

# Exploration and Construction of Ecological Teaching Mode of “Fundamentals of Mechanical Design” Course

## -- A Case Study of Zhaoqing University

Huicun Shen<sup>1</sup>, Xiao Shen<sup>1,\*</sup>, Junhua Chen<sup>1</sup> and Yunqian Chen<sup>2</sup>

<sup>1</sup>Zhaoqing University, Zhaoqing, Guangdong 526061, China

<sup>2</sup>Zhongyuan University of Technology, Zhengzhou, Henan 450000, China

### Abstract

**This paper explores and constructs a harmonious, efficient, intelligent, energetic and sustainably improved teaching ecology of “Fundamentals of Mechanical Design” course by reforming the teaching concept, content, mode and assessment and evaluation of the course according to the actual situation and current situation of the mechanical design fundamentals course offered in Zhaoqing University.**

### Keywords

**“Fundamentals of Mechanical Design” Course; Teaching Reform; Eco-teaching.**

### 1. Introduction

The course " Fundamentals of Mechanical Design " is an important professional foundation course for mechanical and near-mechanical majors, which has a wide audience and benefits a lot, and provides the necessary theoretical foundation for students to study mechanical courses in the future. "Fundamentals of Mechanical Design" course has a long history in Zhaoqing University, since its establishment in 1970s, the teaching of the course has gone through decades of inheritance and accumulation, and experienced time and time again the baptism. With the continuous expansion of the school's professional categories, the course construction of "Fundamentals of Mechanical Design" course has been developed together with the school, and it has become more and more perfect and mature in terms of teaching foundation, teaching conditions, teaching scale and faculty. In order to implement the spirit of the National Conference on Undergraduate Education in the New Era, "colleges and universities should deeply integrate modern information technology into education and teaching, make efforts to promote the renewal of curriculum content, promote the classroom revolution, reform the traditional teaching and learning forms, create a smart learning environment, explore the implementation of intelligent and precise education, improve teaching effectiveness, and cultivate students' core competitiveness in the age of intelligence. "[1]. In 2019, the School of Mechanical and Automotive Engineering of Zhaoqing University set up a teaching team of " Fundamentals of Mechanical Design " catechism, which provided strong support for the reform of " Fundamentals of Mechanical Design " teaching. The importance and necessity of Internet-based teaching. After more than three years of exploration and practice, the teachers of the course " Fundamentals of Mechanical Design " successfully completed the teaching tasks under the epidemic, which provided a further practical background for the exploration and construction of the course " Fundamentals of Mechanical Design " ecological teaching mode. The construction, reform and development of "Fundamentals of Mechanical Design" course are of great significance for the reform of undergraduate teaching in the new era based on the inheritance of traditional teaching essence, the integration of Internet and information technology, the adaptation to daily teaching under the normalization of the epidemic, and the

challenges of teaching and education concepts and methods under the construction of new engineering disciplines.

Due to the wide range and universality of "Fundamentals of Mechanical Design" course, institutions have done a lot of meaningful work on the teaching reform and research of this course, some have explored the reconstruction of the course content system [2]; some have specialized in the design of Civics [3]; some have thought about the assessment and evaluation mode [4]. Some have made innovations in the teaching mode [5]; some have done targeted exploration and research on course teaching [6]. In this paper, according to the actual situation and the current situation of "Fundamentals of Mechanical Design" course in Zhaoqing University, we integrate all aspects of the teaching of "Fundamentals of Mechanical Design" course, through the reform of the teaching concept, content, method, mode and assessment mode of the course, combined with practical experience, from the ecological teaching mode to the ecological teaching mode. Through the reform of the course teaching concept, content, method, mode, assessment method and other aspects, combined with practical experience, the reform method and implementation path of "Fundamentals of Mechanical Design" course teaching are explored from the perspective of ecological teaching mode construction, in order to build a harmonious, efficient, intelligent, dynamic and sustainable improvement of "Fundamentals of Mechanical Design" course teaching ecology. The aim is to build a harmonious, efficient, intelligent, dynamic and continuously improving teaching ecology of "Fundamentals of Mechanical Design" course.

