

## Application of project-based teaching method in teaching the heat engine

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### Abstract

Project-based teaching is an important form of teaching to implement the modern teaching perspective such as learner orientation, action orientation, and problem solving teaching and integrated teaching perspective. The more developed science and technology, teaching methods in the field of engineering (technical pedagogy) are also increasingly rich, diverse and sophisticated. Content of this article presented on the application of project-based teaching method to teach for subject of the “heat engine” of technical university. The initial results showed that this teaching method has been promoting a positive, creative and create excitement for learners in the learning process. This method should be further studied and applied much more in practice teaching in the colleges and universities.

**Keywords:** Project-based teaching; Teacher; Learner; Heat engine

### 1. Introduction

The teaching process is a collection of continuous interpenetration actions of teachers and students under the guidance of teachers. Thus, the teaching process is understood as gathering the activities of teachers and students under the guidance of teachers, in order to help students develop their personalities and thereby reach their teaching goals [3]

Education and training in the context of integration and globalization requires schools, teachers to have fundamental innovations in thinking and organizing training. Innovating teaching methods, applying positive teaching methods in a suitable way to meet the requirements of the change from training with schools and teachers as a center to learners as a center to increase the positivity, initiative and creativity of learners. That also makes the quality of education and training of our country constantly increasing. One of those teaching methods when applied in technical teaching has brought many positive results, which are project-based teaching methods The project - based teaching method is built on important orientation questions, integrated high-level content and thinking standards in a real context, helping to develop relevant knowledge and skills through open-ended tasks, encourage learners to explore, realize the knowledge learned in the process of implementing and creating their own products.

### 2. Methods

What does the content show as a complete description of the research, including what is included? how? and analyze the data like? Details are as follows:

#### 2.1. Research design

- Application of project-based teaching (PBT) model in teaching "heat engine" part of college, university of technology.

## 2.2. Research subjects

- Teaching activities according to the project.
- The Project- based teaching method has certain basic characteristics, which are oriented towards practice, learner-oriented, product-oriented... These characteristics have clearly demonstrated the outstanding advantages of this teaching method compared with traditional teaching methods.
- Teachers play a role as instructors and counselors for learners. Teachers themselves are not only experts but also participate in searching and processing information with learners. Teachers must promote the autonomy of learners and attach the learners' initiative to solving lesson content.
- In project-based teaching, learners are make many decisions, worked collaboratively, get ideas, be presented to the crowd, and in many cases learners are set up their own knowledge. Although at first it can be a big challenge, most learners find this project work very meaningful, practical and relating to life and very attractive.

## 2.3. Research location and time

- Maritime colleges and universities in Hai Phong City, Vietnam. The research time is from January 2018 to the end of December 2019.

## 2.4. Sample

- Experimental group (EG) and control group (CG).
- PBT is a form of teaching and learning that requires learners to use many skills to complete the set task. Through organizing the project about the application of “technical thermodynamics base” in PBT for specialisation of thermal engine, we found: Learners find, exploit and handle quite well the information gathered from books and newspapers, from the Internet and other media. Learners' ability to use computers increased significantly. In addition to using computers to search for information, learners also use proficiently presentation software, even make very beautiful publications. Groups are working actively, urgently to ensure the schedule and have a rational assignment among the members of the group. The leader group organises and manages well. The reports of the outline as well as the product report, the exchange groups exchange and make question quite enthusiastically, expressing understanding of content, critical thinking and creatively absorbing. Learners learn how to self-assess their own and other team's products objectively and accurately.
- Because the number of “learner samples” selected as experiments and control is still low, so in order to achieve higher reliability, we have used statistical methods. The results show that learners in the experimental group are knowledgeable and skills that have been transmitted than learners in the control group. Thus, PBT is more effective than conventional teaching, experimentation has brought good results.

## 2.5. Research tools and information collection techniques

The set of questions oriented the curriculum framework in PBT is "a set of orientation framework questions to provide a structure in questioning throughout PBT, developing thinking at all levels". This set helps PBT create a balance between understanding and exploring fascinated ideas that make learning suitable for learners. The set of questions orients program frameworks to help learners connect basic concepts in the same subject or between subjects. These questions facilitate the orientation of learners' learning through thought-provoking problems. Oriented questions help "attaching project goals with program and learning goals."

