MINISTRY OF EDUCATION AND TRAINING
THAI NGUYEN UNIVERSITY

LE KHOA

Applying method of project-based teaching in teaching knowledge of electric power production and use for high school students

Speciality: Theory and Methods of Teaching Physics
Code: 62 14 01 11

SUMMARY OF DOCTORAL DISSERTATION
OF PHISOLOPHY IN EDUCATION

THAI NGUYEN – 2015

This dissertation is completed at
College of Education - Thai Nguyen University

Scientific Superviser:
Asso. Pro. Nguyen Van Khai, PhD.

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PREFACE

1. Reasons for the topic

One of important tasks of current education is not only to equip the students with not only minimal, necessary knowledge from the subjects but also to provide them with certain abilities to participate in production or scientific research, so that they can adapt the requirements of society. Central Conference Resolution 8 term XI on basic, comprehensive innovation of education and training (2013) stated: "*Transfer the education from knowledge equipment to comprehensive development of students' capacity and quality*". Following educational guidelines of the Party, targets and tasks of high schools are implemented through teaching processes of the subjects, including Physics. Therefore, it is necessary to research new teaching methods, such as teaching by the projects on physical applications in production, use of electric power in order to form and develop students' capacity, contribute to improve the quality of general technical education at high schools. For such reasons, we choose the topic: ***Applying method of project-based teaching in teaching knowledge of electric power production and use for high school students.***

2. Purposes

Research apply project method of teaching in "production and use of electric power" according to higher secondary Physics program in order to develop the capacities of knowledge utilizing, problem solving, contribute to improve the quality of general technical education.

3. Research subject and scope

Research subject: Teaching and studying activities in teaching by project method.

Research scope: Teaching and studying activities in teaching by project method in production and use of electric power – higher secondary Physics.

4. Scientific hypothesis

Teaching "production and use of electric power" by project method according to higher secondary Physics program may help to develop the capacities of knowledge utilizing, problem solving and contribute to improve the quality of general technical education.

5. Research tasks

1) Research the theory on teaching by project method.

2) Analyze the contents on production and use of electric power in higher secondary Physics program and then propose some projects.

3) Organize teaching by project method in "production and use of electric power" according to higher secondary Physics program.

4) Study actual situation of teaching on production and use of electric power in higher secondary Physics program, find out the advantages, difficulties in order to deploy project method of teaching at some high schools.

5) Design the process of teaching by project method in production and use of electric power through some higher secondary Physical subjects.

6) Pedagogical experiment: Organize to implement the designed process of teaching by project method in order to test the scientific hypothesis and feasibility of the topic.

6. Research method

6.1. Theoretical research method: Study theoretical documents; systematize the concepts, theories relating to capacity development and general technical education to build theoretical bases for the topic.

6.2. Experimental research method:

- Observation
- Questionnaire
- Interview
- Expert
- Pedagogical experiment

6.3. Mathematical statistics method

7. Result and new contribution of the dissertation

1) Theory:

- Supplement and develop theoretical bases of project method of teaching as the basis for teaching by project method in production and use of electric power, in particular, as well as in teaching of Physics, in general, including the concept, characteristics, classification of teaching by project method, process of teaching by project method in production and use of electric power.

- Systematize theoretical bases on general technical education and the role of teaching by project method in general technical education in Physics, and then establish the basis for integrating general technical education in teaching process by project method in production and use of electric power.

- Propose some measures to develop the capacities of utilizing knowledge in actual situations, solving problems and to improve the quality of general technical education for students in project method of teaching.

- Propose subjects on production and use of electric power for teaching process by project method make evaluation plan and design evaluation toolkit for project method of teaching in production and use of electric power. The toolkit has dual purpose (qualitative and quantitative evaluations) and will be the level which helps to promote studying process of the students.

2) Practice:

- Build the system of project subjects on "production and use of electric power".

- Design 2 processes for project method of teaching: Teaching process by projects on electric power production and Teaching process by projects in electric power use which are suitable for high school students (11th, 12th grade). These processes are practical and may be applied in general Physics teaching.

- Build the plan of teaching by project method with the subjects on production and use of electric power – higher secondary Physics.

- Organized to implement the process of teaching by projects in electric power production and the process of teaching by projects in electric power use according to higher secondary Physics program (2-term pedagogical experiment). The result of pedagogical experiment confirmed that the topic achieved the research purpose of developing the capacities of knowledge utilizing, problem solving and improving the quality of general technical education for students. Teaching activities may be applied in other contents of higher secondary Physics program.

8. Structure of the dissertation

Beside the preface (5 pages), conclusion and recommendations (2 pages), references (6 pages) and appendices (55 pages), the dissertation

includes 3 chapters:

Chapter 1. Theoretical and practical bases of Applying project-based method on teaching knowledge of electric power production and use - higher secondary Physics (54 pages, including 2 figures and 3 tables).

Chapter 2. Designing process of teaching by project method in knowledge of electric power production and use – higher secondary Physics (44 pages, including 6 tables).

