

## Reflection on the reform of Thermal Engineering

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**Abstract.** Research on the teaching reform was conducted from the point of teaching methods and teaching medium. The author deems that multiplier teaching effect can be achieved by combining those two aspects in view of different teaching contents during the course. To obtain the positive result, teacher should take the teaching key points as principal line based on the prerequisite of evoking the students' interest.

### Introduction

Teaching reform, of which the improvement of teaching methods and styles is most important, is the core part of higher education reformation. It directly affects the results of teaching and quality of professional talents, thus being the key point to the pursuit of dramatically improving higher education quality by classroom teaching. We are exploring practical ways to apply ideas and modes inspired by modern educational theories to the course Thermal Engineering.

Thermal Engineering (TE) is a basic and important course of the major constructional environment and equipment engineering. TE mainly describes application of students' prior knowledge, puts forwards theories about some certain natural phenomena and industrial procedures, and gets students ready for further learning of other professional courses. The content of TE mainly include engineering thermodynamics and heat transfer. Due to its sophisticated logic, enormous concepts and abstract generalization, most students find it difficult to learn, understand and apply [1]. With the promotion of teaching reform and the revises of teaching syllabus, the course of TE has been compressed from 144 hours via 96 to 72 hours, and nowadays 60 or envn 56, rendering it harder to complete the course systemically. So it's urgently needed to contemplate how to effectively use the limited time to improve teaching quality of the course , trigger interests of the students on the major and enable them to go through the major more independently. In this paper, we will discuss these questions and accordingly propose some necessary reform of the course's teaching.

### Perfecting teaching methods of TE

#### A. *Inspiring interests by application in life.*

Albert Einstein has indicated that Interest is the best teacher of students, and teachers are just torches that light their interest up. Studies of educational psychology convince us that students are more eager to learn and to solve problems when their learning content are related to their prior knowledge and life experience [2]. So teaching of TE should strive to relate the course with students' life experience through various teaching methods and styles, aiming to getting students more interested and positive in the course. The first class is of the most importance, which enlighten the target, an important element of interest, of the course. Introduction is commonly the theme of the first class, and tutors will introduce not only themselves but more important the course to students, through the Introduction.

The Introduction of TE mainly includes heat and its utilization, a brief history of thermodynamics' development, how to transfer heat, and various research methods. The authors think it needs an evolutionary procedure to make good introduction. Technically, the students' prior knowledge should be extended and contacted to the new course, thus clearly compared in range and

difficulty before the students. When telling a brief history of the course, it is important to make it realistic and amiable to life. First introduced, for instance, may be the relationship between the development of TE and progress of society. Before the 18th century, the major source of power was human labor, animal power, wind and water. In the middle 18th century, steamer was realized to transfer power from heat to mechanics, triggering early research of thermal engineering. Down to the 19th and 20th century, combustion and jet engine were invented which power the train, the mobile, and the plane, respectively, and also provide power for many other modern industries. These great achievements attribute to lasting and profound research of TE, so here comes the conclusion that TE is closely related to life. Then the tutor can explain the relationship between TE and various heat powering apparatuses. Every procedure taking place in those apparatuses is researched and elaborated by TE, so if students are clear of this point and understand how their familiar products work under thermodynamic principles, they will find this course of great importance [2]. Moreover, when telling a brief history of this principle, the tutor may properly tell some anecdotes of great names in this field to get students more interested and active in the course. Finally, a general description of the course's research content should be made, emphasizing on its application in practice and status in the major. Additionally, videos (e.g. productive process of heat power station) and wall graphs (e.g. energy conservation project of a community and its heat power apparatuses) are very useful in a visual and direct description on the research and application of TE.

A good introduction is able to get an all-around image of the course across to the students and urge them to learn it well, facilitating descending classes of this course.

#### *B. Sticking to the marrow and emphasizing on the key points*

The course of TE is frequently described as “quite abstract with many concepts, more formulas and the most contents, almost impossible to understand” by students, the timing is also more limited, as mentioned before, so the tutor must grasp the marrow of the principle and clearly explain the key points.

In term of its contents, the textbook of TE initially elaborates the basic concepts and theories of engineering thermodynamics and its application in different media and thermodynamic cycle in the first part, and then demonstrates some basic theory and solving methods. Apparently, the former part is the basis of the latter one, whereas the latter is the extension of the former, thus the connected parts making up the whole course, of which the marrow contains the first and second law of thermodynamics. The first law of thermodynamics is the base of TE and the key of students to learn the course, proclaiming the numerical conservation of energy when it's being transferred or converted and deriving many other basic concepts. However the first law merely describes common characteristics of various modes of energy, it overlooks the nature of energy's transfer and conversion process, which is elaborated by the second law. In this sense, the second law is independent from the first law and of great theoretical and practical meaning, because it has solved the problem of direction and practicability of thermal processes. What's more important, it introduces the concept entropy to analyze thermal processes [3]. Therefore internal links of the course's main contents need to be explained to enable students systematically master the whole course and the proper methods of thermal analysis. The main task of this course is to explain basic concepts, theories and laws, for example, ideal gas, status parameters, status formulas and thermal processes. Only by understanding those basics can students learn the whole course well from the tutor's effective lecture in class.

