

# Developing Strategies for Teaching Thermodynamics Subjects to Improve Understanding and Application Through Hands-on Experiences

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## Abstract

This study aimed to investigate the relationship between the development of teaching strategies for thermodynamic topics and improving understanding and application through practical experiences among mechanical engineering students in Iraq, and the researcher relied on the descriptive approach to describe the variables of the study and the problem of the study and its interpretation to reach the required results. The researcher reached through reviewing many previous Arab and foreign studies that dealt with practical experiences and the development of teaching strategies to the following results: There is an impact of developing teaching strategies for thermodynamics topics on improving understanding and application through practical experiences among mechanical engineering students in Iraq. As the results of the study showed that the use of scientific experiments helps teachers to clarify and explain everything related to the laws and ideas of this subject, through practical and direct application to the thermal machine in front of learners, which increases their ability to explore everything related to the thermal machine by applying the laws of thermodynamics to it in front of them, Accordingly, the researcher recommends increasing reliance on practical experiments while explaining thermodynamics, increasing the time allocated for its application, and updating and developing the tools and machines in the thermodynamics laboratory at the College of Mechanical Engineering in Iraq.

**Keywords:** teaching: strategies, practical experience, scientific laboratory.

## تطوير إستراتيجيات تدريس مواد الديناميكا الحرارية لتحسين الفهم والتطبيق من خلال الخبرات العملية

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## المستخلص

هدفت هذه الدراسة إلى معرفة العلاقة بين تطوير إستراتيجيات التدريس للموضوعات الديناميكية الحرارية وتحسين الفهم والتطبيق من خلال التجارب العملية لدى طلاب الهندسة الميكانيكية في العراق، واعتمد الباحث على المنهج الوصفي لوصف متغيرات الدراسة ومشكلة الدراسة. الدراسة وتفسيرها للوصول إلى النتائج المطلوبة. وتوصل الباحث بمراجعة العديد من الدراسات العربية والأجنبية السابقة التي تناولت التجارب العملية وتطوير إستراتيجيات التدريس إلى النتائج التالية: يوجد أثر لتطوير إستراتيجيات التدريس لموضوعات الديناميكا الحرارية في تحسين الفهم والتطبيق من خلال التجارب العملية لدى طلاب الهندسة الميكانيكية في العراق. وأظهرت نتائج الدراسة أن استخدام التجارب العلمية يساعد المعلمين على توضيح وشرح كل ما يتعلق بقوانين وأفكار هذه المادة، عبر

التطبيق العملي والمباشر على الآلة الحرارية أمام المتعلمين، مما يزيد من قدرتهم على الاستكشاف. كل ما يتعلق بالآلة الحرارية عبر تطبيق قوانين الديناميكا الحرارية عليها أمامها، ومن ثم يوصي الباحث بزيادة الاعتماد على التجارب العملية عند شرح الديناميكا الحرارية، وزيادة الوقت المخصص لتطبيقها، وتحديث وتطوير الأدوات والآلات في مختبر الديناميكا الحرارية في كلية الهندسة الميكانيكية في العراق.

الكلمات الدالة: التدريس: الإستراتيجيات، الخبرة العملية، المختبر العلمي.

## 1. Introduction:

The world today is experiencing a scientific and technological revolution that has affected the educational process directly, it is necessary to employ modern methods in teaching and rely on scientific experience, which is an integral part of scientific education, as it is one of the necessary elements that must be available in any educational institution, regardless of its size and location, As scientific experiments represent the beating heart in the teaching and study of scientific and engineering subjects, including thermodynamics, so many modern trends and strategies have emerged in the field of teaching thermodynamics, relying directly on practical experimentation and scientific education in their implementation [1,p718].

The importance of these modern educational strategies has emerged significantly through recent research and studies that highlighted their value in the educational process and the urgent need to pay attention to the amount of learning resulting from the use of such modern strategies in order to reach the desired educational goal, it is necessary to use the appropriate method and strategy for the level of the student and develop a plan drawn in an accurate scientific manner to achieve the desired goals, The strategies are considered a set of movements made by the teacher within the classroom, which occur in a professional sequential manner aimed at achieving the educational goals prepared in advance, meaning that the teacher, although he follows his own method of giving the lesson, but he follows a specific strategy of steps to guide and walk according to them during the lesson to give the lesson well and develop standards and scientific foundations according to the materials and courses presented [2,p9].