## **2. Basic Concept and Main Ideas of the Construction of Eco-teaching Model**

The word ecology, which originated in ancient Greece, originally meant "shelter" or "habitat". Simply put, ecology refers to the state of existence of all living things and the interlocking relationship between them and their environment. With the development of the word, ecology means how to coordinate with the environment and sustainable development. Nowadays, the word ecology has penetrated into various fields, and people often use ecology to define many beautiful things, such as healthy, beautiful, harmonious and vibrant things. The main idea of "Fundamentals of Mechanical Design" course reform is to explore and build the "Internet + teaching" ecology, and effectively integrate information technology and Internet resources into traditional teaching. By adjusting the teaching content, innovating the teaching mode, reforming the assessment method, and implementing the traditional and modern, online and offline, in-class and out-of-class hybrid teaching through the construction of catechism, flipped classroom, intelligent teaching and other flexible forms, we promote the classroom revolution of "Fundamentals of Mechanical Design" course teaching, cultivate students' ubiquitous learning and stimulate students' deep learning. In order to achieve the emotional quality goal and knowledge and ability goal of the course teaching, to realize the student-centered and output-oriented education concept, to implement the fundamental task of establishing moral education, to deepen the education and teaching reform, and to continuously improve the quality of personnel training.

## **3. The Main Methods and Implementation Paths of Eco-teaching Model Construction**

### **3.1. Ecological Content of Teaching**

"Fundamentals of Mechanical Design" course and related courses have a wide audience in schools and benefit a large number of people. Because of the rich teaching content of "Fundamentals of Mechanical Design" course, it is roughly divided into the following five parts: "Composition of mechanism and introduction to mechanical design" mainly about the

structural analysis of plane mechanism, introduction to mechanical design and application of modern design method, which is the common basic knowledge of mechanism and mechanical design. Mechanical design is a common basic knowledge of institutions and mechanical design; "common institutions" mainly from the perspective of transferring motion about some common institutions (such as linkage mechanism, cam mechanism, wheel system and other common institutions) working principles, applications and motion design methods; "mechanical transmission" mainly from the perspective of transferring power about some common institutions. From the perspective of transferring power, "mechanical transmission" mainly describes the working principle, standard specification and design calculation method of some common mechanical transmission (such as belt transmission, chain transmission, gear transmission and worm gear transmission, etc.); "shaft system components" mainly describes the shaft system (including sliding bearings, rolling bearings, shafts, couplings, clutches and brakes and other major components) Mechanical coupling" introduces the working principle, standard specification and calculation method of common mechanical static coupling (including key, pin and threaded coupling) and elastic coupling (spring) [7]. In the face of different professional categories and different basic teaching objects, in order to teach according to the material and target, the first step to build the ecological teaching mode of "Fundamentals of Mechanical Design" course is to start from the teaching content, clarify the teaching objects and teaching objectives, sort out the teaching content, teach according to the learning, study the graded teaching, reform the teaching content, reconstruct the teaching content and credit hours in different levels and specialties, and implement different teaching contents and hours. Teaching content and credit hours, implement differentiated teaching, highlight professional characteristics, select teaching content and improve teaching relevance. As shown in Table 1, the specific practices: First, according to the training objectives and credit hour requirements of different majors, the contents related to majors and disciplines are strengthened, and the contents with less relevance are weakened. The maximum number of theoretical teaching hours should not exceed 64 hours and the minimum number should not be less than 48 hours. In order to meet the needs of different majors, the content is divided into the course "Fundamentals of Mechanical Design A" and the course "Fundamentals of Mechanical Design B". Among them, the course "Fundamentals of Mechanical Design A" is provided for students of mechanical majors, with a total of 64 hours, for "Composition of Mechanism and Introduction to Mechanical Design", "Common Mechanisms", "Mechanical Drives", "Mechanical Engineering", "Mechanical Engineering", "Mechanical Engineering" and "Mechanical Engineering". The content of "mechanical transmission", "shaft system components" and "mechanical connection" is taught in more detail, and supplemented by online self-study. The course "Fundamentals of Mechanical Design B" is offered to students of nearmechanical majors for a total of 48 hours, which includes "Introduction to Mechanism Composition and Mechanical Design", "Common Mechanisms" and "Mechanical Drives". and "mechanical transmission" are taught in more detail, while "shaft system parts" and "mechanical connection" are mainly self-study on line. Secondly, the experimental teaching of "Fundamentals of Mechanical Design" course provides "mechanism cognition experiment", "mechanism motion sketch mapping and analysis", "linkage mechanism Motion parameter testing and analysis", "Gears' modeling experiment", "Gears' parameter measurement experiment", "Convex contour line detection experiment", "Computer-controlled hard-supported dynamic bearing experiment". "computercontrolled hard-supported balancing machine test", "innovative design experiment of mechanism motion scheme", "mechanical parts cognition experiment", "bolt connection tensile experiment", "belt transmission characteristics", "sliding bearing experiment", "mechanical transmission system combination experiment "Mechanical transmission efficiency measurement and analysis", "shaft system combination design and analysis", "reducer assembly and disassembly experiment", "gear

