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PROJECT – BASED LEARNING MODULES OF THE AUTOMOTIVE TECHNOLOGY OCCUPATION

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ABSTRACT OF PH.D. EDUCATION SCIENCE DISSERTATION

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LIST OF WORKS RELATING TO PUBLISHED THESIS

[1] Dinh Huu Sy (2013), "Some issues of project-based learning in vocational schools", Journal of Education, Special Issue, April 2013, pages 78-80.

[2] Dinh Huu Sy (2013), "Teaching vocational modules as Automotive Technology Learning Projects", Journal of Educational Sciences, No. 95, August 2013, pp. 36-38.

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OPENING

1. Reasons for theme selection

Weak teaching methods are a problem in Vietnam's educational and vocational training system. The modernisation of the teaching methods in vocational training is a major concern of the Party and of the state, as well as the involved teachers and trainers.

Project - Based Learning (PBL) is an active teaching method that is widely applied in many countries in the world. In Project - Based Learning, the students work in groups together to carry out a learning task by integration of theory and practice with the help of the teacher. Futher more they learn to self-evaluate their results according to the standards and criteria of occupational fields.

Currently in Vietnam, PBL has been introduced and applied in a number of areas such as higher education, secondary education, and a number of overseas projects implemented in Vietnam. But in the field of teaching, no job-related research about PBL has been done and PBL has not been applied in vocational settings, and therefore guided theoretical studies of PBL in vocational schools are needed.

For the reasons stated above, the author selected the research topic *"Project-Based Learning Modules of the Automotive Technology Occupation"* to contribute to develop a theoretical basis for the initial application of PBL in the training.

2. Research purposes

The proposal is analyse the application of the principles, methods and organizational processes of PBL vocational modules in Automotive Technology (AT) at the college level to enhance the initiative and creativity of students in learning, thereby contributing to an improvement in the quality of teaching.

3. Objects, subjects and scope of research

3.1. Objects of Research: Project - Based Learning modules pertaining to the AT occupation.

3.2. Subjects of Research: Teaching Automotive Technology at the college level in vocational schools.

3.3. Scope of Research: The dissertation research proposal focuses on the use of only 10 PBL modules required by an AT program at the college level. Each module requires the selection of a particular learning project (for a total of 10 different projects). The two

experimental learning projects selected in the thesis cover the content "high pressure PE pump repair" and "repairing a friction clutch" in the module "Maintenance and repair of systems using diesel fuel" and "Maintenance and repair of transmission systems" in Vocational College No. 8 during the 2012-2013 school year.

4. Hypothesis

Currently, the professional colleges which offer training in the occupation AT use traditional methods of training and do not equip students with the adequate competencies wich they need as AT occupations. If the principles, methods, and organizational processes of PBL are applied in teaching vocational modules, a positive impact can be expected in the training of the AT occupation and the initiative and creativity of students in the learning process will be enhanced strongly. This will increase the quality of the performance of the students in this occupation.

5. Research Tasks

(1) Building a theoretical and practical basis for PBL modules for the AT occupation.

(2) Proposing principles, methods and organizational procedures for PBL modules of the AT occupation.

(3) Specifying criteria for the selection of content, and proposing a list of learning projects to be used in PBL compulsory modules (hardware) in AT occupation at the college level.

(4) Constructing 10 lesson plans to be used in compulsory modules for PBL in the AT occupation.

(5) Carrying out an experiment with a pedagogical project involving two lessons to demonstrate the feasibility of using PBL for the AT occupation and proving the soundness of the scientific hypotheses mentioned above.

6. Research Methods

6.1. Approach Methods

Approach methods include the system approach, the power output approach and the operations approach.

6.2. The specific methods

The method is based on theoretical studies, empirical research, experimental pedagogy and mathematical statistics.

6.2.1. Methods of theoretical studies

Information gathering, sorting, analysis, synthesis, chemical systems, model building, analysis and synthesis documents related to the research were used to build a theoretical basis for the thesis.

6.2.2. The practical research methods

- *Survey:* The author surveyed 48 vocational teachers and over 200 students and alumni of AT occupation in 8 vocational colleges, 30 Automotive repair businesses, managers of 40 high quality vocational schools, 2 teachers directly experimental project-based teach and 36 students participating in the Department of Mechanical Engineering at the Vocational College No 8 about the real of teach modules Automotive Technology occupation at the college schools. Also examined were teacher perceptions, student method PBL, business needs in terms of professional training, as well as evaluation of the experimental results.

- *Product Research Methodology*: To assess the quality of learning, to increase accountability, and to improve learning behaviors of students.

- *Professional method:* To obtain an opinion on the necessity and feasibility of professional training in PBL automotive technology.

- *Observation:* to monitor the morale, attitude, behavior and academic performance of students during the PBL process.

6.2.3. Experimental pedagogy

Two lessons, pertaining to experimental high-pressure PE pump repair and to the repair of friction clutches, were carried out according to the principles of PBL. This was done to assess the reasonableness and feasibility of teaching methods and organizational procedures using PBL. Automotive technology training modules will be proposed based on the evidence of the scientific hypotheses.

6.2.4. Methods of mathematical statistics

The experimental results were processed and evaluated by means of mathematical statistics.

7. New contributions of the thesis

- ***In terms of theory***

- This thesis formalized the rationale for using PBL in teaching and modular implementation capacity.

