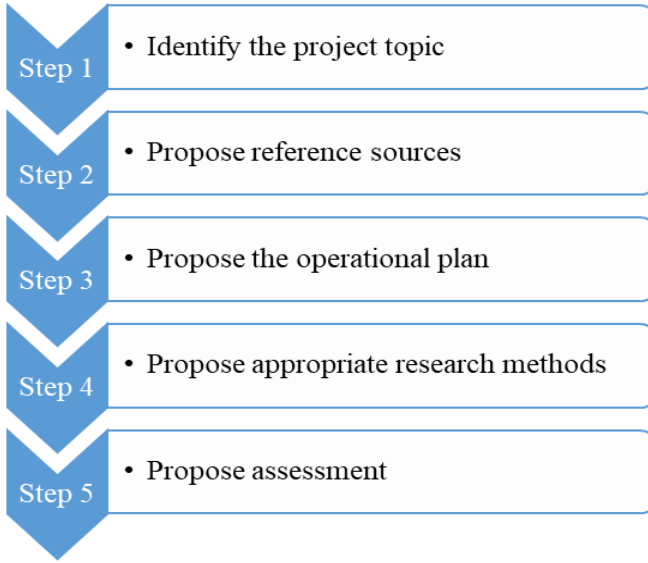

Figure 2.7. Process of designing a learning project

Table 2.2. Estimated assessment of scientific research capacity

Evaluation	Evaluation form / Characteristics
• **Skills** (accounts for 70/100 points with teachers evaluating different groups)	- Process Evaluation - The evaluation criteria are based on the quality manifestations of the products and the level of task completion (the products are not required to be complete).
• **Knowledge** (accounts for 15/100 with teachers evaluating individuals)	- Outcome Evaluation - Based on the results of answering questions about the content of the learning topic
• **Group-work Attitude** (accounts for 15/100 points with the group members evaluating one another)	- Đánh giá quá trình quá trình hoạt động theo nhóm - Process Evaluation for the process of working in groups

Stage 1: PREPARATION	
Teacher	**Students**
Organization Introducing lists of learning projects/topics Introducing references to students	Forming learning groups Selecting topics Giving the name and hypotheses of the topics

Stage 2: STUDY PLAN DEVELOPMENT/SET UP	
Teacher	**Students**
Checking the feasibility of the project implementation plan/topics of the groups	Developing the project implementation plan (overall and phased plan, products of each stage and expected research methods)

Stage 3: LEARNING PROJECT IMPLEMENTATION	
Teacher	**Students**
Interacting with teams to monitor, orient and support	Collecting, synthesizing, processing data or information Accomplishing the products

Stage 4: REPORTS AND ASSESSMENT	
Teacher	**Students**
Evaluating and giving comments on each group Awarding points to groups and individuals with positive performance.	Submitting the products in the format of hard copies, and the reports are presented with power point presentation in front of the Evaluation Board and the whole class. Giving feedback on topics from other groups and on each group member's contribution

2.5. Applications of project-based learning to develop scientific research capacity for students in teaching the module of Ecology - High School

2.5.1. Requirements for teachers and students in project-based learning

2.5.2. Process of application

2.5.3. Example

2.6. Assessment of students' scientific research competencies

2.6.1. Rules

2.6.2. In terms of knowledge

2.6.3. In terms of skills

2.6.4. In terms of attitude

CONCLUSION OF CHAPTER 2

Applying project-based learning to develop scientific research capacity for high school students in teaching Ecology Module is the content of chapter 2. The analysis of this content allow us to draw some conclusions as follows:

- The content of the Ecology module is in close proximity and attached to real life and nature. This is a favorable condition for teachers to implement project-based learning approach to develop scientific research competencies for students while teaching this section.

- To apply project-based learning, teachers need to restructure the textbook contents into topics. Because, project-based learning is believed to create opportunities for teachers to implement positive teaching methods including project-based learning.

- The core issue of project-based learning is to design learning projects. In other words, if learning projects are not developed, it is impossible to claim that project-based learning has been implemented.

- The process of designing a learning project includes 5 steps: determining the name of the learning project; expected source of materials; expected operational plan; expected research methods and expected assessment.