Thermodynamics is one of those educational courses that apply to modern standards and techniques used, and the means developed in the teaching processes, and thermodynamics is one of the specialized materials in engineering education and is classified as one of the materials that are the basis in the first-year curriculum of the Department of Machinery and Equipment at the Institute for the Preparation of Technical Trainers, and is the main pillar in the subject of internal combustion engines, which is taught in the curriculum of the second stage, which is considered one of the basics of the study of car engines, The goal of the subject is focused on the student's numbers of engines so that he can describe and distinguish the parts of the car engine and know how the runs and the number of cycles are done, and in order to enhance theoretical education Education Theoretical, this view has expanded and developed among specialists in engineering education and appeared within the framework of modern education the introduction of practical training in thermodynamics, i.e. practical laboratory material. The thermodynamics laboratory is one of the important laboratories in technical education because of its contents, devices and standards.

In view of the difficulties that students were facing in the theoretical subject because of the preservation of laws and a detailed explanation of the thermal machine and due to the rapid development and the need for accuracy and optimal performance and the difficulties experienced by students in understanding the material, especially since it is taught in English in the traditional lecture method and even after adding the display technology by a device (data show), however, the success rate for students did not increase except by 5-3% more than the previous year, The addition of the practical laboratory material has been used to help understand and understand thermodynamics by applying practical experiments [3,p3].

## 2. Research problem:

This study provided discusses the essential role of evolving pedagogical strategies for thermodynamics to enhance comprehension and practical application among mechanical engineering students in Iraq. It highlights a critical educational shortfall linked to traditional, narration-based teaching methods, in contrast with the global shift towards experimental learning. The paper emphasizes the benefits of incorporating scientific experiments into the educational framework, suggesting a move towards more practical experimentation, increased hands-on time, and updates to thermodynamic labs in Iraqi mechanical engineering departments. It outlines the investigation into current teaching challenges, posits a hypothesis on the effectiveness of innovative teaching methods, and validates this hypothesis with a thorough review of practical experiences and their impact on students' understanding and skills.

## 3. Research Objective:

This study aimed to investigate the relationship between the development of teaching strategies for thermodynamic topics Improving understanding and application by relying on the practical experiences of mechanical engineering students in the Iraqi state.

## 4. Research hypothesis:

The development of teaching strategies for thermodynamics topics has an impact on improving understanding and application through practical experiences among mechanical engineering students in Iraq.

## 5. Importance of Research :

Scientific importance:

Enriching the Arabic library with a study dealing with a topic of educational and scientific importance, which is to rely on practical experiences to improve understanding.

Special importance:

The study is particularly important by examining the impact of developing teaching strategies for thermodynamics topics on improving understanding and application through practical experiences among mechanical engineering students in Iraq.

## 6. Scope and limits of research:

Objective limits: limited to the study of the development of teaching strategies for thermodynamic topics.

Improve understanding and application through practical experiences.

Spatial boundaries: College of Mechanical Engineering in Iraq.

Human Frontiers: Mechanical Engineering Students in Iraq.

Time limits: during the year 2024.

## 7. Model

Independent variable: teaching strategies for thermodynamic subjects.

Dependent variable: improved understanding and practical experiments.

## 8. Effectiveness and achievement:

The effectiveness of the research and the achievement of the researcher is highlighted by its added practical value, which is to highlight the impact of developing teaching strategies for thermodynamics topics on improving understanding and application through practical experiences among mechanical engineering students in Iraq.

## 9. Terminology of studies:

**9.1. Teaching Strategies:** It is a set of guidelines and rules that are concerned with the means of achieving the educational goals of a particular situation, which lies in the form of performance carried out by the teacher during the educational and teaching process with the aim of facilitating and achieving the task of education, and modern teaching strategies are represented as a set of modern steps followed or methods used by the teacher within the classroom to achieve the desired goals [4,p228].