- The findings are consistent between the teaching profession and AT PBL modular implementation capacity.

- The thesis proposed the principles, processes and techniques to craft

modules for AT PBL at the college level.

- It proposed criteria for content selection and implementation methods for modular vocational AT PBL at the college level.

- ***In terms of practice***

- The thesis evaluated the status of teaching professional AT modules at the college level in vocational schools.

- It proposed a list of projects for academic professionals for use in compulsory modules of AT occupation at the vocational college level.

- It compiled 10 PBL lesson plans for compulsory modules of the college level AT program.

- It organized two projects in experimental pedagogy to assess the feasibility and effectiveness of PBL AT vocational modules.

8. Defending theoretical points

- Teach AT to apprentices with methods which are in line with the PBL approach: The implementation of PBL will closely integrate teaching of theory and practical lessons to reach the capacity and to have a specific output. Therefore, applying AT PBL in the training by the teacher is appropriate and will promote the autonomy and creativity of students in the learning process, thereby improving the quality of teaching.

- Teaching professionals should teach AT cluster repair of auto parts. Each cluster and each department has its own repair process. Therefore the application of vocational PBL AT is important to build a PBL process consistent with the process of repairing auto parts for the new teaching to achieve the desired results.

- Note that the content of the AT job can also involve PBL. Therefore to the organization of vocational PBL AT should be effectively, based on criteria which should be developed to determine the appropriate content for PBL.

9. Structure of the theme

Apart from the preface, conclusion and recommendations, the theme comprises three chapters, namely:

Chapter 1: *Theoretical basis of Project – Based learning modules in Automotive Technology*.

Chapter 2: *Real situation involving the use of teaching modules in college level occupation in Automotive Technology*.

Chapter 3: *PBL modules in college level Automotive Technology*.

CHAPTER 1
THEORETICAL BASIS OF PROJECT - BASED LEARNING MODULES IN AUTOMOTIVE TECHNOLOGY

1.1. Overview of research issues

1.1.1. Abroad

There are many research works on projects overseas and Project-Based Learning (PBL), such as Kilpatrick's work: *The project method* (1918), *School method from the project point of View* (1927), the *Project work in education* of James Leroy Stockton (1920), the *Project method of teaching* of Stevenson (1921); the *Experience and education* of John Dewey (1938); and *A review of research on Project-Based Learning* by John Thomas (2000). These works constructed the theoretical basis for the project method and mentioned concepts, principles, processes and methods involved with PBL. In addition, many other studies of Alberty (1927); Bleeke (1968); Knoll (1989); Knoll (1997); Stevenson (1921); Inwent (2003), William N. Bender (2012); John Larmer and John Mergendoller (2013)... also mentioned the various aspects of PBL. However, these studies mainly in the field of primary school, secondary school and high school. PBL has not been studied and applied to the vocational school.

1.1.2. In Vietnam

Projects in teaching methods involving researchers taking a reasoned approach to the education system in Vietnam are examined in many works, such as *Project-Based Learning and Use in Teacher Training Technology for Home Economics* by Nguyen Thi Dieu Thao (2007); the thesis *Organization Project-Based Learning in subject Methods of teaching Mathematics contribution to improve Math-Teaching Ability for the Math teacher students* of Tran Viet Cuong; the thesis *Organization Project-Based Learning in University Probability and Statistics Courses* by Tran Thi Hoang Yen (2012); the thesis *PBL Methods in Teaching Nonmetal Chemistry to High School Students* by Pham Hong Bac (2013); *The Application of PBL in Teaching Engineering Applications of Physics* by Do Huong Tra and Pham Van Ngoc (2009); *Using PBL Diagrams to Organize Knowledge of Subject Content* by Tran Van Thanh (2009); *Organizing PBL Problem-Solving Situations for Physics Students* by Cao Thi Song Huong (along with her experimental results, 2010); Article *Using Project-Based Learning in Organizational career orientation active* by Nguyen

Thi Thanh Huyen (2007); and the specialized reference book *Theory of teaching method* by Dang Thanh Hung, Trinh Hong Ha, Nguyen Khai Hoan, and Tran Vu Khanh (2012) etc… All these authors have clarified the concept of project, PBL and propose the characteristics, classification, nature of project-based learning and provided some examples of design PBL.

Hanoi National University of Education, Hochiminh University of Pedagogy, Thainguyen University, Dongthap University, Fisheries College, and Hanam College of Education put the project method of teaching into many subjects such as history, mathematics, physics, career orientation education, English and others.

In summary, a good deal of research has been done in Vietnam on the applications of project-based learning to general education and university education as well as to a number of foreign projects in Vietnam. However, no research has been carried out so far regarding PBL in vocational training.

1.2. Project – Based Learning

1.2.1. A number of concepts

1.2.1.1. Project

A project is a plan to carry out a task, a plan essentially characterized by having particular conditions laid out for its completion; for example, a specific goal, a time limit, a particular allotment of manpower, and other conditions, as opposed to other organized special activities.

1.2.1.2. Project Learning

A learning project is a project designed and implemented by students with the support of teachers to perform a task or job in order to achieve a set of goals.

1.2.1.3. Project – Based Learning

Project-based learning is a teaching method that integrates theory and practice to complete the task of mastering a skill. This task is performed with a high level of self-reliance during the entire learning process, from identifying goals and planning to project execution and also testing, adjustment, evaluation and implementation of the results of the project. Students are also expected to present the results of their project.