Chapter 3. Pedagogical experiment (47 pages, including 30 figures and 16 tables).

The dissertation uses 70 references, including 51 documents in Vietnamese and 19 documents in foreign languages.

Chapter 1
THEORETICAL AND PRACTICAL BASES OF APPLYING PROJECT-BASED METHOD ON TEACHING KNOWLEDGE OF ELECTRIC POWER PRODUCTION AND USE – HIGHER SECONDARY PHYSICS

1.1. Overview of research problems

We have researched and outlined the researches on teaching by project method in the world such as Boaler (1999), Thomas J. W. (2000), Railsback J. (2002)… as well as in Vietnam such as Nguyen Cao Cuong (2009), Nguyen Thi Dieu Thao (2009), Bui Tri Thuc (2010), Nguyen Nguyet Hue (2010), Nguyen Thi Mai (2011), Tran Van Thanh (2013), etc. However, there are many problems which need to be researched and solved, specifically:

- There have been no specialized works or researches on project method of teaching in production and use of electric power – higher secondary Physics, aiming to develop the capacities of knowledge utilizing and problem solving, contribute to improve the quality of general technical education.

- None of researches propose teaching process by project method in production and use of electric power – higher secondary Physics.

- There have been no researches on general technical education through project method of teaching in production and use of electric power in higher secondary Physics.

Above problems show that the topic "*Applying method of project-based teaching in teaching knowledge of electric power production and use for high school students"* satisfies theoretical and practical requirements on application of project method of teaching in Physics, contributes to innovate teaching method at high schools.

1.2. Teaching by project method

1.2.1. Project and studying project: According to Vietnamese dictionary, project means "a draft on something". Studying project means a studying task in teaching by project method, of which the purpose is also the purpose of teaching.

1.2.2. The concept of teaching by project method

Teaching by projects is a method of teaching in which the students themselves, under the instructions of teachers, solve a complex studying task in both theory and practice, primarily under the form of group work. The groups define their target, make plan and implement the project, participate in the inspection on implementation process and result evaluation. Results are the products which may be introduced, presented.

1.2.3. Target of teaching by project method, Project method of teaching focuses on the capacity, including: knowledge, skill and attitude.

1.2.4. Characteristics of teaching by project method, according to Nguyen Thi Dieu Thao (2009): a) Oriented on students; b) Oriented on practice; c) Complex project; d) Oriented on products.

1.2.5. Philosophical, psychological, didactic bases

1.2.5.1. Philosophical basis: cognitive theory of dialectical materialism.

1.2.5.2. Psychological basis*:* basing on two development theories of J. Piaget (1896-1983) and L. Vygotsky (1896-1934).

1.2.5.3. Didactic basis: According to Nguyen Van Cuong (1995), the teaching principles are: a) Suitability for students; b) Promote self-reliance of the students; c) Encourage the motivation of studying; d) Promote the coordination; e) Close to reality, combine theory and practice; f) Consider inter-subject feature.

1.2.6. Development of students' capacities in project method of teaching: According to Tran Van Thanh (2013), organization of teaching by project

method may improve and develop the capacities of students. However, this dissertation focuses on the capacities of utilizing knowledge in actual situations and solving problems. We evaluate students' capacities basing on the criteria built on their manifestations.

1.2.7. Classification of teaching by project method: According to K. Frey (1982), Classification by available time: Small project (2 to 6 hours), Medium project (under 40 hours), Large project (1 week or longer); according to Nguyen Sy Duc (2009), Classification by complexity of studying contents: Practical project, Complex project; according to Nguyen Van Cuong (2009), Classification by task: Studying project, Researching project, Creating project, Acting project; according to Nguyen Van Cuong (2009), Classification by form: Subject project, Inter-subject project, etc.

1.2.8. Process of teaching by project method: Basing on Kilpatrick (1918), we built a process of teaching by project method, including 3 stages: Preparation; Implementation; Evaluation.

1.2.9. Preparation steps for a project of teachers and students: According to Do Huong Tra (2011), include: Finding ideas of the project; Defining targets of the project; Building orienting questions; Designing the project; Plan of teacher and students; Supporting documents for teacher and students; Preparing necessary conditions for project implementation.

1.2.10. Organization of teaching by project method: means deploying the plan of teaching by project method of the teacher, including: proposing ideas, assigning tasks, and grouping, assigning works, inspecting, supporting students and evaluating results.

1.2.11. Evaluation in teaching by project method

1.2.11.1. Viewpoints on evaluation in teaching by project method: According to Marx R. W (1994), there are many viewpoints, but until now, no unity has been achieved in the viewpoints on evaluation in teaching by project method.

1.2.11.2. Purpose of evaluation in teaching by project method: To inspect the level of implementing teaching targets on knowledge, skill and attitude; to evaluate both teaching and studying processes in a project.

1.2.11.3. Principles of evaluation in teaching by project method: According

to Bui Tri Thuc (2010): a) Ensure reliability of the measurement, accurately reflect the qualification of students, proper evaluation targets; b) Ensure the value; c) Ensure the adequacy and comprehensiveness; d) Combine different types of evaluation tools, aiming to specific criteria.