efficiency experiment ", "Comprehensive experiments of mechanical transmission performance", "friction and wear experiments", "determination of spring characteristics", "basic experiments of fatigue strength". "fatigue strength basic experiment", "bicycle disassembly experiment" [8] and other experimental projects for different majors to choose. Each major selects at least 6 experiments not less than 12 hours, and students who are interested and have spare capacity can add other experiments. Third, lower the learning starting point and learning requirements for students with poor foundation, and progress step by step. For students with good foundation to guide students to learn on their own and additional extension training. The implementation of individualized teaching for students. Fourth, the introduction of the curriculum of Civics. In the teaching content to explore the elements of political thinking. The humanistic and interesting contents such as the development history of "mechanical engineering", mechanics in life and the frontier of mechanical engineering development are implanted. Combine the content of each chapter with the general education content and the way to teach the development of mechanical engineering and the future of the past and present. With the emotional content and humanistic feelings, we help students understand and master the rational and rigorous mechanical engineering concepts, so as to cultivate students' engineering feelings, learning interest, scientific literacy and innovation ability. Through the above four points, the teaching content of "Fundamentals of Mechanical Design" course is ecologically constructed, dynamically adjusted and flexibly configured to meet the needs of different disciplines and specialties, so as to provide practical teaching of "Fundamentals of Mechanical Design" course for the construction of new engineering disciplines. To better serve the cultivation of high-quality talents under the new situation.

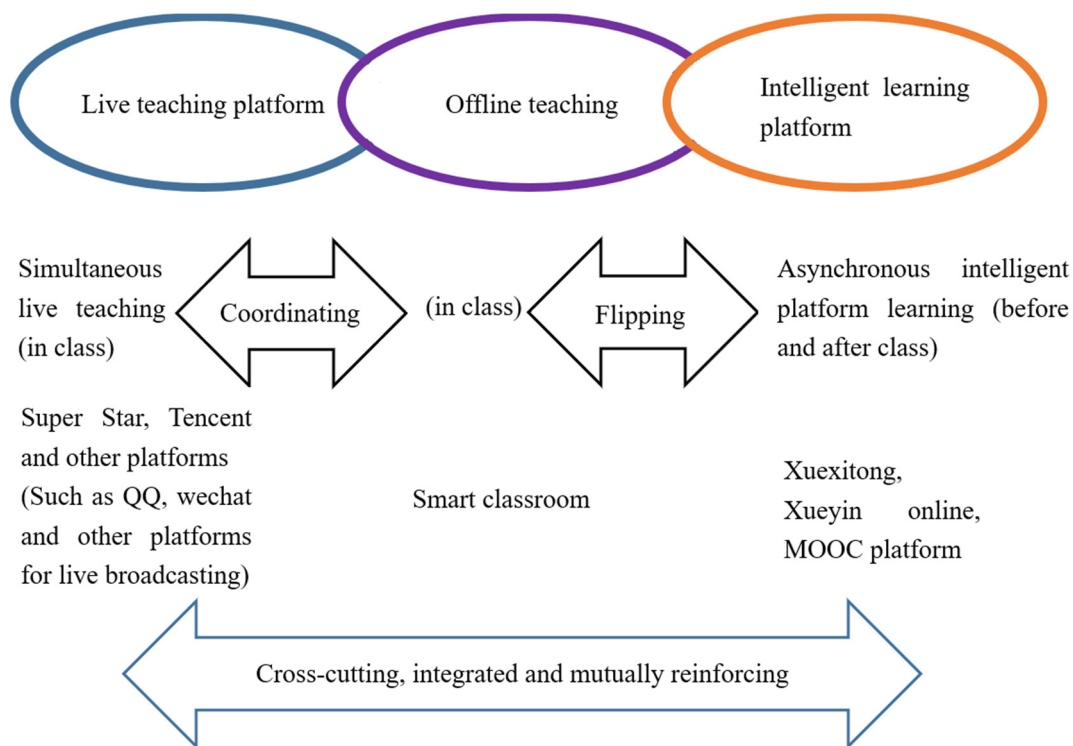
**Table 1.** Hierarchical and Grading Teaching of "Fundamentals of Mechanical Design" course