The set of questions orients program frameworks will help projects focus on core teaching activities. Learners are introduced to the project through questions that suggest big, cross-cutting, specialized ideas. Learners are forced to think more deeply about the subject matter of the subject regarding to standards and objectives. There are three types of questions oriented the program framework: Overview Questions, Lesson Questions and Content Questions designed to be integrated into each other. Content Questions support the Lesson Questions and overview questions. The overview Question is often given first, highly challenging. Overview Questions are open, wide-ranging questions that stimulate exploration, aim for big and long-term concepts, require higher-order thinking skills and are often interdisciplinary.

Lesson Questions are opened questions that relate directly to specific projects or lessons, require higher-order thinking skills, help learners build their own answers and knowledge from the information that the learners have collected. Content Questions is "closed questions" with clearly defined "right" answers, directly supporting the teaching and learning of specific knowledge, often relating to definitions or requirements which recall information (like normal test questions).

Pedagogical experiment: What causes environmental pollution in a heat engine? Formula for calculating the efficiency of a heat engine? In experimental classes, teachers organize teaching according to the project on technical application according to the proposed process. With the control classes, teachers use traditional teaching methods, the lessons are conducted on schedule as the program delivery of the Ministry of Education and Training. Including: What is a heat engine? Which principle does the heat engine work? How is the thermodynamic principle I applied to the operation of a heat engine?

## 2.6. Data analysis

Mathematical statistics, data analysis and data processing are obtained from pedagogical experimental results. Structure of a heat engine? Which principle does the heat engine work? How is the thermodynamic principle I applied to the operation of a heat engine? How to do project-based teaching, apply project-based teaching methodology in heat engine teaching? What causes a heat engine to adversely affect the environment? How to improve the performance of heat engine?

*In addition*, consulting the research authors first; Searching of library materials and data was developed at the beginning of the study. Searching for data mixes through access to electronic databases on the Internet related to "Teaching by project", specifically as follows:

- <http://www.ascd.org/Publications/Books/Overview/Project-Based-Teaching.aspx/>.
- <https://www.pblworks.org/what-is-pbl>.
- <https://www.teachthought.com/category/project-based-learning/>.

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## 3. Research content

### 3.1. Concept of project-based teaching

Project-based teaching is a form of teaching in which learners perform a complex learning task, combining a theory and practice, and creating products that can be introduced. This task is carried out by learners with high self-reliance throughout the learning process, from goal identification, planning, project implementation, testing, adjustment, process evaluation and result. Teamwork is the basic form of teaching by project method. The essence of project-based teaching methods is that the learners acquire knowledge and skills through the process of solving a case study with the project-based practice. The end of the project will produce a specific product [6].

According to Kilpatrick, PBT is a teaching method. He defined the project in teaching as "deliberate action, with all enthusiasm, taking place in a social environment, or in short, a deliberate and dedicated activity" [13]. According to Him, the PBT method can be applied to all different teaching contents, maybe the theoretical content without being associated with the practice of creating products. According to [8], [18]: PBT is a form of teaching organization. Besides, PBT can be understood as a complex teaching method. According to Tran Thi Hoang Yen: "PBT is a teaching method; in which, under the orientation, organization, guidance and adjustment of teachers, students self-make action plans, carry out learning tasks to create products, thereby acquiring knowledge. New approaches through projects of practical significance" [7].

Although educational researchers in the world and in Vietnam have different definitions and interpretations of PBT, the authors agree on some of the following connotations about PBT: PBT is a teaching's organizational form that is directed at learners, learners are centered. In PBT, students study by themselves, perform a learning task set by the teacher or the teacher and learners to formulate the necessary knowledge and skills. The learning activities in PBT are specifically designed, detailed, stick to the curriculum, have a range of interdisciplinary knowledge and skills, integrating theory and practice. Create realistic products.

### 3.2. Basic characteristics of project-based teaching

The Project- based teaching method has certain basic characteristics, which are oriented towards practice, learner-oriented, product-oriented ... These characteristics have clearly demonstrated the outstanding advantages of this teaching method compared with traditional teaching methods. The basic features of teaching by project are shown as follows (According to Brandsford J [9], Lewin [14], and Thomas JW [17])

- Learners are the center of the teaching process;
- The project focuses on important learning objectives associated with standards;

- The project is oriented according to the program framework questionnaire;
- The project requires diverse and regular forms of assessment;
- The project relating to reality;
- Learners express their understanding through products and implementation process;
- Modern technology supports and promotes learners' learning;
- Thinking skills are indispensable factors in project - based teaching method.