1.2.2. Scientific basis of project-based learning

1.2.2.1. Philosophical basis

The cognitive theory of dialectical materialism is

considered to be the primary and most directly perceived basis of project-based learning. The awareness of experience and perceptions and their dialectical relationship with each other form the cognitive basis of reasoning.

1.2.2.2. Psychological basis

Knowledge as a process and product is individually constructed through interactions between learners and matters to be learned. Studying in groups is important, as it is through social interaction in the self-help groups that one may regulate one's own learning.

1.2.2.3. Theoretical teaching basis

PBL must be:

- Consistent with the learners; - Promote the self-reliance of the school; - Encourage motivation to learn; - Promote collaboration in learning; - Incorporate practice, and combine theory with practice; - Cross over different disciplines.

1.2.3. Classification of learning projects

(1) Classification by time; (2) Classification by task; (3) Classification by the level of complexity of the content to be learned; (4) Classification by the manner in which the learning project is taught.

1.2.4. Characteristics of Project - Based Learning

(1) Practical orientation; (2) Orientation actions; (3) Orientation products; (4) Orientation for students interested; (5) A very high level of self-reliance in students; (6) Collaborative teamwork; (7) High integration.

1.2.5. The role of teachers and students in project-based teaching

- The role of teachers in PBL

In PBL the teacher provides guidance, orientation, counseling, support and is sometimes learning together with the students. The teacher's task is to provide learning opportunities. A teacher must create an environment that promotes interaction among students and encourages students to interact with their teacher and with their materials, technical equipment, supplies, and models to achieve the learning objectives in the shortest time possible such that all requirements are fulfilled and all technical standards are maintained.

- The role of students in PBL

In PBL, students participate in choosing the subjects they will study and work to attain self-determined learning objectives consistent

with their individual abilities and interests, thereby encouraging a positive attitude, self-reliance, accountability, and creativity among students. Students create learning projects to meet a set of prescribed requirements.

1.2.6. Principles of Project - Based Learning

(1) The interdependence of processes and learning outcomes; (2) The responsibilities of work and individual learning; (3) Direct interaction opportunities to expand operations; (4) Thorough teaching and a reliance on social skills, both a mainstay of PBL; (5) Handling team collaboration; (6) In the problem of learning content, the main issue is the social content; (7) The participation of all students in all aspects; (8) Exploration, discovery and work to achieve academic goals through working towards a final product, not the learning content available; (9) The self-reliance and continuous positive attitude of students.

1.2.7. Sequence of project - based teaching and learning

The PBL *sequence* has 4 stages: (1) Identify the topic and project objectives; (2) plan the project; (3) implement the project; (4) project evaluation.

1.2.8. Evaluation of Project - Based Learning

In PBL the evaluation phase of the project involves first evaluating the particular formulation of the project, followed by an evaluation of the plan to implement the project. The project implementation study is assessed, and a summative assessment of learning projects is performed. A summative assessment includes project reviews, performance evaluations and assessment of the time necessary to implement a project.

1.2.9. Advantages and disadvantages of Project - Based Learning

1.2.9.1. Advantages of PBL

- For teachers: PBL enhances professionalism and provides opportunities for collaboration with colleagues in the teaching process, as well as creating more learning opportunities for students.

- For students: PBL encourages a positive and proactive attitude, as well as creativity in learning. It allows the consolidation of knowledge and the formation of solid professional skills.

- For teaching: PBL helps to implement principles and promotes active learning. It links schools more closely to society and encourages professional and productive teaching methods.

1.2.9.2. Disadvantages of PBL

- On the program content: It can be difficult to integrate theory and practice in curriculum content. Teachers need to select appropriate content for PBL to be effective.

- For teachers: Teachers need more time to prepare for issues related to PBL. Teachers must be very skilled to use PBL effectively.

- For students: The school needs to provide more time to study and learn, as well as to complete the required learning project. A proactive attitude is necessary.

1.3. Project - Based Learning modules relating to the AT profession

***1.3.1. A number of concepts*:**

1.3.1.1. Capacity and implementation capacity

a) *Capacity as the set of individual psychological characteristics necessary to meet the demands of certain operations and the conditions necessary to perform the resulting operations*.

b) *Capacity to implement the knowledge, skills and attitudes necessary for employees to be able to perform their job up to professional standards as stipulated in the conditions given.*

1.3.1.2. Module, module implementation capacity

Modules are units of learning that integrated professional knowledge, practical skills and a professional attitude to prepare qualified apprentices adequatly to enter their new occupation.

Thus, the module has to be understood as the intrinsic capacity to implement modular integration between theory and practice.

1.3.2. The compatibility between PBL with teaching modules: Automotive Technology implementation capacity

1.3.2.1. The philosophy of teaching vocational subjects by implementation capacity

(1) Vocational training must be linked to employment; (2) Vocational training for mastering the craft work, to have the opportunity to find work; (3) Preparing a measure of professional expertise in order to enter professional work is the purpose to be achieved; (4) To work proficiently requires certain conditions.

1.3.2.2. Some vocational orientation to teaching modular implementation capacity

(1) Orientation to the output; (2) practical orientation; (3) The

course of action; (4) Orientation products.

