



# Research and Practice on Teaching Reform of Heat Transfer Course

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**Abstract.** According to the characteristics of Heat Transfer Course, such as too many basic concepts and principles, strong theory and abstract knowledge points, this paper adopts flipped classroom and introducing engineering cases to carry out the course teaching reform, and has achieved obvious results.

**Keywords:** Heat transfer · flipped classroom · reform in education

## 1 Introduction

The Heat Transfer Course is a science that studies the heat transfer law caused by temperature difference [1]. Most of the technical problems encountered in modern production fields and even many phenomena in nature are related to heat transfer, and almost any form of energy is dissipated in the environment and the universe in the form of heat energy. Therefore, heat transfer is an important technical foundation course for most engineering majors such as energy, power and civil engineering, and it is also one of the most important technical foundations for the development of science and technology today [2]. Learning this course well not only affects students' study of follow-up professional courses, but also affects students' ability to solve practical heat transfer problems in future work.

## 2 Problems in the Teaching of Heat Transfer

### 2.1 Characteristics of the Course Itself

The knowledge framework of Heat Transfer Course is clear, which mainly includes three basic heat transfer processes: heat conduction, convection heat transfer and radiation heat transfer and their comprehensive applications. But there are too many basic concepts and principles in the course, which characterized by theoretical and abstract. It can be summarized as: there are many concepts, which are easy to be confused; There are many formulas and the derivation process is complicated, which is difficult to remember; The abstract content is difficult to understand, but the application is flexible and difficult to master [3]. In addition, due to the publishing cycle of textbooks and other issues, heat transfer problems in many professional frontiers cannot be reflected in textbooks.

## 2.2 Problems Existing in Teaching

First, as a teacher's main body, Heat Transfer is a basic course for energy and power majors, which lays the foundation for follow-up professional courses and future work. This requires teachers to have a good understanding and grasp of the connection between teaching content and practical engineering application, as well as the connection between follow-up professional courses. However, most teachers simply teach the textbook content in the course of teaching, focusing on the teaching of concepts, theorems and the derivation of formulas, but rarely mention how to apply this knowledge point in future professional courses and how to use this knowledge point to solve practical engineering problems, which leads to students' rote memorization of knowledge points but can't apply what they have learned. Second, students are the main body, because they haven't been exposed to specialized courses, they don't know much about their future work, their learning objectives for this course are unclear, they lack learning enthusiasm and initiative, and their dependence on textbooks, teachers and classrooms is high, so they are still passive receivers in learning cognition. In addition, "Heat Transfer" contains a large number of mathematical formula derivation and simplification processes, and students' interest in theoretical courses is weakened, so that their understanding of knowledge only stays in simple conceptual memory, and they don't really grasp its essence and connotation, and lack the flexible application of knowledge points [4]. Third, the teaching methods and ways, the traditional indoctrination teaching, almost all of which are explained by teachers in class, while students only passively attend classes. For typical examples, most teachers ask themselves and answer them, and directly teach students the methods and steps to do them. Although it seems that teachers are skilled in lectures and students are relaxed in lectures, this kind of teaching method can't cultivate students' ability to analyze and solve problems independently.

## 2.3 Problems Existing in Curriculum Assessment

In the course assessment, the final grade and the usual grade account for 70% and 30% respectively. From the point of view of the composition of scores, the grade mainly depends on the test scores, and the usual grade accounts for a small proportion. At the same time, there is a single evaluation method, emphasizing the results and neglecting the process; Neglecting the communication between evaluators and evaluators and the distortion of evaluation information, it is necessary to reform the evaluation mode to solve the problems that traditional evaluation can't truly reflect students' ability and level and can't drive effective teaching and learning [5]. In order to give prominence to quality education, we should strengthen the monitoring of students' usual learning quality and increase the proportion of their usual grades.

# 3 Measures Taken in Curriculum Reform

## 3.1 "Online + Offline" Deep Integration, Explore the Implementation of Online Flipped Classroom

Dig deep into high-quality online resources, and make use of online learning resources of Heat Transfer on the platform of MOOK network of Chinese universities, so that students

can preview and review in advance. At the same time, the online test bank resources of heat transfer courses are established through learning, and the topics and assignments are discussed through learning, so that students can consolidate and practice the courses they have learned offline in time. At the beginning of the semester, the teachers of the research group selected two teaching contents suitable for one class hour from all chapters. Through the learning platform, relevant learning videos are pushed to students for pre-class study, and online teaching activities are carried out in the form of flipped classroom in class. Through interactive teaching, online communication before class, group discussion in class, and evaluation of after-class exercises, the classroom teaching mode is changed from “teaching before learning” to “learning before teaching”, giving students more learning initiative, which can effectively solve the common problems in online teaching such as inactive classroom atmosphere and inability to carry out effective interaction [6].

In addition, before class, teachers should prepare for students’ good and bad performance in class:

- (1) The flip class courseware is beautifully made, the knowledge points are clearly explained, and most students can master the content of this lesson. The rest of the time will be spent practicing in class and explaining exercises.
- (2) Most students can’t grasp the contents of this section because of inadequate preparation of the flipped classroom courseware and unclear explanation of knowledge points. In the rest of the time, the teacher will rearrange and re-teach the content of this lesson according to the important and difficult points in teaching, and the exercises in class will be pushed to the students as homework after class.