### **3.3. The role of teachers and learners in project- based teaching (PBT)**

#### *3.3.1. The role of teachers*

According to George Lucas [10], Marzano [15], Railsback, J. [16]: Teachers play a role as instructors and counselors for learners. Teachers themselves are not only experts but also participate in searching and processing information with learners. Teachers must promote the autonomy of learners and attach the learners' initiative to solving lesson content.

#### *3.3.2. The role of learners*

In project-based teaching, learners are make many decisions, worked collaboratively, get ideas, be presented to the crowd, and in many cases learners are set up their own knowledge. Although at first it can be a big challenge, most learners find this project work very meaningful, practical and relating to life and very attractive [10], [15], [16].

#### *3.3.3. The advantage of teaching "thermal motor" subject according to project method compared to teaching the contents of other subjects*

*For learners*, first of all, the topic of "heat engine", integrating theoretical content with practical content (Diesel engine; gasoline engine ...) should be lively, attractive, and dominant in creating motivation, interest in learning for learners. Learning the topic of "thermal engines", learners are enhanced using synthetic knowledge to solve practical situations, less to memorize knowledge mechanically. The more important is the topic of "thermal engines", which helps learners not to repeat the same knowledge content in different subject areas (for example, engineering thermodynamics; technical heat ...), both overloading, boring, and not having a general understanding as well applicability of synthesized knowledge into practice [1], [2], [11].

*For teachers*, it may be a bit difficult at first because of the deeper understanding of the knowledge of other subjects (technical thermodynamics; technical heat ...). However, this difficulty is only the first step and can be easily overcome by two reasons:

- *Firstly*, in the process of teaching the "thermal engine" subject according to the project method, teachers often have to teach the knowledge related to other subjects and therefore have the understanding of the relating knowledge;
- *Secondly*, with the renewal of current teaching methods, the role of teachers is no longer a knowledge communicator but a person who organizes, inspects and orients the learning activities of learners both inside and outside the class; hence, teachers of other subjects related to the "thermal engine" subject have more conditions and proactive in coordination and support each other in teaching.

*Thus*, project- based teaching not only reduces the load for teachers in teaching the relevant knowledge content in "thermal engine" subject but also has the effect of fostering and improving high knowledge and pedagogical skills for teachers, contributing to the development of teaching staff of the subject "thermal engine" into a contingent of teachers who have the capacity to teach in general knowledge and skills. Teachers need to be trained in project- based teaching method in pedagogical schools [1], [2], [11].

### **3.4. Process of implementing PBT**

The process of implementing PBT includes the following steps

#### *3.4.1. Step 1*

Teacher determines the content of the lesson to implement the project, review the relevant knowledge. Learners have group distribution, discuss and select project topics. The project topic may be explaining the structure, operation principles of equipment, machinery (topic 1), or higher, asking learners to devise design option about a device to solve technical demand in practice (topic 2).

### 3.4.2. Step 2

Teachers guide learners to develop outline and plan for project implementation, in which need to clearly define the work to be done, the expected time, means, funding, methods of conducting and assigning tasks in the group

- *With the topic 1:* The work that the groups need to do is to select the objects models or drawing models, thereby explaining the structure, operational principles and understanding the purpose of the device in practice. .
- *With the topic 2:* The work of the groups is to propose and select a design plan of a technical device. The groups conduct discussions and idea exchange to choose the most effective design option. Teachers ask groups to develop outline and implementation plan; determine the work to be done, time, facilities needed for design, estimated budget, assembly method, etc. and organize work assignments for members based on their capacity as well specific work of the group.

### 3.4.3. Step 3

Members perform the work according to the plan and tasks set for the group and individuals. In the process of implementation, teachers need to organize learners' discussions, presenting product outline to exchange ideas and contribute ideas. Teachers are only responsible for urging, guiding, examining and answering questions according to learners' requests but not directly participating in the implementation.

### 3.4.4. Step 4

Learners publish project products including:

A presentation of PowerPoint explains the structure and principles of the device based on the principles and laws of thermodynamics.