- As the learning projects have been built, implementation of these learning projects should be carried out following the proposed process to ensure the development of scientific research capacity for high school students.

- In order to evaluate students' scientific research capabilities, teachers accordingly need to build a set of proper criteria and assessment tools.

Chương 3
PEDAGOGICAL EXPERIMENT

3.1. Purposes of pedagogical experiment
3.2. Contents of pedagogical experiment
3.3. Experimental plan and methods
3.3.1. Experimental plan
3.3.2. Experimental methods
3.3.2.1. Selecting experimental subjects
3.3.2.2 Conducting experiments
3.4. Results of pedagogical experiment
3.4.1. Quantitative results
3.4.1.1 Empirical results assess the level of students' achievement in scientific research skills
a. Experimental results assess the level of students' achievement in identifying the research topic.
b. Experimental results assess the level of students' achievement in identifying the research title.
c. Experimental results assess the level of students' achievement in building scientific hypotheses.
d. Experimental results assess the level of students' achievement in setting up research plans.
e. Experimental results assess the level of students' achievement in data collection.
f. Experimental results assess the level students' achievement in data analysis and synthesis
g. Experimental results assess the level of critical thinking, reasoning skills, writing and making scientific reports.
h. Summarized experimental results evaluate the overall level of students' achievement in scientific research skills.

As in the first survey we only assessed 3 skills, the overall evaluation of scientific research skills was only conducted in experiments (1st time) and after experiments (2nd time) in both 2 academic years, 2016-2017 and 2017-2018. The results are as shown in Table 3.13 and Figure 3.8 below:

Table 3.13. General results of the level of students' achievement in scientific research skills in different stages of pedagogical experiment

Times	Total	Number (n) and percentage (%) of students gaining the level i							
		Level D		Level C		Level B		Level A	
		n	%	n	%	n	%	n	%
Before experiment (1st time)	652	312	*47.9*	240	*36.8*	100	*15.3*	0	*0.00*
After experiment (2nd time)	652	57	*8.7*	*149*	*22.9*	363	*55.7*	83	*12.73*

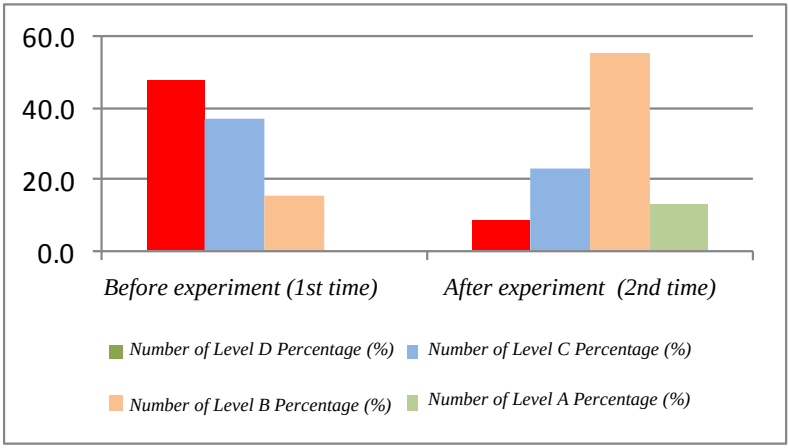

Figure 3.8. Results of general assessment of the level of students' achievement in scientific research skills in pedagogical experiment stages

3.4.1.2. Experimental results assess the level of knowledge acquisition of high school students

Table 3.15. Results of students' knowledge acquisition through tests

Time	Total	Number (n) and percentage (%) of students gaining the level i							
		Level D		Level C		Level B		Level A	
		n	*Tỷ lệ %*	n	*Tỷ lệ %*	n	*Tỷ lệ %*	n	*Tỷ lệ %*
Before experiment (1st time)	652	320	*49.1*	229	*35.1*	100	*15.3*	3	*0.46*
After experiment (2nd time)	652	65	*10.0*	*152*	*23.3*	348	*53.4*	87	*13.34*