1.2.11.4. Evaluation toolkit, including: observation note, project logbook, evaluation sheet, questionnaire on students' attitude (Linker scale).

1.2.11.5. Evaluation plan in teaching by project method: is the combination of teacher's evaluation, cooperative and coequal evaluation and self-evaluation.

1.3. Organization of teaching by project method in "production and use of electric power" according to higher secondary Physics program.

1.3.1. Reasons for organization of teaching by project method

Higher secondary Physics program with much knowledge relating to production and use of electric power may be organized to teach by project method in order to form and develop the capacities of knowledge utilizing and problem solving for students, contribute to general technical education.

1.3.2. Physical bases of production and use of electric power

1.3.2.1. Physical bases of electric power production: Power is produced in different ways, primarily by generators in power plants; they have the same principle - Faraday's law of induction.

1.3.2.2. Physical bases of electric power use: Principle of electric power use primarily bases on impacts of the current: force impact, magnetic impact, chemical impact, thermal impact…

1.3.3. Theoretical bases of general technical education for students

1.3.3.1. General technical education and the relationship between general technical education and vocational guidance: According to Nguyen Van Khai (2008), the relationship between general technical education and vocational guidance is expressed by that: whether the students can get accurate guidance in their career choices if they implement general technical education well.

1.3.3.2. The task of general technical education in teaching of Physics*:* According to Nguyen Van Khai (2008), including: Basic and common scientific, technological, technical principles of major production processes;

Basic directions of scientific – technical processes; Training students in practical skills, habits.

1.3.3.3. Implementing general technical education through teaching by project method in production and use of electric power: Teaching by project method in production, use of electric power in Physics not only provide students with technical knowledge but also develop their capacities of technical creation, solving technical problems and actively studying the industries of electric power production and use. Therefore, project method of teaching in production and use of electric power can implement the task of general technical education.

1.3.4. The role of teaching by project method in general technical education: In project method of teaching, the students may design, manufacture simple machines, etc. train the skills of using common production tools (through the projects). So, teaching by project method not only helps to transmit the knowledge but also contributes to general technical education to students.

1.3.5. The process of teaching by project method in production and use of electric power:

Basing on general teaching process by project method, we built a teaching process with the projects of Physical applications in "production and use of electric power"; the process is divided into 3 stages, equivalent to 7 phases: Phase 1. Observing practical production and use of electric power; Phase 2. Stating problems/questions; Phase 3. Proposing solutions – Choosing subjects; Phase 4. Making project plan; Phase 5. Implementing the project; Phase 6. Reporting and introducing products; Phase 7. Evaluating; Summarizing/Reviewing the project.

1.3.6. Making plan of teaching by project method: In order to organize teaching by project method, the teacher needs to make a plan, including: *Step 1. Before starting the project:* prepare teaching conditions; instructing students about studying steps; *Step 2. During project implementation:* implementing the processes of teaching by project method; *Step 3. After finishing the project:* mark each group, individual.

1.4. Actual state of teaching knowledge on production and use of electric power in Physics at high schools: In order to get practical bases for the research, application of teaching by project method, we have surveyed the situation of teaching and studying in the knowledge on production and use of electric power in Physics at some high schools of Vinh Phuc province, Quang Ninh province and Thai Binh province. The results showed that: research and application of teaching by project method in Physics are very necessary.

Conclusion of Chapter 1

With four outstanding characteristics: oriented on group work, oriented on practice, oriented on products and oriented on complexity, project method of teaching has many advantages in Physics teaching in order to develop the capacities of knowledge utilizing, problem solving and contribute to general technical education for the students. Research results, supplementations on formed theory and process of teaching by project method will be used for designing the process of teaching by project method in the subjects of production, use of electric power, higher secondary Physics.

Chapter 2
DESIGNING PROCESS OF TEACHING BY PROJECT METHOD IN KNOWLEDGE OF ELECTRIC POWER PRODUCTION AND USE – HIGHER SECONDARY PHYSICS

2.1. Analyzing contents on production and use of electric power in Higher secondary Physics program.

Higher secondary Physics program has much knowledge relating to production and use of electric power; it can be designed as studying projects suitable for qualification and characteristics of students.

2.2. Building system of subjects on production and use of electric power

2.2.1. Principles of choosing and building project subjects: 1) Suitable for psychological, physical characteristics and development of students; 2) Close to the program for higher secondary education; 3) Practical, close to life and production; 4) Suitable for local characteristics and customs.

2.2.2. The system of subjects on production and use of electric power*:*1)

Hydropower plant ; 2) Thermal power plant; 4) Solar cell; 5) Atomic power plant; 6) Principles of electric power use; 7) Electric cooker; 8) Electroplating; 9) Electric automobiles.

2.3. Designing process of teaching by project method in electric power production

2.3.1. Designing projects in electric power production

2.3.1.1. Building orienting questions

* *Summary question:* How is electric power produced?