A product announced:

- *With the topic 1:* Products can be brochures or presentations on practical use of the device, can also be the latest uses of the device, etc.
- *With topic 2:* Product is an object model with functions corresponding to the selected design plan. For the operation model, preliminarily check the validity of the design plan, this is a quite important stage. The operation of the model determines the correctness of the selected design plan. From here, learners draw the errors (if any) as a basis for completing the model. Under adequate facilities, learners can conduct assembling real equipment based on the sample model designed. However, this task should only be applied to colleges, universities, etc.

A website publishes the project's achievements and shares information. It is possible to organize the introduction of project products in one or more sessions, each product or a combination of products depending on time conditions as well as project scale. In order to perfect the product, teachers let groups discuss and question each other.

### 3.4.5. Step 5

At the end of the project, teachers reinforce their just learned knowledge and skills.

### 3.4.6. Step 6

Teachers organize for learners to evaluate and self-assess the process of implementation as well as project products of the groups obtained [1], [2], [12].

## 3.5. The questionnaire oriented the curriculum framework in PBT

### 3.5.1. Overview of the questionnaire oriented the curriculum framework in PBT

The set of questions oriented the curriculum framework in PBT is "a set of orientation framework questions to provide a structure in questioning throughout PBT, developing thinking at all levels" [12; p72]. This set helps PBT create a balance between understanding and exploring fascinated ideas that make learning suitable for learners.

The set of questions orients program frameworks to help learners connect basic concepts in the same subject or between subjects. These questions facilitate the orientation of learners' learning through thought-provoking problems. Oriented questions help "attaching project goals with program and learning goals."

The set of questions oriented the program framework will help projects focus on core teaching activities. Learners are introduced to the project through questions that suggest big, cross-cutting, specialized ideas. Learners are forced to think more deeply about the subject matter of the subject regarding to standards and objectives. There are three types of questions oriented the program framework: Overview Questions, Lesson Questions and Content Questions designed to be integrated into each other. Content Questions support the Lesson Questions and overview questions. The overview Question is often given first, highly challenging.

Overview Questions are open, wide-ranging questions that stimulate exploration, aim for big and long-term concepts, require higher-order thinking skills and are often interdisciplinary. Lesson Questions are opened questions that relate directly to specific projects or lessons, require higher-order thinking skills, help learners build their own answers and knowledge from the information that the learners have collected.

Content Questions is "closed questions" with clearly defined "right" answers, directly supporting the teaching and learning of specific knowledge, often relating to definitions or requirements which recall information (like normal test questions) [12; p73], [19], [20], [21]

*3.5.2. Build program framework questions for the project in specialized thermal engineering teaching*

(\*) Overview Question:

How has the development of science and technology changed our lives [2; p44-47]?

(\*\*) Lesson Questions:

How the heat engine effect on environmental protection?

(\*\*\*) Content Question:

- How is the law I content of technical thermodynamics stated [2; p44-47]?

- Heat engine:

+ What is heat engine [1; p9]?

+ Which principle is the thermal motor operating? Indicate the relationship with Law I of engineering thermodynamics in the operation of thermal motors [1; p12-25]?

+ Structure of basic parts of heat engine [1; p10-11]?

+ What causes environmental pollution from heat engines?

+ The Cac-No cycle, the meaning and performance of the cycle [2; p185-200]?

+ The formula for calculating the efficiency of the heat engine in the Cac-No cycle [2; p185-200]?

**3.6. Results and discussion in PBT**

Based on the above analysis, the author presents 3 criteria tables for evaluating the project with a total of 100 points as follows:

**Table 1** Evaluation of project implementation process (20 points) [12; tr75], [19], [20], [21]

Criteria	Request	Maximum point
Assign tasks in the group	Assigning tasks equally, reasonably and effectively.	5
Positive in discussion	Participating in active and lively discussions, asking many questioning questions.	5
Positive in information gathering	Diverse, rich information, extracted from many sources.	5
Positive in preparing the outline	Detailed, complete outline, completed on time	5