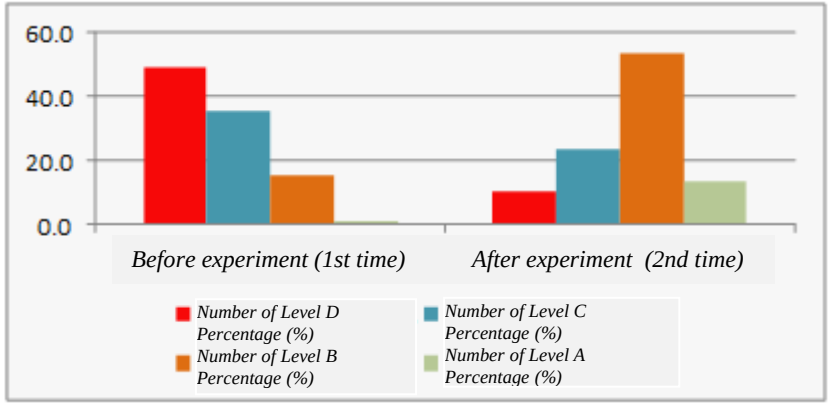

Figure 3.9. Results of students' knowledge acquisition through tests

As there is a situation where students have good scientific research skills but the acquired knowledge is not positive or vice versa, to assess whether there is a difference between students' knowledge acquisition level and scientific research skill level, we continue to use the Chitest Function with $\alpha = 0.05$. The data obtained demonstrates that skills development and knowledge acquisition are not of difference. Thanks to the learning projects built and organized by teachers, students not only develop scientific research skills but also improve the level of knowledge acquisition (achievement of dual goals).

3.4.1.3. Experimental results assess the level of students' attainment of scientific research attitudes

3.4.1.4. Experimental results generally assess the level of students' achievement in scientific research capacities.

After evaluating each criterion of scientific research competencies, we conducted a general assessment on the level of students' achievement in scientific research competencies based on Table 2.7 as proposed above.

General classification

Excellent: 85-100 points and criteria rated B or higher

Good: 70-84 points and criteria rated C or higher

Average: 55-69 points or having 01 criteria rated D and a score of over 55 points.

Weak: 40- 54 points.

Failed: Less than 40 points.

Experimental results of the overall assessment on student's achievement in scientific research capacity are shown in Table 3.18 and Figure 3.11 below:

Table 3.18. Results of general assessment on students' level of achievement in scientific research competencies

Time	Total n of sts	General Classification									
		Failed		Weak		Average		Good		Excellent	
		n	%	n	%	n	%	n	%	n	%
Before experiment (1st time)	652	87	13.3	238	*36.5*	271	*41.6*	54	*8.3*	2	*0.31*
After experiment (2nd time)	652	10	1.5	67	*10.3*	*152*	*23.3*	348	*53.4*	75	*11.50*

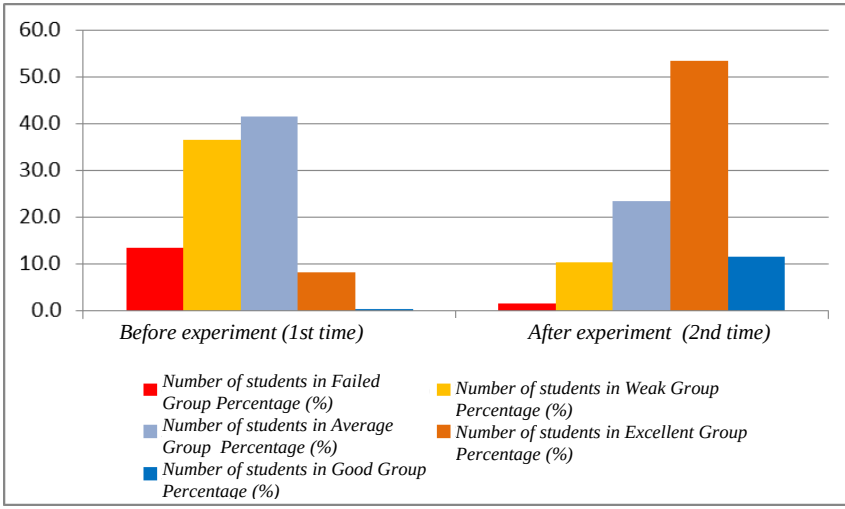

Figure 3.11. Results of general assessment on students' level of achievement in scientific research competencies

3.4.2. Qualitative analysis results

3.4.2.1. In terms of skills

It can be noticed that through experiments, skills belonging to students' scientific research competencies have been formed and developed thanks to proper application of designed learning projects, which accordingly enables students to gain knowledge related to scientific research and gradually develop the qualities and attitudes of scientists in the future.