1.3.2.3. Comparison of PBL and teaching the AT modular implementation capacity

No	Project – based learning	Teaching the AT modular implementation capacity
1	- Practical orientation	- Perform each given task on request
2	- Orientation actions	- Apprenticeship is learning to do a profession, to work competently
3	- Orientation products	- Teaching profession is teaching made products.
4	- Orientation on the interests of students	- Learn how to create a product because there is a clear result after school to create excitement and enhance positive, proactive learners
5	- Self-reliance very high by students	- Each person must learn self-discipline, and self-reliance, so that after finishing the training the students will have sufficient capacity to carry out all the work of a job at the request of producers.
6	- Collaborative teamwork	- Organization of teaching practice, teaching to a group because there may not be enough equipment for each student to have a computer, on the other hand, AT apprentices often have to do hard work, too much for one person.
7	- High integration	- Teaching apprenticeship under implementation capacity to integrate teaching theory and practice

1.3.3. Some principles to apply PBL modules in Automotive Technology

(1) Ensure consistency between AT with PBL contents; (2) Ensure practices; (3) Ensure feasibility; (4) Ensure effectiveness.

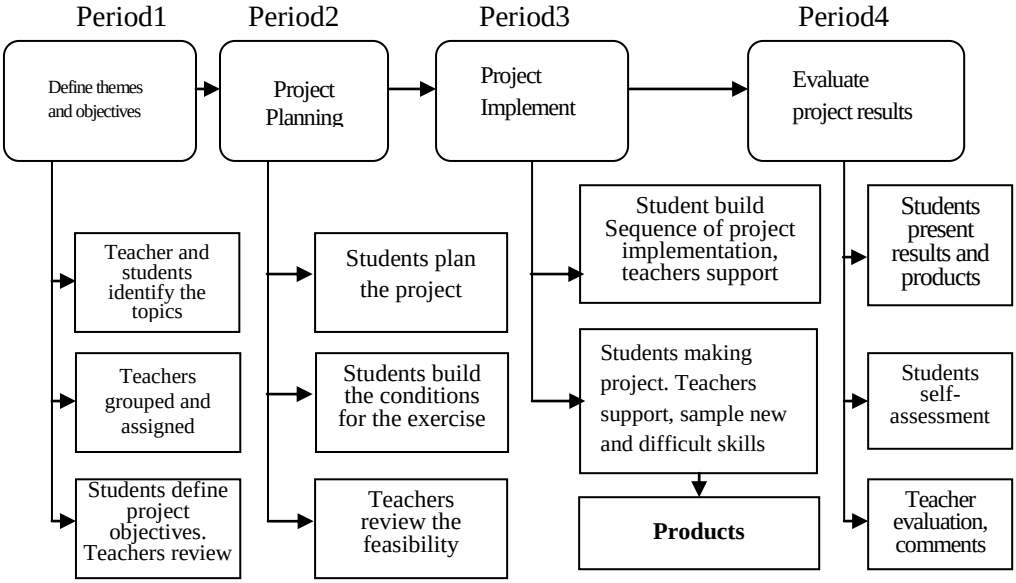
1.3.4. Conditions for the use of PBL modules in teaching Automotive Technology

(1) The teacher is qualified to teach both theory and work with a practical medium; (2) Students should have an initial understanding of project-based learning methods; (3) The training program should be structured modularly with an implementation capacity between theory and practice; (4) The learning project takes a moderate amount

of time (1-2 weeks is reasonable). (5) All necessary facilities, vehicles and tools should be available.

1.3.5. Sequence of PBL modules for teaching Automotive Technology

Based on 4 stages of the sequence in part 1.2.7, the author proposed a general process for PBL Automotive Technology career training, including four period and 11 steps.



1.3.6. Design lesson plans for PBL modules in Automotive Technology:

1.3.6.1. The role of design lesson plans

The designing of lesson plans has a specific functional orientation for the teaching process; teachers help the students to understand what they are expecting to do and how students should learn the things they need to learn. Teachers must do what is necessary to assist students in the successful implementation of their work without distraction or discouragement.

1.3.6.2. Principles of design lesson plans

(1) The teaching and learning operations must reflect the mentioned sequence of the learning process, as well as the design of a project; (2) The teaching and learning operations must be consistent with the formation of the output power of the module; (3) The teacher

has to design the learning project including the activities for the students; (4) The teacher has to plan lessons well and carefully prepare teaching materials, such as teaching tools and learning models; (5) The teaching activities must ensure the implementation of the lesson content in the allotted time.

1.3.6.3. Pattern's technical design lesson plans

Framework for the design of learning operations

Operations / Contents	The operations exploration, discovery	The operations change, processing, development	The operations application, consolidate	The operations assessment, adjusted
Content 1	Operation 1 Operation 2	Operation3 Operation4	Operation5 Operation6	Operation7 Operation8
Content 2	Operation 9	Operation10	Operation11	Operation12
Content 3	...	...	...	...

(Nucleus of the design is the lesson involving learning operations)

1.3.6.4. Evaluation criteria for designed lesson plans (10 criteria)

(1) Transfer of learning content to the learner's operations; (2) The opportunity to experience different kinds of learning operations; (3) The purpose of the operations; (4) The interaction between teaching and learning operations; (5) The optimal teaching facilities; (6) A description of the specific expected learning outcomes; (7) The methodology or philosophy of teaching is evident; (8) a reasonable time; (9) designed mobility; (10) The effectiveness.