* *Lesson questions:*

- How can the hydropower generator be designed?
- How is the thermal power generator designed?
- How can the wind power generator be designed?
- What are the design and model of solar cell?
- What are the structure and operational principles of an atomic power plant?

With 5 questions, teacher directs the students to 5 projects: Hydropower plant; Thermal power plant; Wind power plant; Solar cell; Atomic power plant.

* *Content questions:*

1) Hydropower plant project

- Could you tell me how power of water of a reservoir is transformed through following components: water pipe, turbine, generator of a hydropower plant?
- Which physical principle is the basis for structure of generator?
- What components does a hydropower generator consist of?
- Describe the structural diagram of a hydropower plant?

2) Thermal power plant project

- Could you tell me how power is transformed through following components: coal burner, boiler, turbine, generator of a thermal power plant?
- What are the differences between hydropower plant and thermal power plant?
- Which physical principle is the basis for structure of generator?

- Describe the structural diagram of a thermal power plant?

3) Wind power plant project

- Could you tell me how power is transformed through following components: wind turbine, generator of a wind power plant?

- What are the differences between wind power plant, hydropower plant and thermal power plant?

- Which physical principle is the basis for structure of wind power generator?

- Describe the structural diagram of a wind power plant?

4) Solar cell project

- How is light power transformed to electric power in solar cell?

- Which semi-conductor does solar cell use in its design?

- Describe the structural diagram of solar cell?

5) Atomic power plant project

- What is the structural principle of 3-phase AC generator?

- How do nuclear interactions take place in an atomic reactor?

- Could you tell me how power is transformed through following components: reactor, boiler, turbine, generator of an atomic power plant?

- Describe the structural diagram of an atomic power plant?

2.3.1.2. Ideas of the projects:

1) Hydropower plant project: Through the documents on natural resources of Vietnam, we realize that our country has a great potential in hydroelectric power with many rivers, springs, lakes, dams, especially in mountainous regions. So how is electricity produced from mechanical power (water power), what are its advantages and impacts to the ecological environment? Our team decided to study this problem.

2) Thermal power plant project: In recent years, the environmental pollution caused by thermal power plants has been discussed frequently. However, after studying the history, we know that the first generators were manufactured to operate by oil. How is electric power produced from traditional resources such as gas, oil and coal? That’s what we want to study.

3) Wind power plant project: Currently electricity is produced primarily

from natural resources such as gas, coal, oil… However, these resources cause serious environmental pollution and are becoming exhausted. Therefore, finding an alternative energy is now more urgent than ever!

4) Solar cell project: Many mountainous regions of our country, especially the remote, isolated ones, haven't had any power grid, which causes difficulties to the life of ethnic minorities. Can solar energy generate electricity and make the life there easier?

5) Atomic power plant project: Through newspapers, television, we know that atomic power plant is now being used in many countries all over the world. Vietnam also intended to construct 2 atomic power plants in Ninh Thuan, which were commenced in 2014 and finished in 2020. Why does atomic power plant develop so strongly and what is its operational principle? Our team decided to study more about these problems.

2.3.2. Making teaching plan for the projects have topic in electric power production, higher secondary Physics: After designing the projects, we establish a process of teaching by project method in *electric power production* and make teaching plan. It is adapted from the process of teaching by project method which was stated in item 1.3.5.

2.4. Designing process of teaching by project method in electric power use

2.4.1. Designing projects in electric power use

2.4.1.1. Building orienting questions

* *Summary question:* Where can electric power are applied in production and life?

* *Lesson questions:*

- Which works can electric power be applied in and what is the principle?
- How can we design an electric cooker?
- How is electroplating equipment designed?
- How is the engine of electric automobiles designed?

With 4 questions, teacher directs the students to 4 projects: Studying the principle of electric power use; Electric cooker; Electroplating; Electric automobiles.

* *Content questions:*

1) Project Studying the principle of electric power use

- What is the importance of electric power to human?
- Which fields is electric power applied in?
- Basing on which physical principles are electric devices designed, manufactured?
- Why do we have to save electricity?

2) Project Electric cooker

- How is Joule-Lenz law applied in electric cooker?
- Which metal is used to design electric cooker?
- Describe the structural diagram of electric cooker?

3) Project Electroplating

- State nature of the current in electrolyte?
- What are secondary reactions in electroplating?
- What is the mechanism of electroplating?
- Describe the diagram of cooper plating equipment on metal?

4) Project Electric automobiles

- How is power transformed in electric automobiles?
- Describe the structural diagram of electric automobiles?
- Basing on which physical principles is electric engine structured?
- Describe the structural diagram of electric engine?

2.4.1.2. Ideas of the projects:

1) Project Studying the principles of electric power use: Nowadays, electric power is used in many works such as: lighting, cooking, operating machines, operating vehicles, communication… in production, travelling, construction and living activities. Why can electric power be applied so widely? And which physical principle is the basis for such application? That's what we care about.