**Scientific experiment:** They are practical methods and methods developed in the course with the aim of developing the targeted skills of students according to specialization [5, p3].

**Scientific Laboratory:** It is the place that includes all the scientific materials and devices and the exploratory laboratory scientific program, which includes presenting the problem in the form of a question produced by open questions that require the student to research and investigate through its application of activities in laboratory experiments prepared according to the program (mentally and practically) based on its self-activity and mental abilities under the guidance and guidance of the school to reach the results at the end of the experiment [6,p5].

### 9.2 The importance of practical experiences

In light of the recent global trends in the field of teaching and learning thermodynamics, and the increase in the volume and growth of knowledge, it was necessary to reconsider the development of its teaching and learning methods and the mechanism for presenting the contents of its curricula, and attention to helping students develop their abilities and mental capabilities to deal with thermal machines, to keep pace with the ever-renewed global thought, and to ensure that the educational system meets the needs and requirements of the world in which we live and the challenges of the current era [7,p467].

Therefore, scientific experiments have been relied upon as a modern teaching strategy due to their great importance, which can be clarified according to the following points:

- Scientific experiments contribute to providing engineering students and technical institutes with practical experience in how to deal with materials and machines, and they also contribute to the development of students' abilities to discover, sound scientific thinking and conclusions based on accurate observation of what happens during the experiment and contribute to increasing students' ability to scientifically justify what the heat machine produces [8].
- Relying on scientific experiments also increases students' achievement and understanding of materials, because this provides students with better educational opportunities than abstract education, and develops students' basic science skills such as observation, conclusion, and prediction, all of which make education more effective, which contributes to improving achievement and understanding [9,p253].
- He pointed out [7,p467] that the method of teaching strongly affects the extent to which learners understand what they learn and if teaching is based on experimentation it becomes clearer and more accessible, and the acquisition of skill is becoming a possibility.
- He added [10,p3] that it helps to enable the learner to absorb the theoretical side of the subjects, including thermodynamics, and contributes to raising the level of student skills by enhancing the practical side, which is based on the presence of an integrated laboratory and students' acquisition of manual skills necessary to deal with the machine, identifying the negatives to avoid them, providing the learner with direct sensory experiences, and applying scientific concepts in new situations, Achieving the principle of learning by doing, contributing to the formation of scientific concepts, developing mental abilities, developing scientific tendencies and trends, arousing scientific curiosity, in addition to appreciating the efforts of scientists, developing various practical skills and possessing the ability to deal with techniques.
- She pointed out [6,p12] that the adoption of this method according to the procedures and processes of many mental gives an incentive for students to inquire and research in the material given to them and also produces direct interaction between students and give more responsibility in the educational process where the researcher believes that the experimental method is one of the important teaching methods because it contributes to the development of scientific thinking skills of students.

### 9.3 Types of scientific experiments:

The types of scientific experiments carried out by students in educational institutions vary, and they are of two types:

#### First: Verification Experience:

It aims to ensure the validity of information, facts and laws known in advance, where the teacher clarifies what is related to the experiment in terms of determining its goal, identifying the necessary tools and materials, and clarifying the steps of conducting the experiment step by step, and expect the observations and results that the student will notice, and the student only remains to write a report of the experience that the students saw, and the types of experimental practical presentations vary, there are presentations

implemented by the teacher and they are the most common, and Presentations are made by a specialist, visitor or teacher with the participation of students, while the experimental practical presentations presented by a student or group of students are very few, because the teacher prefers to present experimental practical presentations himself for many reasons, including: the difficulty of students doing this presentation because he believes that the success of presenting the practical presentation depends on the efficiency of the presenter, and the seriousness of some practical presentations may expose the student to danger, As well as the process is expensive and the students' submission of these presentations exposes them to damage, and in the implementation of this type of experiments determine the steps of work step by step, without students realizing the meaning of the implementation steps or thinking and meditating on them, and perhaps this method resulted in the student's loss of interest in science and the weakness of his thinking and rigidity and often this type of experiments fails to provide an appropriate educational environment, and does not lead to improved understanding of students and is about the implementation of scientific experiments in the laboratory (NRC) boring and confusing them.