1.3.7. Methods and techniques for teaching Automotive Technology with PBL modules:

To use PBL vocational modules in teaching AT, one can apply many of the methods and techniques of teaching, which primarily include the following:

(1) Teaching groups of students using grouping techniques, group discussion; presentations, slideshows ...; (2) Identify and solve problems: Including the above-mentioned technical problems, ask questions, stimulate the intellect, problem identification, problem solving ...; (3) Teaching practice: including modeling

techniques, market scope, modeling, programing ...

1.3.8. The role of teachers and students in Automotive Technology PBL modules:

In PBL modules used to teach AT the role of the teacher and the students is as mentioned in section 1.2.5. However, due to particular characteristics of the project, at each stage of the repairing and maintening of specific apparatuses, teachers and students have different roles.

Conclusion of Chapter 1

- PBL has been developed since the sixteenth century. Currently, PBL is of interest to many researchers in educational methodology and has been developed into a distinct teaching method that is now widely used at many different levels of education. In our country, PBL has interested a number of researchers working over a number of disciplines and educators from the elementary to the university level. However, specific research has been lacking with regard to the use of PBL as a pedagogical technique in general vocational training, particularly in training students of Automotive Technology.

-The thesis for a codified rationale of project-based learning is based on philosophical, psychological concepts and theories and also theories of teaching. In particular, seven unique characteristics of PBL were analyzed; namely its orientation to practice, orientation on the interests of the learner, orientation on the action, encouragement of students self-reliance, encouragement of collaborative work, high integration, and orientation on results. The principles and processes of teaching and assessment involved in project-based learning were also mentioned.

- Relevant concepts and connotations were clarified, such as capacity, implementation capacity, training modules, and modular implementation capacity. It was indicated that learning modules used in professional occupation must be designed to be compact. Also, modules must be started with a view to their implementation capacity (also known as modular skills practice), and the mismatch between project-based learning and teaching a profession according to modular implementation capacity must be addressed. To apply PBL for teaching modules of the occupation Automotive Technology, PBL must be carried out in four stages: definition of the themes and objectives of the project, planning the implementation of the project, implementation of the project and finally, evaluation of the project. Each stage consists of a number of different steps. The thesis also specified the

procedures to be applied to type 2 projects for teaching specific modules pertaining to vocational Automotive Technology, which involve teaching and repair process modules carried out on protected motorways used for teaching.

- However, the use of PBL in the modular teaching of professional automotive technology must meet certain conditions. The thesis gave 4- and 5-rule conditions to be performed in PBL modules used to teach Automotive Technology.

- To implement PBL in the occupation of professional modular Automotive Technology, it is necessary to apply more integrated specific teaching techniques. The dissertation offers many teaching techniques, such as group learning, problem-solving teaching, and practice in teaching professionals. Based on the specific conditions of the lessons one can use one or more types of organized teaching.

Chapter 2

REAL SITUATIONS INVOLVING THE USE OF TEACHING MODULES IN COLLEGE-LEVEL OCCUPATION IN AUTOMOTIVE TECHNOLOGY

2.1. Characteristics of the occupation Automotive Technology

The occupation Automotive Technology involves vocational technical training in maintenance and repair of machines and clusters of automotive systems with the following characteristics:

(1) Automotive transport equipment is highly complex, related to various fields such as mechanical systems, electronics, micro-electronics, automation, pneumatics, hydraulics, ... Therefore, while repairing automobile breakdowns, it is necessary to apply interdisciplinary knowledge to be able to carry out even more complex repairs. (2) An automotive cluster consists multiple parts. For maintenance and repair of each cluster, each automobile part which is involved should be dealt according to a specific procedure. (3) For each cluster repair in an automobile, learners need to apply integrated knowledge, skills and attitudes in a clever and creative way. Thus, teaching automotive technology skills involves integration between theory and practice. (4) Automotive repair professionals must work with heavy and complex pieces of machinery, often weighing hundreds of kilograms. Therefore, it is necessary to work in teams, in which each individual is assigned a specific task, and these tasks must be coordinated and completed in such a way that there is no interference between different people's tasks. (5) The results must be

specific: the cluster, the entire system and automotive repair have to meet technical standards. (6) Vocational Automotive Technology uses techniques associated with modern technology. Therefore teachers of Automotive Technology must update the content of their occupation to take into account all recent improvements in advanced technology.

With the above characteristics, project-based modular implementation capacity is very useful for vocational teaching of Automotive Technology.

2.2. Training programs in Automotive Technology at the college level

At the present time, vocational schools are implementing framework programs for college degrees in Automotive Technology granted by the Ministry of Labour, Invalids and Social Affairs. The program contains 14 modules for mandatory occupational career competencies, including 11 modules compiled to effect the integration between theory and practice. However, this module is designed to be completed over a long time: 150-190 hours. With some modules lasting as long as 335 hours, and consisting only of theory or only of practice, a situation unfavorable to PBL is created.