2) Project Electric cooker: Currently many types of cookers are being used: wood stove, gas cooker, electric cooker… Which of such cooking equipment do you care the most?

3) Project Electroplate: There are many gold, silver plated items around

us, such as: spoon, fork, knife… We don't know which method is used to plate metals. So we decide to study this problem.

4) Project Electric auto: Electric automobile is a new kind of vehicle which is being promoted because it does not pollute the environment. So how is its engine structured and operated? We really care about this equipment and decide to study it.

2.4.2. Making plan of teaching projects have topic in electric power use, higher secondary Physics: After designing the projects, we establish a process of teaching by projects in *electric power use* according to the process of teaching by project method stated in item 1.3.5, and make teaching plan.

2.5. Evaluating studying results of students

2.5.1. Establishing evaluation toolkit: Basing on research purposes of the topic, we establish evaluation criteria in two fields: evaluation on student's capacity and evaluation on the quality of general technical education, including: student's capacity evaluation toolkit and general technical education evaluation toolkit.

2.5.2. Making plan of evaluating studying results of the students

Basing on research purposes, we make common evaluation plan for both fields – student's capacity and quality of general technical education – as follow: evaluation of teacher, cooperative evaluation, coequal evaluation and self-evaluation. Evaluation result is the combination of all above evaluations.

Marking method is specified in item 2.5.2.3 of the dissertation.

Conclusion of Chapter 2

In Chapter 2, we have designed the process of teaching by project method in production and use of electric power by theoretical bases on project method of teaching. The teaching process is divided into 3 stages, equivalent to 7 phases. Evaluation toolkit participates in all stages of the process of teaching by project method to evaluate as well as to support, encourage the students. Research results of Chapter 2: process of teaching by project method in electric power use, evaluation toolkit, student-supporting documents will be used in pedagogical experiment at some high schools.

Chapter 3
PEDAGOGICALAL EXPERIMENT

3.1. Purpose of pedagogical experiment: To test scientific hypothesis and feasibility of the topic.

3.2. Tasks of pedagogical experiment: Investigate, survey the situation of teaching knowledge on production and use of electric power in Physics at pedagogical experiment schools; Make experimenting plan; Organize implementation of project method of teaching in production and use of electric power (chapter 2) at experiment class; Organize review on the knowledge on production and use of electric power at reference class; Evaluate experimental results.

3.3. Subject of pedagogical experiment: 11^{th} and 12^{th} grade students.

3.4. Method of pedagogical experiment: pedagogical experiment is performed in 2 terms at high schools (Vinh Phuc): *term 1: at the end of school-year 2011-2012; *term 2: at the end of school-year 2012-2013.

3.5. Method of evaluating pedagogical experiment results

3.5.1. Bases for evaluation: Project implementation of the students, report on products, marks of observation notes, evaluation notes at practicing class; Test results at experiment, reference classes.

3.5.2. Evaluation method: 1) Evaluating student's capacity and quality of general technical education through the process of teaching by project method; 2) Evaluating the level of knowledge mastering by tests at experiment, reference classes.

3.6. Implementation of pedagogical experiment

3.6.1. Teacher: Do Thanh Ha, Le Khoa, Bui Thi Thu Thuy.

3.6.2. The process of teaching by project method used in pedagogical experiment: 1) Process of teaching by project method in electric power production; 2) Process of teaching by project method in electric power use.

3.6.3. Schedule of teaching by project method at experiment classes

Time	Class	School	Process	Teacher
2011-2012	12A	Nguyen Viet Xuan	Process of teaching by project method in electric	Do Thanh Ha

			power production	
	11C	Nguyen Viet Xuan	Process of teaching by project method in electric power use	Le Khoa
2012-2013	12 A1	Tam Duong 2	Process of teaching by project method in electric power production	Bui Thi Thu Thuy
	11 A3	Tam Duong 2	Process of teaching by project method in electric power use	Le Khoa

3.6.4. Analyzing happenings of pedagogical experiment

3.6.4.1. Process of teaching by project method in electric power production

Table 3.3. Teaching method at experiment, reference classes

Class	*Duration*	*Content*	*Hour*	*Partici-pants*
Experi-ment	2 hours	Introducing project method of teaching, instructing students to study by project method.	Curricular / Optional	Teacher, students
	2 hours	Students choose one of subjects: hydropower, thermal power, wind power, solar cell, atomic power, and grouping.	Optional	Teacher, students
		Teacher instructs students to make plan and provides supporting documents.		
	3 weeks	Groups implement different projects, design different products. Teacher support, if necessary.	Outside class hours	Students working in groups
	2 hours	Groups report, introduce the products.	Optional	Teacher, students
		Teacher, students evaluate.		

Reference	2 hours	Teacher uses traditional method to review some knowledge relating to electric power production in higher secondary Physics program.	Curricular	Teacher, students

During project implementation, the groups use their knowledge in manufacturing generators, solar cells; their capacities of utilizing knowledge and problem solving are trained. This is also a method of general technical education.