### **Second: Investigative Experiments:**

It is the one in which students answer a question whose answer is unknown or reveal the validity of an assumption by carrying out experiments that they plan themselves and record their observations or the results of what they do, and that a person practices investigation since birth, as he is young he touches things randomly and puts them in his mouth to know their taste, texture and shape, but unfortunately at some point in our life path he loses his natural curiosity to know the world around him [11,p147].

## **10. Conditions for the success of scientific experiments:**

The laboratory management in the department (laboratory administrator) shall comply with the following:

- Preparing a database of all laboratory devices and tools.
- Preserving and maintaining laboratory equipment and equipment and removing damaged and damaged ones.
- Ensure the cleanliness of devices, equipment and machines.
- Availability of methods of operating devices in laboratories.
- Ensure the readiness of devices, their type and field of use accurately.
- Use dust protectors with laboratory devices and equipment, especially during exams or long vacations.
- Implementation of the required calibrations of the machines periodically and from authorized bodies.
- Providing data projectors and improving laboratory teaching techniques according to the competence of the laboratory.
- Providing the requirements for conducting experiments fully and alternative test methods, whatever the specialization
- Ensure the calibration of devices before using them in educational examinations and[5, p8].



- Forming a scientific council in the department of qualified and experienced people, and if possible from outside the college in the same specialization.
- Motivate and encourage students to participate actively in research and experimentation and encourage them to intellectual and professional creativity
- Participate effectively and continuously develop training courses to develop the capabilities of professors in line with the requirements of conducting scientific experiments for the course professor and students [12].

### **11.Difficulties in conducting practical experiments:**

Despite the great importance of conducting scientific experiments in teaching and understanding thermodynamics, the results of many studies have shown a disparity in the degree of use of scientific experiments by teachers in the Arab and international environments [13]. This is due to the presence of several obstacles, the most important of which are the following:

- Lack of safety and security means during scientific experiments such as:(fire extinguishers, and first aid) .
- The lack of laboratories necessary to conduct scientific experiments, as some educational institutions contain only one or two common laboratory halls, which leads to their lack of fair exploitation [14] .
- Weak practical testing methods, as only a few educational institutions test their students practically and seriously in the laboratory within systematic experiments.
- Some teachers do not have vacant lessons to be used to prepare the laboratory and prepare for the experiment
- Most of the existing educational institutions do not have the appropriate rooms to allocate them to educational laboratories [15].
- A number of administrations of educational institutions, especially in recent years, resorted to canceling educational laboratories and converting them into classrooms due to the increase in the number of students.
- Imposing materials, tools and laboratory equipment on educational institutions without ensuring that there are rooms suitable for use for temporary laboratories.
  - Some teachers are afraid of using laboratory equipment for fear of damage and there are fears when teachers responsible for laboratories, materials and devices to bear the inclusion of their amounts in case of malfunction or damage.
- The lack of laboratory assistants, and the lack of a manual for various electrical and mechanical devices through which the teacher is trained to operate them.
- Lack of evidence for practical experiments to be used by the teacher in preparing the prescribed methodological experiments [16,p129].

### **12.The results of the study:**

The development of teaching strategies for thermodynamics topics has an impact on improving understanding and application through practical experiences among mechanical engineering students in Iraq.

### 13. Discussion of results and hypotheses:

Research hypothesis: There is an impact of developing teaching strategies for thermodynamics topics on improving understanding and application through practical experiences among mechanical engineering students in Iraq.

The results showed that there is an impact of developing teaching strategies for thermodynamics topics on improving understanding and application through practical experiences among mechanical engineering students in Iraq.