2.3. Current status of the use of teaching modules for the occupation Automotive Technology at the college level

The survey showed that:

(1) The quality of education: An assessment of the business expertise of relatively good students showed their professional skills to be limited. Attitude: The spirit of responsibility and initiative in work, the spirit of teamwork, and innovative capacity is not high; (2) On the capacity of teachers: Multifaceted skills are limited, such as skills in training, testing and evaluation. Most were professionally trained in pedagogy. Foreign language and computer skills of vocational teachers are generally low. (3) Regarding the use of teaching methods: Mostly teachers still use traditional methods: theoretical lectures and practical training workshops in schools are essential, but the positive teaching methods are rarely used. Training in enterprises is still limited. PBL is not well known to teachers. (4) Awareness by vocational teachers about the need for innovative teaching methods and understanding PBL: Most of the surveyed vocational teachers were aware of innovative teaching methods, especially those teaching chemistry classes. Most vocational teachers are unfamiliar with PBL; only about 20% are aware of and understand PBL but it has rarely if ever been applied. (5) On physical vocational training equipment: The equipment is in general

lacking in variety, quantity and is technologically not up-to-date compared to other countries in this region and the world. On the demand side, the majority of enterprises wish to use specialized craftsmen (with a narrowed training focus), but some small businesses in the private sector require repair mechanics with a broad training.

Conclusion of Chapter 2

This thesis draws some conclusions on the status of teaching Automotive Technology at the college level:

(1) In terms of content and training programs, the current program frameworks are structured in modules that require excessive amounts of time and consist of multiple modules dealing either with purely theoretical subjects or purely practice, and are therefore not favorable for use of PBL. Integration of PBL requires a modular structure of occupation coupled with an appropriate selection of topics. (2) With regard to methods of teaching, a number of different approaches have been adopted by teachers in vocational schools. However, most use the lecture method to teach the theory sections of a lesson, with practice confined to weekly sessions in a machine shop. Teaching at manufacturing facilities has now been implemented, but not extensively. Most vocational teachers recognize the importance of innovative teaching methods and a number of vocational teachers have become aware of PBL, but no teacher training in PBL methods has yet been carried out for vocational school faculties. (3) Vocational teachers must meet basic qualifying requirements, but they are not required to have mastered training techniques or innovative testing and assessment methods. Therefore, the pedagogical training of vocational school faculty should include positive teaching methods, including PBL. On the language level, the application of information technology in vocational teacher training in general is weak. (4) In the past few years many schools have been funded by various sources; however, the quantity and quality of equipment and teaching aids leaves something to be desired as they often do not work reliably or are not suitable to every class's need. Investment in new lines of technology and adoption of modern techniques associated with current practice of other businesses remain at a limited level. (5) The quality of education is generally weak, yet it meets the needs of employers' businesses. (6) To meet their demand for labor, the majority of businesses wished to see vocational programs focus on more in-depth occupation on a smaller scale. However, some private facilities need employees with extensive training, such as general mechanics.

CHAPTER 3
PROJECT - BASED LEARNING MODULES IN COLLEGE LEVEL AUTOMOTIVE TECHNOLOGY

3.1. Content selection and organization in planning Project-Based Learning modules in Automotive Technology

3.1.1. Develop selection criteria for PBL content modules of the occupation Automotive Technology

The author has proposed four criteria to select content modules in Automotive Technology, which can be organized by vocational colleges to be compatible with PBL: (1) They have to integrate contents where theory and practice is matched; (2) Content must be attached to reality; (3) Content must be results-oriented; (4) The time needed to complete the content of a module should about 1-2 weeks (under 40 hours). On this basis the author selected 48 lessons that can be organized in modules to teach Automotive Technology at the vocational college level, according to PBL.

3.1.2. Development of an implementation plan for PBL

The author has developed implementation plans for PBL modules in Automotive Technology career training. The plans clearly define the detailed content of each task, the time required for each activity, the location where it will be carried out, the conditions to be met, and the aims to be achieved. It is important that preparatory steps to organize the implementation of a PBL module are completed in the stipulated time. The thesis gives examples of detailed implementation plans for a PBL lesson in repair of a friction clutch.

3.2. Design Sequence of PBL modules in Automotive Technology

3.2.1. Sequence of PBL lessons / projects in automobile repair

The thesis proposed procedures for PBL lessons involving cluster repair and auto parts including four phases: (1) Identify themes and objectives; (2) Plan the project; (3) Implement the project; (4) Evaluate the results.

With regard to the phase of implementation: the cluster repair process includes 13 steps: (1) Preparation of equipment, materials and tools; (2) Development of a process to remove the cluster; (3) Removal of the cluster from the model; (4) Removal of parts; (5) Cleaning and checking out the parts; (6) Diagnosing the problem; (7) Preparing a repair plan; (8) Deciding on details of the repair; (9) Set up a process to reassemble the cluster; (10) Installation of the parts; (11) Adjustment; (12) Return the cluster model; (13) Operation and checking.

Above is show the general procedure for the lesson / repair project on the cluster. However, each cluster is structurally different and can suffer damage in different ways. Thus, the process of removal, assembly, and repair will be different. This difference is expressed specifically in each PBL lesson plan for each individual cluster.

3.2.2. Sequence of PBL lessons / projects in automotive maintenance

The process of planning lessons and projects relating to automotive maintenance includes four phases as in the case of lessons in repair procedures, but with a difference in phase 3. Implementation can be more complicated because automakers issue strict regulations for the repair procedure of each type of car and so clusters and parts will vary between makes and models of automobile. Thus, in this case phase 3 consists of two steps: (1) Students should read the documents issued by the car manufacturer pertaining to maintenance and repair procedures. Then, they should prepare to implement the steps according to those procedures, and remove the cluster. (2) Students should perform maintenance in accordance with the regulations.