3.6.4.2. Process of teaching by project method in electric power use

Table 3.6. Teaching method at experiment, reference classes

Class	*Duration*	*Content*	*Hour*	*Partici-pants*
Experi-ment	2 hours	Introducing project method of teaching, instructing students to study by project method.	Curricular / Optional	Teacher, students
	2 hours	Students choose one of subjects: studying principle of electric power use, electroplating, electric automobile; grouping.	Optional	Teacher, students
		Teacher instructs students to make plan and provides supporting documents.		
	3 weeks	Students implement project plan. Teacher supports if necessary.	Outside class hours	Students work in groups
	2 hours	Groups report and introduce their products.	Optional	Teacher, students
		Evaluate the project		
Reference	2 hours	Teacher uses traditional method to review some	Curricular	Teacher, students

		knowledge relating to electric power use in higher secondary Physics program.		

By designing, manufacturing some models of technical materials, collecting information, students are trained in the capacities of analyzing, synthesizing, knowledge utilizing, problem solving. They are also trained in practicing skills, getting acquainted with the models in "electric power use" which helps to implement general technical education.

3.7. Evaluating the results of pedagogical experiment

3.7.1. Qualitative evaluation

3.7.1.1. Advantages*:* 1) Processes of teaching by project method designed and used in pedagogical experiment have achieved teaching purposes: on knowledge, on skill, on attitude; 2) Training, developing the capacities: knowledge utilizing, problem solving and improving the quality of general technical education; 3) The processes of teaching by project method are feasible.

3.7.1.2. Restictions*:* 1) Difficulties in time; 2) Difficulties in finance; 3) Restricted reality studying.

3.7.2. Quantitative evaluation: performed on all respects: Evaluating capacities and quality of general technical education for students in experiment and reference classes.

Table 3.12. Final marks on capacities of participating students

Member	***Final marks of members in the groups***								
	Green energy	*White smoke*	*Future energy*	*Solar energy*	*Notron*	*Studying books*	*Technical books*	*Afternoon blue smoke*	*Motivation*
1	82.5	82.8	76.3	84.1	82.5	90.1	83.8	86.2	86.2
2	90.5	85.3	91.1	84.8	83.8	75.6	77.4	86.9	86.9
3	75.2	84	86.4	83.5	81.2	73.5	76.8	77.6	77.6
4	86.5	84.7	91.8	86.1	85.1	81.8	86.8	92.6	92.6
5	91.1	80.2	93.1	90	86.4	95	88.1	87.6	87.6
6	85.2	82.8	85.7	80.9	83.8	95	93.2	91.9	91.9
7	81.9	82.1	92.5	85.4	90.3	80.4	86.1	80.6	80.6

8	91.1	90	91.8	86.1	85.1	93.6	92.5	95	95
9	81.2	83.4	90.4	82.8	83.1	92.2	83.8	87.6	87.6
10						84.6	83.1	82.6	82.6

Table 3.14. Final marks on the quality of general technical education of participating students

Member	***Final marks of members in the groups***								
	Green energy	*White smoke*	*Future energy*	*Solar energy*	*Notron*	*Studying books*	*Technical books*	*Afternoon blue smoke*	*Motivation*
1	81.1	83.1	80.3	88.2	79.3	82.2	82.6	90.8	82.6
2	84.9	90.4	91.1	88.2	83.0	78.2	80.5	86.8	90.2
3	83.6	84.4	90.4	81.7	79.3	80.2	81.5	80.8	82.6
4	85.6	90.7	91.3	90.3	85.8	78.2	82.6	91.8	86.8
5	84.3	82.5	92.1	91.0	88.1	90.08	80.5	90.8	90.8
6	83.6	83.8	88.1	81.7	83.0	90.08	94.9	91.8	90.5
7	80.4	82.5	92.1	88.0	91.1	82.2	91.0	80.8	90.5
8	90.0	91.1	90.4	90.3	85.8	91.1	94.9	93.1	92.1
9	90.0	84.4	90.4	88.2	79.3	86.5	91.0	90.8	90.2
10						91.1	82.6	84.2	82.5

Comment: through the processes of teaching by project method in pedagogical experiment, beside accepting knowledge (on production and use of electric power), the students also form and develop their capacities of knowledge utilizing, problem solving; and the quality of general technical education is improved significantly.

Table 3.15. Test results on the knowledge on electric power production (term 2)

School	Class	No. of students	Mark									
			1	2	3	4	5	6	7	8	9	10
Tam Duong 2	Experiment: 12A1	45	0	0	0	0	2	5	11	15	11	1

	Reference: 12A2	45	0	0	2	4	14	15	6	3	1	0

Average mark: Experiment class: $\overline{X}$ = 7.7; Reference class: $\overline{Y}$ = 5.6

Table 3.16. Ranking by the knowledge on electric power production (term 2)

Class	No. of students	Ranking (%)				
		Failure (0-2)	Poor (3-4)	Fair (5-6)	Good (7-8)	Excellent (9-10)
Experiment	45	0%	0%	15.5%	57.7%	26.8%
Reference	45	0%	13.3%	64, 5%	20%	2.2%