### 3.2 Promote Learning by Competition and Stimulate Learning Enthusiasm

Docking the “National University Artificial Environment Science Award” professional basic competition and typical heat transfer test questions of postgraduate entrance examination in major universities, organically integrating the relevant contents into the teaching, distributing the test questions of the competition to everyone in the form of usual homework, and organizing the classroom knowledge competition of Heat Transfer at the end of the term, aiming at enhancing the classroom interest and stimulating students’ learning enthusiasm.

Enhance students’ extracurricular learning ability, arouse students’ enthusiasm, and divide the teaching process into three stages: pre-class preparation, classroom teaching and after-class expansion. Pre-class preparation focuses on stimulating students’ interest in learning, cultivating their autonomous learning ability, requiring students to independently complete online teaching videos before class, increasing the proportion of students’ extracurricular learning, and keeping students busy; Classroom teaching pays attention to teachers’ guiding role, adopts task-driven method to complete corresponding tasks, and helps students explore new knowledge; After-class expansion focuses on improving students’ ability and their comprehensive quality. Combined with “Rain Classroom” and other blended teaching modes, we should change the channels and ways for students to acquire knowledge, improve students’ participation in class, and enhance the interaction between teachers and students.

**Table 1.** Example of course ideological and political element mapping and integration points

Knowledge point	Curriculum ideological and political mapping and integration points
The Application of Heat Transfer in Production Technology	Peak carbon emission and achieve carbon neutrality
Thermal conductivity	Technology cutting-edge—New building materials
Fourier law	the spirit of workmanship
Development history of heat transfer	Make the students understand the truth, dare to challenge the authority of the truth
Condensation heat transfer	Technology cutting-edge—The Application of the lotus leaf effect
Boiling heat transfer	Highlight the importance of production safety
Strengthening and weakening of heat transfer	Inspire students to establish energy conservation and environmental protection awareness, establish and improve the efficiency of energy conversion thinking mode
Critical insulation diameter	Through the critical insulation diameter, some things are not the more the better, to moderation, moderation, otherwise it will backfire

### 3.3 Join the Ideological and Political Elements and Strengthen the Ideological and Political Consciousness

In the process of teaching design, the elements of ideological and political education should be deeply excavated to realize “all-round education”. We will organically combine current political hotspots and social news cases with teaching content, and organically combine ideological and political elements, professional quality and teaching content [7]. For example, for the control of heat transfer process, we can combine the latest energy-saving materials and energy-saving measures to help students establish awareness of energy conservation and emission reduction, and cultivate students’ sense of responsibility; For Fourier’s law, we can carry forward the spirit of “great country craftsman” to students by combining the examples of thousands of experiments conducted by previous scientists to obtain reliable data; For boiling heat transfer in large vessels, safety education can be carried out in combination with the concept of critical heat flux, emphasizing the importance of safe production. Table 1 lists some examples of the mapping and integration points of Ideological and political elements in the curriculum.

### 3.4 Introduce Life Examples and Engineering Cases Step by Step

In the teaching of Heat Transfer, the concept of CDIO education and training is introduced [8], the course content is arranged according to the idea of first foundation, then synthesis and then innovation, and professional application cases close to engineering practice are added. The analysis of complex heat transfer process is emphasized, students are

**Table 2.** Examples of integrating CDIO education and training concepts into the classroom

Thermal conductivity	Example in life	Why is the kettle handle wrapped up with rubber? Plastic and stainless steel spoon into hot water, which spoon in the butter melts faster?	Basic level
	Project case	Building energy-saving materials	Comprehensive level
	Improvement measures	1 Structure transformation 2 Choose materials with small thermal conductivity 3 Increase the thickness	Innovation level

encouraged to take the initiative to learn and practice, and the cultivation of students' analytical ability, innovative spirit and cooperative consciousness is strengthened. Table 2 is an example of integrating CDIO education and training concept into classroom.

### 3.5 Reform the Way of Course Assessment and Increase the Process Assessment

In terms of examination, the total score of heat transfer course in our school is composed of the final examination score (70%) and the usual score (30%). Students' grades are assessed according to the classroom performance, the staged tests and the grades of their homework at ordinary times. Judging from the composition of scores, the scores mainly depend on the final exam results, and the usual scores account for a small proportion. In order to highlight the cultivation of applied talents [9], we should strengthen the monitoring of students' usual learning quality and increase the proportion of their usual grades to 50%. Incorporate staged tests, online learning, course group scoring, etc. into the process assessment, and update students' usual grades in real time every month, so that students can see their usual performance, encourage students with lagging grades to try to catch up, and ensure that every student does not fall behind.

## 4 Conclusion

Through the practice of this teaching reform, the research group has achieved certain results. Teachers actively participate in teaching and training, carry out teaching research, and take the initiative to build courses and majors. Relying on this course, teachers have won many successes in ideological and political teaching competitions and young teachers' lecture competitions. A variety of modern teaching methods, such as flip classroom,

online and offline mixed teaching and so on, are combined to form a lively classroom teaching atmosphere. At the same time, the interactive discussion between teachers and students enhances the classroom attraction, and students have a lively classroom atmosphere and concentrate. Combining with the CDIO education and training concept, students can form a team to learn by doing and learning by doing through specific engineering cases, and constantly think critically to improve their ability to find, analyze and solve problems.

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