The result of these maintenance projects is that cluster / auto parts are properly maintained according to prescribed techniques.

3.3. Design of some lesson plans for PBL modules in Automotive Technology at the college level

The thesis presents a design for lesson plans using ten PBL modules in Automotive Technology: Clutch repair, repair of high pressure pumps, piston repair, group valve repair, cooling system repair, carburetor repair, boot repair systems, suspension repair, structural repair and the repair of a power steering system's hydraulic brake actuator.

3.4. The methods and techniques used to process the sequence of PBL modules in Automotive Technology training

On the basis of the above mentioned PBL principles, the author chosed methods and techniques of teaching Automotive Technology in modules, as expressed in the following table:

Organizational sequence for the learning project	Methods and techniques in teaching
Period 1. Define themes and objectives of project	
1.1. Identify topics	- Raise the issue and solve problems
1.2. Divide the group and the task	- Grouping technique
1.3. Define the project goals	- Organization group action
Period 2. Planning for project implementation	
2.1. Determination of the content and progress of project implementation	- Technical thinking
2.2. Selection of project implementation conditions	- Teaching a team - Using the computers, Internet
2.3. Consider the feasibility of the project	- Technical questions, suggestions
Period 3. Project Implementation	
3.1. Students organize the project implementation	- Teaching a team - Working as a team - Observations
3.2. Teachers support and sample new and difficult skills	- Observations - Teaching practice - Do sample
Period 4. Evaluate project results	
4.1. Students presentation of results, products	- Technical design, Slide - Technical demonstration
4.2. Students self-assessment	- Self-assessment Technical
4.3. Teacher evaluation, comments	- Technical evaluation

3.5. Experimental teaching - learning project

3.5.1. Practical purposes: One main function of experiments is to prove the correctness of theories. This thesis proposes means to experimentally verify the feasibility and effectiveness of the applying the principles, methods and organizational processes of PBL in the teaching of vocational modules of Automotive Technology.

3.5.2. Experimental content: Project experiment 1: Fix friction clutch and project experiment 2: High pressure PE pump repair.

3.5.3. Experimental Subjects: Experimental teaching is conducted on two groups: The experimental (treatment) groups and a control group. Each class involved in the experiments contains 18 students.

3.5.4. Experimental Organization: The experiment was conducted during Semester 2, 2012-2013 school year. The experimental and control groups were surveyed both in the engine department of the Faculty of Mechanical Engineering, Vocational College No. 8. The author has provided training for teachers and students to participate in experiments regarding the concept, characteristics, content and methodology of PBL, according to a common experimental plan.

3.5.5. Tools and methods for evaluating experimental results

- *Measurement tools:* These tools remove, install, measure and control; a rubric is present for each student group stage by stage, step by step. After the procedure, teachers fill out an evaluation form.

- *The parameters for evaluation and assessment scores:*

For quantitative assessment of the learning process project, it is necessary to measure and evaluate non-material results. Such results are the processes used by the students. There are also material results; i.e., the use of materials in the final product. The experimental project was evaluated according to the following rating scale:

(A) Products: 10 points;

(B) Sequence: 10 points, including:

- Act in a reasonable sequence: 5 points;
- Perform the correct sequence: 5 points;

(C) Time used: 10 points, including:

- Timely implementation of total execution (5 points),
- Timely implementation of each phase (5 points).

$$\textbf{Average point} = \frac{A + B + C}{3}$$

3.5.6. The experimental results

a) Quantitative Results

Table 3.2. Learning outcomes of the experimental group

No	Evaluation criteria	Satisfactory				Unsatisfactory (<5 points)
		Excellent (9-10 points)	Good (8- reach 9 points)	Fair (7- reach 8 points)	Average (5- reach 7 points)	
1	Products	2(11.11%)	4(22.22%)	5(27.78%)	6(33.33%)	1(5.56%)
2	Sequence	4(22.22%)	7(38.89%)	6(33.33%)	-	1(5.56%)
3	Time	3(16.67%)	6(33.33%)	5(27.77%)	3(16.67%)	1(5.56%)

Table 3.3. Learning outcomes of the control group

No	Evaluation criteria	Satisfactory				Unsatisfactory (<5 points)
		Excellent (9-10 points)	Good (8- reach 9 points)	Fair (7- reach 8 points)	Average (5- reach 7 points)	
1	Products	-	2(11.11%)	6(33.33%)	9(50%)	1(5.56%)
2	Sequence	-	4(22.22%)	6(33.33%)	7(38.89%)	1(5.56%)
3	Time	3(16.67%)	5(27.77%)	3(16.67%)	6(33.33%)	1(5.56%)

Interpretation of the quantitative results

The result of both scores in the experimental class and the control class represented by a two-line frequency and the frequency of convergence show that the convergence path frequency of the experimental group tended always to the right and above in comparison with the control class, meaning that students in the experimental group gain from Xi or more points over the scores of the control group; also, the experimental group had fewer scores in the "average (5 to 7 points)" range. The number of students attaining a score of "proficient" (7 to 10 points) was higher in the experimental than in the control group, especially in the second trial. During the entire experiment, the expression of creativity (which accounted for 20% of all product points) and the evidence of practical experience helped students in the experimental classes perform better than the control class students.

b) Qualitative results

- Comments of teachers regarding PBL

In direct interviews, teachers involved in the use of PBL methods expressed their opinion that the use of PBL is feasible and offers many advantages over the traditional forms of teaching.