**Table 2** Evaluation of multimedia presentations (60 points) [12; tr75], [19], [20], [21]

Criteria	Request	Maximum point
About knowledge	Accurate, complete, logical and scientific.	20
About form	Presentation slides are reasonable, suitable for content and creative, high aesthetics	10
	Beginning slide shows vividly the project topic, report date.	5
	The last slide has a thank you note, there are slides on reference sources.	
About presentation	Guaranteed time specified	5
	Logical, coherent, confident, highly persuasive	10
	Good answer to questioning questions.	10

**Table 3** Evaluation of project publications and website (20 points) [12; tr75], [19], [20], [21]

Criteria	Request	Maximum point
About content	The accurate, diverse, selective information from many sources	3
	Clearly expressing the ideas of the group	3
	The content of the article has a profound meaning in learning and in practice	4
About form	Presenting creativity, clarity, aesthetics and high science	5
	Reasonable and Illustrating images..	5

### 3.6.1. Detailed content of the project

Build a detailed table of the project, including the contents for the project: Project name; Project objectives; Exercises for learners; Role plays. Specific results are presented in Table 4 below.

**Table 4** Detailed contents of the project [12; tr76-78], [19], [20], [21]

Name of project	Objectives of the project	Exercise for learners	Play roles
Limit the impact of the engine heat to the environment	<p>Presentation of the basic components and principles of thermal engine operation, the cause of environmental pollution due to emissions from heat engines and some restrictive measures.</p> <p>Applying the law of technical thermodynamics to explain the operation principle of the heat engine.</p>	<p>“-Science &amp; technology is more and more developing to bring benefits for human life but it is also the cause of the increasingly polluted environment. Every day, the heat engine releases many toxic gases to the atmosphere. Acting as experts in the field of technology and environment, you and your team learn about the operation principle of the thermal engine in general and analyze its impact on the environment. Since then there is a propaganda method for people to actively protect the environment ”</p> <p>In order to complete this project, you will work in groups and specific tasks as follows:</p> <p>Finding out the definition of heat engine, structure of basic parts and operation principles of the thermal engine. Applying law I of technical thermodynamics to explain the operation principle of the thermal engine;</p>	<p>Captain: Role division, assign tasks to each member, monitoring the progress of the project.</p> <p>Engineer: Learning the structure and operation principles of heat engine, the cause of environmental pollution from thermal engines.</p> <p>Information expert: Collecting some data about environmental pollution.</p> <p>Member of City Environment Protection Committee: Giving out propaganda forms to raise awareness of friends and people about environmental protection.</p>

	<p>Powerpoint Post, propaganda leaflets; website or blog.</p> <p>Raising awareness and proper attitude about environmental protection for learners.</p>	<p>Finding out the causes of environmental pollution from heat engines;</p> <p>Learning and giving some measures to limit environmental pollution caused by heat engines;</p> <p>Processing Information and demonstrating by using Powerpoint;</p> <p>Propaganda on environmental protection issues;</p> <p>Sharing information of the group via website or blog.</p>	<p>Designers: Designing project products.</p> <p>Rapporteur: Presenting products before class.</p> <p>Secretary: Summarizing information, recording project log</p>
<p>Improve the performance of thermal motors</p>	<p>Present the Cac-no cycle and state its meaning.</p> <p>Evaluate the performance of a heat engine (specific data).</p> <p>The Powerpoint of the results obtained, leaflets propagating the harms of some waste from heat engines polluting the air; website or blog.</p> <p>Raise awareness and proper attitude about environmental protection for learners.</p>	<p>Energy is always a hot issue interested in the whole world. With the current level of exploitation, resources are increasingly exhausted. How to improve the performance of a heat engine (to save energy) is a top priority for manufacturers. With the role as fabricating engineers, you (your team) explain the principles to improve the performance of the heat engine in the best conditions. At the same time, there are measures to propagate for people to use and save natural energy sources to protect the environment”.</p> <p>To complete this project, you will have to work in groups and specific tasks as follows:</p> <p>Learning the general structure of heat engine;</p> <p>Definition of reversible and irreversible process, presenting the Cac-No cycle; performance and significance of the Cac-No cycle;</p> <p>Application of the Cac-No cycle in assessing the performance of thermal motors, specifically: Evaluating the performance of a heat engine. Indicating the input temperature is 270C; Output temperature (exhaust gas) is 4500C;</p> <p>Processing received information and demonstrating by Powerpoint;</p> <p>Propaganda leaflets for all users to save natural resources;</p> <p>Sharing information of the group via website or blog.</p>	<p>Team Leader: Assign roles, assigning tasks to each member of the team, and monitoring the progress of implementing project that teambe in charge.</p> <p>Engineer: Learning the construction principle of a heat engine, explaining the meaning of the Cac - No cycle.</p> <p>Information specialist: Collecting some data about the status of exploitation and use of natural resources.</p> <p>Scientist: Learning the definitions of reversible and non-reversible process, stating performance and Cac-NO Cyclical meaning.</p> <p>Designers: Designing project products.</p> <p>Rapporteur: Presenting products before class.</p> <p>Secretary: Summarizing information, recording project log.</p> <p>In charge of propaganda: Propagating people with a sense of effective exploitation of natural resources.</p>