#### *C. Flexibly teaching according to students' responses*

TE consists of mainly two parts, i.e. engineering thermodynamics and heat transfer. The course is quite complicated with dozens of concepts and mutually related knowledge points in each chapter. Students would easily miss the key points, mistake with basic concepts and superficially take the basic thermal laws. Consequentially, they will hardly be able to apply the knowledge to practical engineering. Therefore, in order to get students learn the course better, each chapter should be flexibly presented in its proper mode of teaching, for example, Question Mode, Inspiration Mode, Discussion Mode, and Case Mode etc. In class tutors should not present the content as ready-made knowledge but embed them into continuing questions, calling students up to concentrate on the

problems. This Inspiration Mode could motivate students' mind and imagination and develop their brain and logic by positive attempts to answer the questions. For example, when introducing the concept entropy, the tutor may put forward a question such as Does the rise of temperature certainly mean the substance has absorb heat? At first thought most students might applaud the answer yes by experience. After an instructed analysis using the idea of entropy, they will see more possibilities behind the question and better understand the concept [4]. However, the difficulty of questions should be appropriate for students to guarantee both good teaching outcome and enough interest of student. Response of students in class counts. Getting a tough time, the students should be allowed more time to think and catch up, raise different ideas and discuss in class. This kind of Discussion Mode is quite different from traditional Inculcation Mode. When explaining thermal circulation and related apparatuses, Discussion Mode can be utilized to lead students analyzing with their knowledge and mastering better the whole course as a system. Actually Discussion Mode can be used in many scenes through the class teaching, for example, after elaborating the property of wet air, the students could straight away be directed to analyze natural phenomena such as the form of rain, snow, and frost. They are triggered by life experience to think positively with motivated interest, so the class often appears in heated discussion, prompting better teaching effect. A great part of TE's ideas of theories are putting into application in engineering such as compressor, internal combustion engine, refrigeration, and heat pump etc, which can in return be presented as cases to explain their counterparts among basic theories and concepts. While as a basic course of engineering major, TE demands not any special engineering case but common ones enough to help students understand basic concepts and key points and be accustomed to learn theories from their application. The mounts of exercises in foreign textbooks of TE are good sources for such cases.

Bilingual teaching could be utilized appropriately in class according to the students' condition. TE is a very prudent course with lots of theories and concepts, it demands an all-around master and application of knowledge. A proper rate of English teaching can help students understand basic concepts and theories. Terminologies presented bilingually will help students understand and master the basics and facilitate reference to journals and materials in English without rendering the course more difficult.

Every student's aptitude and characteristics should be taken into consideration in the class as a whole, thus every student would attain knowledge and ability. An all-around development of the class supports individual development, while individual development drives an all-around development of the whole class [5]. The tutor needs to know the students as better as possible. Excellent students desire *more difficulty, more contents, more quickly and less waste of time*, they need to be fulfilled with more knowledge and exercises .Ordinary students run behind in *slower pace, faster response, and harder work*, they need help in grasping the key points and mastering the basics through concentration in class and diligence on exercises. Only by mutual help of the students and flexible teaching of the tutor can the whole class solidly master the whole course.

## **Reformation of teaching methods in TE**

### *A. Effectively utilize multimedia*

Multimedia can effectively aid the teaching by displaying the contents vividly and directly to students, but quick shift of the display has dramatically compressed students' time of digestion. Important concepts and formulas may therefore be overlooked, leaving students confused and boring by the course. In this case, multimedia should coordinate with traditional blackboard to present the content more effectively. For example, the first law of thermodynamics can be briefly remembered as the Energy Conservation Law, however, it's quite hard to be used in deduction by formulas. The image-mode vivid presentation of multimedia only helps remember the law well, while only on somehow boring blackboard can students learn to deduct step by step. What kind of method should be used depends on what part of content to get across. A combination of each method's advantage helps get the best teaching result.

Multimedia technology has injected new stimulus for teaching, especially in classroom. Advanced and visualized mode is replacing traditional mode of *books under pens, blackboard*

*behind mouth*. The class is filled with picture-text and phono-video combinations, allowing students to get stereo knowledge about the content through multi-type communication. Eventually comes better result out from higher effect [6]

#### *B. Effectively utilize material objects*

Simply oral introduction of engineering apparatuses and their components in TE course with the widely lack of engineering practice among students degrades teaching results. On the contrary, selected material objects according to teaching content such as products or models of cooling tower, vapor jet, piston air compressor and humidometre, improve teaching positively by help students understand the content directly and visually. Briefly speaking, material objects and models render students more impressive on the course, and vivid explanation of the tutor lays more sensation on the students and cultivates their three-dimension thinking style. Both boosted are the students' interest and the teaching effect.

#### *C. Effectively improve experimental teaching method*

Experiments uncover natural phenomena, verify science hypothesis and disciplines, explore unknown areas of science and perfect functions of science. Experimental teaching bases the teaching on experiments and is directive, practical and objective in better relating basic theories to engineering practice and helping understand the concepts and analyze practical problems. However, traditional experimental teaching method sets students to do experiments, record results and hand in experiment reports under the tutors' explanation of theories, apparatuses, content, and specification of the experiments. That is actually displaying teaching method through confirmatory experiments, which can't inspire students' thinking and train them to independently design and complete researching experiments. Therefore it's necessary to add intensive content on theories and methods of experiment and experiments of comprehensiveness, design ability and research, which together enable students to master experimental research methods and techniques into thermodynamic processes, train their capability of operation and inspire their creativity.

## **Conclusion**

Thermal Engineering is an extensive and profound principle and also a quite important professional basic course. There are already lots of valuable experiences out from researches by seniors and peers. We consider that there are principles but no modes of teaching. It needs us to adopt proper teaching plan and method based on teaching content and objects. Thus developing and integrating functions of different teaching plans and methods to truly teaching on students' responses. Then it is possible to get good teaching results and complete the task of cultivating qualified talents.

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