It was found to be particularly effective because students do most of the work autonomously, including following the details of occupations and finding replacement parts in automotive parts stores. Thus, even while still in school, students who were taught according to PBL methods were able to find employment in workshops, as well as in automotive repair facilities and in schools.

- *Comments of students who participated in the experiments*

Experimental classes

- The rate of students interested in learning projects is 83.2%

- The percentage of working students performing lessons proficiently is 82.5%

- The percentage of students with high self-reliance in learning projects is 77%

Traditional classroom

- The rate of interest of students in the lesson content is 62%

- Percentage of working students performing lessons proficiently is 65%

- The percentage of students with high self-reliance in learning projects is 58%

Through a qualitative survey of the teachers and students who participate in the experiments, we can make the following remarks:

+ PBL is suitable for use in training modules, and rates highly as far as feasibility, practicality, and development of professional skills. It helps to develop the inextricable links between skills learned in the school and work in the professional world. It teaches learners to develop holistically.

+ The excitement, self-reliance and collaborative work in the experimental group are higher than in the control group.

Conclusion of Chapter 3

In chapter 3, the author of the thesis has successfully implemented the main task, namely:

(1) Development of 4 selection criteria for the PBL content; With these criteria, the author analyzed the hardware modules of college-level training programs in Automotive Technology and chose from 48 possible topics to test the effectiveness of PBL. (2) Developing an implementation plan for PBL, designing an implementation process for PBL in "cluster repair / auto parts" and "cluster maintenance / auto parts", and designing 10 lesson plans for PBL modules in Automotive

Technology at the vocational college level. (3) Developing the ten lesson plans according to the PBL methods. (4) Organizing two experimental projects: "Fixing a friction clutch" and "high pressure PE pump repair". The experimental results show that the application of PBL for vocational modules in automotive technology is appropriate, enhances the positive creativity and proactive interest of students, thereby improving the quality of teaching.

CONCLUSION AND RECOMMENDATION

1. Conclusion:

- The thesis codified rationale for the adoption of project-based learning based on philosophical, psychological concepts and theories involved in the use of project-based learning. It analyzes the unique characteristics of PBL, which is practice-oriented, action-oriented, aims to excite students about learning, helps students to develop self-reliance, encourages collaborative work, and promotes the integration of practice and theory. The principles and processes of teaching and assessment in project-based learning were also mentioned.

- The thesis detected a mismatch between project-based learning and teaching professions modular implementation capacity to manipulate PBL Automotive Technology career.

Through analysis shows that PBL has many advantages and it is appropriate to require its use in general training and in vocational training modules, in particular with use in training for automotive technology careers. But it must be realized that to use PBL in general vocational and vocational teaching modules in automotive technology, there is a particular need to adhere to certain principles and to meet the necessary conditions. The thesis proposes four principles and conditions to be applied to a PBL module in professional automotive technology.

-To establish a factual basis for the application of PBL in teaching professional automotive technology, the author carried out a survey, an assessment, and situational analysis in the vocational teaching of Automotive Technology. Through analysis and evaluation, it was shown that training programs in professional Automotive Technology have contents which are highly compatible with PBL. It was also shown that teachers in vocational schools stick argely on theoretical methods, with practical training reserved for workshop practice as opposed to the classroom. The use of PBL in vocational schools is absent at the present time. Therefore, it is necessary

to inquire into means of expanding its use in an effective manner.

- To apply PBL modules in the vocational training in the occupation Automotive Technology in an effective way, the thesis has developed four criteria for PBL content selection, along with 48 possible topics with which PBL may be advantageously used.

- The thesis has developed implementation plans for PBL, presented design implementation processes for PBL in the subjects of "cluster repair / auto completing parts", presented ten lesson plans designed as PBL vocational modules in Automotive Technology courses at the college level and plans to construct ten lectures and lesson plans for some modules according to PBL.

- Two experimental projects were described: "Fixing a friction clutch" and "high pressure PE pump repair." The experimental results show that the application of PBL for vocational modules automotive technology is appropriate and enhances the positive creative and proactive interest of students, thereby improving the quality of teaching. Thus, the scientific hypothesis of the thesis has been proven.

2. Recommendation:

- *To the Ministry of Labour, Invalids and Social Affairs*

+ Adjust the title "Automotive Technology Automotive Maintenance Repairs" to better reflect the name and nature of the profession.

+ Restructuring the program's module frame according to the carrying capacity of a module towards the implementation of appropriate capacity to work to facilitate PBL and meet the needs of the job market now.

+ Train teachers on the theory and practice of active teaching, including PBL, so that they are able to apply expertise in their fields of responsibility, contributing innovative teaching methods and enhancing quality training.

- *With the Department of Defense:*

+ Encourage the use of PBL tests in specialized units through scientific activities: theoretical study and the formulation of appropriate project topics, deploy and apply lessons learned.

+ Investment in schools, that they may be equipped to teach vocational automotive technology by means of PBL projects.

- *With Vocational schools:*

Create learning projects in the occupation Automotive Technology.