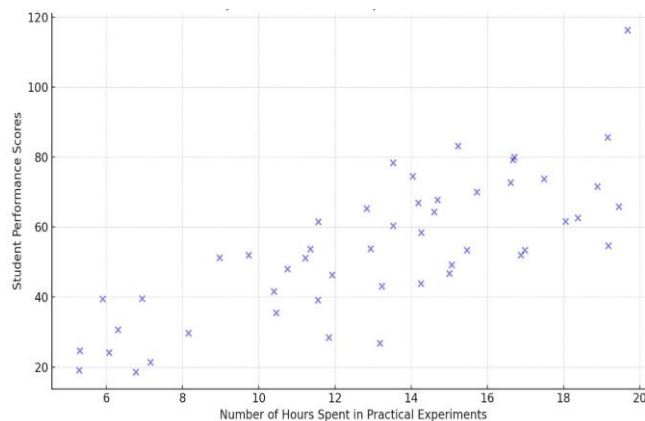
That is the researcher shows that the hypothesis has been accepted, and the researcher explains that scientific experiments help students to interpret and understand laws by seeing the results of their application in front of him accurately, and thus ensuring their validity and knowing how to implement them and absorb everything related to them correctly, as scientific experiments contribute to bringing theoretical information closer to the minds of students, and help them acquire the necessary skill to deal with the machine, and develop their ability to innovate.

Table (1) illustrates a sample of the relationship between the number of hours students spend in practical experiments and their performance scores, supporting the visual representation provided by the scatter plot.

**Table 1: Sample of the dataset used for the scatter plot**

Hours Spent in Practical Experiments	Student Performance Scores
13.23	43.14
15.73	69.99
14.04	74.54
13.17	26.85
11.35	53.69

The figure (1) illustrates the correlation between the number of hours spent in practical experiments and students' performance scores. This visualization demonstrates the effectiveness of practical experience in enhancing understanding, as indicated by a general trend where increased hours in practical experiments are associated with higher performance scores.



**Figure 1:** correlation between the number of hours spent in practical experiments and students' performance scores



#### 14. Comparison between the results of the current study and previous studies:

The results of the current study showed that there is an impact of developing teaching strategies for thermodynamics topics on improving understanding and application through practical experiences among mechanical engineering students in Iraq.

And that these results are somewhat consistent with the study of Al-Shammari[17], which showed that the educational program based on scientific experiments to develop some physical concepts has an effective role for second-grade primary students.

As for the study Al-Ammari [12], its results showed that there is agreement among chemistry and physics teachers that scientific experiments help to teach chemistry and physics, and the results also showed that virtual laboratories help to teach scientific experiments effectively.

#### 15. Conclusion

Most countries of the world seek to update education curricula continuously, and thermodynamics curricula are at the forefront of the concerns of those concerned with developing education policies and planning for their development, due to their importance, status and role in contemporary reality, and the method and strategy of education is an essential factor in the teaching process, as it is the starting point and the main pillar for the success of the educational guidance process. In the era of technology and the explosion of knowledge, it is very important that this process is completed to the fullest, and that various teaching strategies are used that determine the path and direction to achieve the desired goals, The most important of which is relying on scientific experiments in order to increase the level of understanding and perception of students in scientific subjects, including thermodynamics, and the education policy that is based on scientific experiments is one of the modern guiding methods that help students achieve the guiding goals, This educational method is preferred over others in that it works to motivate learners and thus push them and move them towards work for the purpose of production, and it works to provide support to learners with the available means and tools and work on it according to group systems and also enhances independence, and contributes to the acquisition of scientific knowledge that is characterized by motivation instead of transferred experiences and the acquisition of tangible and direct scientific experiences and provide opportunities for self-learning, practice learning processes and acquire manual skills, At the same time, the learner acquires prowess in working within the educational group because this type of learning is full of participation, it provides students with research and experiment in addition to the possibility of comparing the information he was obtaining in the traditional way based on indoctrination with applied reality, and this method depends on observing the student during the actual practice of the steps to be evaluated, and thus education through scientific experiments represents the most important and latest teaching and educational methods, And take care of the applied aspects, education through scientific experiments awakens interest and develops the ability to watch and accurate recording and conclusion based on facts, and develops skills and methods of purposeful value, and therefore scientific experiments are one of the basics of the educational process, which facilitates students to learn and teachers integrated

performance in explaining their lessons and conducting practical experiments with extreme accuracy.

### CONFLICT OF IN TERESTS

There are no conflicts of interest

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