### 3.6.2. Experimental results and evaluation

#### Qualitative results

PBT is a form of teaching and learning that requires learners to use many skills to complete the set task. Through organizing the project about the application of "technical thermodynamics base" in PBT for specializing of thermal engine, we found:

Learners find, exploit and handle quite well the information gathered from books and newspapers, from the Internet and other media;



Learners' ability to use computers increased significantly. In addition to using computers to search for information, learners also use proficiently presentation software, even make very beautiful publications;

Groups are working actively, urgently to ensure the schedule and have a rational assignment among the members of the group. The leader group organizes and manages well;

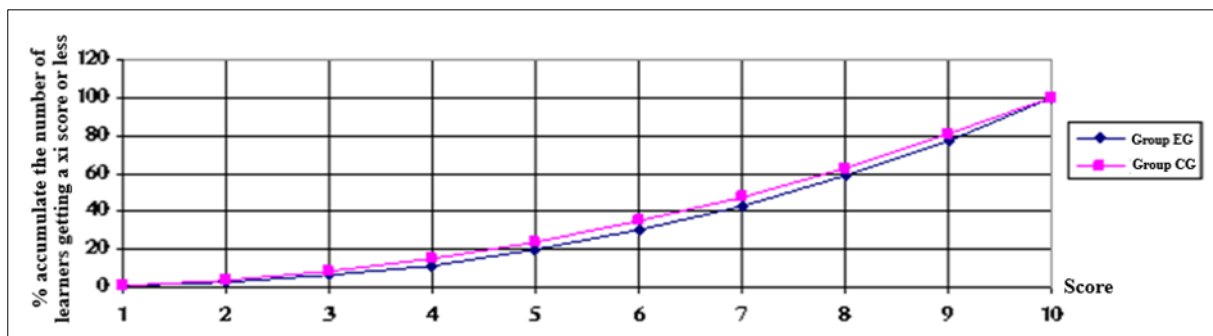
The reports of the outline as well as the product report, the exchange groups exchange and make question quite enthusiastically, expressing understanding of content, critical thinking and creatively absorbing. Learners learn how to self-assess their own and other team's products objectively and accurately.

#### Quantitative results

From the summary table of typical parameters (Table 5) and graph of cumulative frequency distribution, we draw the following remarks:

Classes selected to be experimental group (EG) with an average score (6,80) higher than the average score of control group (CG) (6,00);

From the summary table of typical parameters (Table 5), we draw a graph of cumulative frequency distribution (taking columns: column (1) as horizontal axis; column (6) & (12) as vertical axis). The cumulative line corresponding to the control group is on the left and above the cumulative line of the experimental group (Figure 1).



**Figure 1** Graph of cumulative frequency distribution of two groups [19], [20], [21]

The average score of the experimental group is higher than that of the control group, the standard deviation  $S$  has a small corresponding value, so the data obtained is less dispersed, so the average value is highly reliable.  $S_{EG} > S_{CG}$  and  $V_{EG} < V_{CG}$  showed that dispersion in experimental group decreased compared with control group (see Table 6).

Because the number of "learner samples" selected as experiments and control is still low, so in order to achieve higher reliability, we have used statistical methods.

(\*) Compared to Phan Thi Ha Linh [4] and Intel Corporation [12], the research results of standard deviation and dispersion between control group and experimental group of this PBT are "logical and regular". The results show that learners in the experimental group are knowledgeable and skills that have been transmitted than learners in the control group. Thus, PBT is more effective than conventional teaching, experimentation has brought good results.