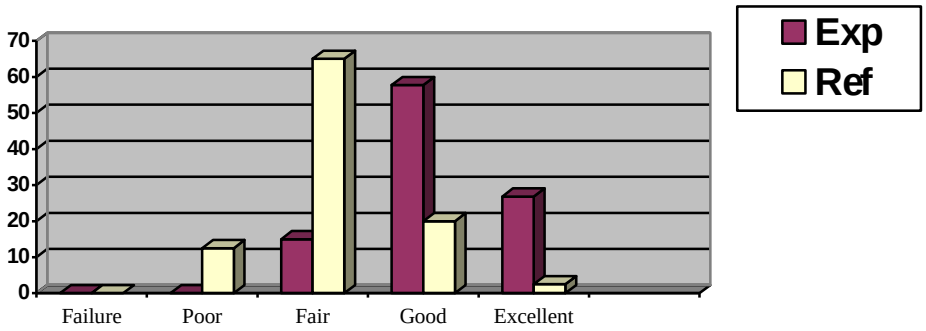
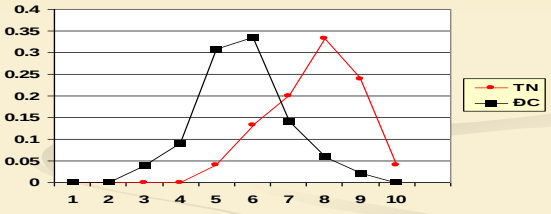


Chart 3.1.Ranking chart by knowledge on electric power production (pedagogical experiment term 2)

Điểm X_i (Y_i)	TN (X)			ĐC (Y)		
	n_i		$)^2$	n_i		$)^2$
1	0	0,000	0,000	0	0,000	0,000
2	0	0,000	0,000	0	0,000	0,000
3	0	0,000	0,000	2	0,044	13,52
4	0	0,000	0,000	4	0,088	10,24
5	2	0,045	14,58	14	0,31	5,04
6	5	0,133	14,45	15	0,333	2,4
7	11	0,200	5,39	6	0,14	11,76
8	15	0,333	1,35	3	0,065	17,28
9	11	0,244	18,59	1	0,023	11,56
10	1	0,045	5,29	0	0,000	0,000
	45	1	59,65	45	1	71,8



Frequency distribution table and frequency chart of test results on the knowledge on electric power production (term 2)

Table 3.18. Test results on the knowledge on electric power use (term 2)

School	Class	No. of	Mark

		students	1	2	3	4	5	6	7	8	9	10
Tam Duong 2	Experi-ment: 11A3	40	0	0	0	0	1	5	9	12	11	2
	Reference : 11A4	40	0	0	3	4	12	12	7	2	0	0

Average mark: Experiment class: $\overline{X}$ = 7.8; Reference class: $\overline{Y}$ = 5

Table 3.19. Ranking by the knowledge on electric power use (term 2)

Class	No. of students	Ranking				
		Failure (0-2)	Poor (3-4)	Fair (5-6)	Goods (7-8)	Excellent (9-10)
Experiment	40	0%	0%	15%	52.5%	32.5%
Reference	40	0%	17.5%	60%	22.5%	0%

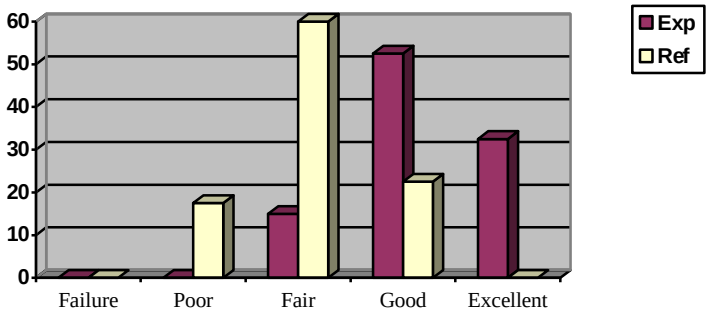
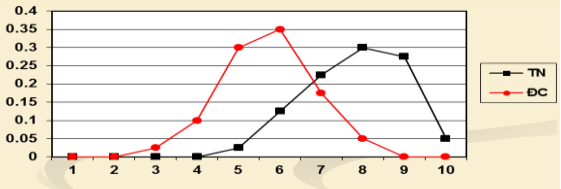


Chart 3.2. Ranking by knowledge on electric power use (term 2)

Điểm X_i (Y_i)	TN (X)			ĐC (Y)		
	n_i		$)^2$	n_i		$)^2$
1	0	0,000	0,00	0	0,000	0,00
2	0	0,000	0,00	0	0,000	0,00
3	0	0,000	0,00	3	0,025	21,87
4	0	0,000	0,00	4	0,100	11,56
5	1	0,025	7,84	12	0,300	5,88
6	5	0,125	16,2	12	0,350	1,08
7	9	0,225	5,76	7	0,175	11,83
8	12	0,300	0,48	2	0,050	10,58
9	11	0,275	15,84	0	0,000	0,00
10	2	0,050	9,68	0	0,000	0,00
	40	1	55,8	40	1	62,8



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Frequency distribution table and frequency chart of test results on the knowledge on electric power production (term 2)

Comment: The numbers of average marks, good marks, excellent marks of the students in experiment class is higher than those of reference class; All the lines representing frequency distribution in the test of experiment class are on right side and move according to the rise in marks in comparison to the reference class, which means the quality of experiment class students is higher than that of reference class students.