3.4.2.1. In terms of knowledge and attitude

In the process of pedagogical experiment, when considering the products submitted as scheduled by students and feedback by teachers participating in experimental teaching, we found that:

- Students are no longer confused about the concept and process of scientific research. After the pedagogical experiment, most of the students, in addition to possessing scientific research skills, also have knowledge of scientific methodology and in-depth knowledge associated with learning projects. After studying about this field, the majority of students appear to be considerably interested and excited about the implementation of the learning projects; many students actively and proactively have proposed the next projects when the previous ones were accomplished.

- Students happen to be proactive in learning when provided with relevant documents to support the study of learning projects. Participants rarely missed group meetings. The members who were assigned to the task also tried to complete it well. The assessment on team members' attitude was conducted fairly and seriously, agreeing with teachers' evaluation to each individual.

CONCLUSION OF CHAPTER 3

- Experimental results of the survey in the pedagogical implementation phase have shown that when there is no impact of project based learning approach, students' scientific research capabilities are at a relatively low level (skills to identify research issues, research topics and skills of research hypothesis-building are mostly at level 1). This is of course, because the students do not have little knowledge of the methodology of scientific research, and have never had any experience in conducting learning projects (especially learning projects in the form of a scientific topic). Therefore, their methodological knowledge and scientific research skills can not be achieved at a higher level but most students are at level 1 instead.

- Project-based learning approach with learning projects designed in the form of a scientific topic has had an influence on the different structural components of scientific research competencies: knowledge, attitude, quality and research skills, such as skills to identify the research topic, identify the name of the topic, and propose hypotheses. These competencies have had positive changes in the implementation process of project- based learning approach to teach the Ecology section to students.

- The results of the quantitative and qualitative analyses have shown that developing and using learning projects in the form of scientific topics, proposed principles and procedures of organizing project-based learning in teaching Ecology is effective and feasible to improve scientific research competencies for students.

CONCLUSION AND RECOMMENDATIONS

1. Conclusion

1.1. With positive, proactive, creative and practical effects, project-based learning has attracted many researchers and educators, both domestic and abroad, to study and apply it. However, applying project-based learning approach to teach the Ecology section at high schools to develop scientific research competencies for students has not been mentioned.

1.2. Applying project-based learning to develop scientific research capacity for students must be associated with the construction of a system of learning projects linked with the content of lessons, subjects and expressed in the form of scientific topics.

1.3. Researchers, to evaluate scientific research competencies as well as other competencies, must follow a certain approach. In the thesis topic, the author has followed the approach of the component structure of this capacity.

1.4. The component structure of scientific research capacity also consists of: knowledge (scientific knowledge and knowledge of methodology in scientific research); scientific research skills (problem detection; identify research title; set up research hypothesis; build research proposal; conduct research; collect and process data; write and report findings; and researchers' attitude and qualities.

1.5. In the content of the thesis, the author has proposed a process of designing learning projects and has introduced a system of diverse learning projects (in the classroom, outside the classroom; in one lesson and in various lessons) linked with learning content and practice. Besides, the author of the thesis also gave a process of organizing project-based learning and applied it in pedagogical experiment process in some high schools in Thai Nguyen and Cao Bang provinces.

1.6. The results of pedagogical experiment have proved the effectiveness and feasibility of implementing project-based learning in teaching the Ecology section to develop scientific research capabilities for high school students.

2. Recommendations

2.1. Pedagogical experiments should be deployed more widely to further confirm the feasibility and effectiveness of applying project-based learning in the development of scientific research capability for students in teaching the Ecology module in particular and teaching Biology in general.

2.2. It is necessary to introduce training materials for high school teachers about the process of designing a learning project process and procedure to implement project-based learning to develop competencies in general and scientific research competencies for students in particular.

2.3. Based on the process of building and organizing the teaching of the Ecology module, (Biology Grade 12 - High School), it is significant to keep carrying out research on the impact of project-based learning approach on students' scientific research competencies and other competencies in different learning sections and sub-divisions of the Biology subject.