**Table 5** Typical parameters of the project [19], [20], [21]

Control group (CG)						Experimental group (EG)					
Score (x <sub>i</sub> )	Number of learners (n <sub>idc</sub> )	Frequency (d <sub>id</sub> =n <sub>idc</sub> /35)	Accumulative frequency (D <sub>id</sub> =(∑d <sub>id</sub> )x35)	% Accumulative frequency (T <sub>id</sub> =D <sub>id</sub> /179,55)	% accumulate the number of learners getting a x <sub>i</sub> score or less (T' <sub>id</sub> =∑T <sub>id</sub> )	Score (x <sub>i</sub> )	Number of learners (n <sub>itn</sub> )	Frequency (d <sub>it</sub> =n <sub>itn</sub> /36)	Accumulative frequency (D <sub>it</sub> =(∑d <sub>it</sub> )x36)	Accumulative frequency (T <sub>it</sub> =D <sub>it</sub> /154,80)	% accumulate the number of learners getting a x <sub>i</sub> score or less (T' <sub>it</sub> =∑T <sub>it</sub> )
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	2	0.07	2.45	1.36	1.36	1	1	0.03	1.08	0.70	0.70
2	2	0.07	4.90	2.73	4.09	2	2	0.06	3.24	2.15	2.85
3	3	0.09	8.05	4.48	8.57	3	2	0.06	5.40	3.50	6.35
4	4	0.11	11.90	6.62	15.19	4	3	0.08	8.28	5.35	11.70
5	4	0.11	15.75	8.80	23.99	5	4	0.11	12.24	7.91	19.61
6	4	0.11	19.60	10.92	34.91	6	4	0.11	16.20	10.46	30.07
7	4	0.11	23.45	13.06	47.97	7	4	0.11	20.16	13.00	43.07
8	4	0.11	27.30	15.24	63.21	8	4	0.11	24.12	15.58	58.65
9	4	0.11	31.15	17.34	80.51	9	4	0.11	28.08	18.10	76.75
10	4	0.11	35.00	19.45	100.00	10	8	0.22	36.00	23.25	100.00
Total	35 (N)	1	179.55	100	-	Total	36 (N)	1	154.80	100	-
Average score of the group (S <sub>ca</sub> ): 6,00						Average score of the group (S <sub>ca</sub> ): 6,80					

**Table 6** Standard deviation and dispersion of the project [19], [20], [21]

No	Name of Group	Total number of learners	Average point value ( $S_{Ca}$ )	Index of variance ( $S^2 = (\sum(x_i - S_{Ca})^2) / (N - 1)$ )	Standard deviation (S)	Dispersion (%) ( $V = S / S_{Ca}$ )
1	Group CG	35	6.00	7.20	2.68	44.66
2	Group EG	36	6.80	7.37	2.71	39.85

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#### 4. Conclusion

Through above research contents can draw some conclusions about Project- base teaching. The implementation of PBT has linked theory to practice, thinking and action, school and society. PBT Stimulates motivation, interest in learning of learners; Promotes self-reliance and accountability; Develops creative ability; Trains your ability to solve complex problems; Trains perseverance, patience; Trains the ability to work collaboratively and Develops assessment and self-assessment capacity.

Project-based teaching is an important form of teaching to implement the modern teaching perspective such as learner orientation, action orientation, and problem solving teaching and integrated teaching perspective. The more developed science and technology, teaching methods in the field of engineering (technical pedagogy) are also increasingly rich, diverse and sophisticated.

Through the “research and deployment of PBT”, we have proposed the “learning projects”, that is “Limiting the effect of heat engines on the environment; and Improving the performance of thermal motors”.

In the process of organizing teaching according to those projects has given the learners “the great significance of inventing the laws of engineering thermodynamic”. The results of research and teaching practice show that the application of PBT method (teaching organization with regard of proposed projects) for thermal engine engineering specialization not only promotes positive and proactive, creative but also form, develop many skills and techniques in learners. The widespread deployment of PBT not only positively contributes to “improving the quality of education and training in specialized thermal engineering in particular, but also contributes to improving the quality of education and training in education and training facilities in general”.

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#### Compliance with ethical standards

##### *Statement of informed consent*

Informed consent was obtained from all individual participants included in the study

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