Above results show that studying results of experiment class students (where teacher implement the process of teaching by project method) are higher than those of reference class (where teacher teaches by traditional method). Therefore, we can confirm that: Teaching by project method can be applied in Physics teaching to form a system of knowledge, capacities in production and use of electric power, as well as to contribute to general technical education for high school students.

Conclusion of Chapter 3

From the results of pedagogical experiment, we can confirm that: Teaching in "production and use of electric power" in higher secondary Physics program according to project method can help to develop the capacities of knowledge utilizing, problem solving and contribute to general technical education. Above teaching activities can be performed in all existing high schools of our country.

CONCLUSION AND RECOMMENDATION

1. Conclusion

During implementation of the topic: *Applying method of project-based teaching in teaching knowledge of electric power production and use for high school students*, the research has achieved following results:

- Supplement and develop theoretical bases of project method of teaching as the basis for teaching by project method in production and use of electric power, in particular, as well as in teaching of Physics, in general, including the concept, characteristics, classification of teaching by project method, process of teaching by project method in production and use of electric power.

- Systematize theoretical bases on general technical education and the role of teaching by project method in general technical education in Physics, then establish the basis for integrating general technical education in teaching process by project method in production and use of electric power.

- Propose some measures to develop capacities and general technical education for students in project method of teaching: Group of measures in developing the capacity of utilizing knowledge in actual situations, group of measures in developing the capacity of solving problem and group of measures in general technical education.

- Propose processes of teaching by project method, evaluation plan, evaluation toolkit in teaching by project method in production and use of electric power; Propose 2 processes of teaching by project method: Process of teaching by project method in electric power production and process of teaching by project method in electric power use, which are suitable for high school students (11^{th}, 12^{th} grade students). These proposals are practical and can be applied in general Physics teaching.

These are new contributions of the dissertation.

Theoretical research results have been tested in pedagogical experiment. Experimental results have confirmed the scientific hypothesis: teaching by project method in “production and use of electric power” according to Physics curriculum at the higher secondary can develop the capacities of knowledge utilizing, problem solving and contribute to general technical education for students.

Research results of this work contribute to build theoretical bases and orient project method of teaching in Physics at high schools. It is totally suitable for current education of our country, focused on students, focused on developing capacities, close to practice, able to improve academic characteristics of teaching contents.

Topic research results include: synthesizing theoretical problems and proposing specific teaching processes, satisfying the requirements on theory and practice, contributing to innovate teaching method then improving actual state, promoting educational quality at high schools. They can be referred and applied in other contents of Physics curriculum at the higher secondary and other subjects.

2. Recommendation

For better results of application of teaching by project method at high schools in Vietnam, we would like to recommend that:

- While building frame programs for the subjects, Ministry of Education and Training should increase the duration of optional programs to create good conditions for teachers to apply positive teaching methods such as: action-oriented teaching, teaching by project method...

- School leaders may organize training meetings, thematic reports on project method of teaching at their schools, training the teachers on theory and practice of teaching by project method so that they can apply in their subjects, contributing to improve teaching quality at high schools.

- Schools should create good conditions in time, facilities, necessary funds or cooperate with manufacturing bases to implement studying projects.

- Encourage teachers to study and apply project method in teaching, deploy and draw experiences; encourage students to study by project method, contributing to improve teaching and studying quality, innovate teaching method in current period.

LIST OF AUTHOR'S PUBLISHED WORKS RELATING TO THE TOPIC OF THIS DISSERTATION

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2. Le Khoa (2012), "Organization of teaching by project method in production and use of electric power in Physics at high schools", *Education magazine*, (issue 290), term 2 7/2012, page 52 – 54.
3. Le Khoa (2012), "Evaluation in teaching by project method", *Education magazine*, (special issue), 11/2012, page 71 – 72 and 87.
4. Le Khoa (2013), "Integration of knowledge on electric power use in Physics at high schools", *Educational equipment magazine*, (edition 90), Feb 2013, page 29 – 32.
5. Le Khoa (2013), "Designing process of teaching by project method in "electric power production" in higher secondary education", *Education magazine*, (issue 307), term 1 April 2013, page 56 – 58.
6. Le Khoa (2013), "Designing process of teaching by project method in "electric power use" (Physics program for 11th grade)", *Magazine of education and society*, issue 32(93), November 2013, page 30 – 32.
7. Le Khoa (2014), "Experiment of teaching by project method at some high schools in Vinh Phuc province", *Education magazine*, (issue 327), term 1 February 2014, page 54 – 56.