Teaching Content	Teaching Object	Theory Teaching Hours	Experimental Teaching Hours
"Fundamentals of Mechanical Design" course A	Mechanical major (required for majors)	64	18+ open
"Fundamentals of Mechanical Design" course B	Near-machine majors (required for majors)	48	12+ open

### 3.2. Ecological Teaching Mode

College students in the information age are all "natives" of the Internet, and they have a natural affinity for the Internet, and the information they get from the Internet is more easily accepted by them. Therefore, using the means and methods of information technology and Internet resources to transform teaching is a necessary requirement to realize student-centered education. The key to the construction of the ecological teaching mode of "Fundamentals of Mechanical Design" course lies in the flexible application and organic integration of diversified teaching methods and teaching means. The rapid development of modern education technology and the Internet provides a strong guarantee for diversified teaching mode, reforming teaching methods and teaching means, changing the traditional single classroom lecture method, deeply integrating modern education information technology, enriching teaching means and flexible teaching process, breaking the boundaries of time and space, exploring traditional and modern, mixing online and offline and "Internet+" based classroom flipping ecological teaching mode. The ecological teaching mode of classroom flipping based on "Internet+" is an effective way of ecological teaching of "Fundamentals of Mechanical Design" course. In order to facilitate online teaching and students' online learning, we have made our own catechism "Appreciating Mechanical Engineering" as the warm-up and preparation content of "Fundamentals of Mechanical Design" course, which can be used as both pure online teaching content and flipped

content for offline teaching, and the self-made course content makes students feel more intimate. In the teaching format, according to the different chapter content, can be online, offline, mixed, and flipped, and use a variety of effective teaching methods and forms such as heuristic, discussion, inquiry, personalized, participatory teaching and assignment classes to strengthen communication between teachers and students and between students, guide students to think independently, enlighten students' thinking, stimulate students' learning initiative and autonomy, and enhance students' ability to apply network. The specific practice is shown in Fig. 1.



**Fig 1.** Schematic diagram of ecological teaching mode

On the one hand, students can use network resources and online wisdom learning platform to independently choose learning mode according to their own foundation and learning habits anytime and anywhere, and communicate and interact on the platform to improve learning efficiency, stimulate learning motivation, promote teaching efficiency, enhance teaching effectiveness, and help cultivate students' ability to propose, analyze, and solve problems; on the other hand, teachers are unable to conduct offline teaching situation such as during the epidemic, with the help of learning pass, Xue Yin online and Tencent QQ, WeChat and other platforms for live broadcast, and the offline flip transplanted to online, live lecture platform and online wisdom learning platform cross-fertilization, complement each other, and carry out a class of multi-teacher teaching. Offline live lectures can be conducted in smart classrooms, which is an effective way to internalize knowledge, solve difficult points to achieve flipping and enhance communication. Whether online or offline, teachers can choose different content and knowledge points according to students with different majors and foundations, reflecting differentiated and personalized teaching, and realizing the integrated teaching design of "online independent learning + offline teaching and discussing and flipping + after class extension" before, during and after class. Before class: teachers set tasks, students learn independently. During the lesson: teachers and students communicate and interact. Post-lesson extension: students expand and deepen their learning and thinking, learn to apply, and teachers reflect

and summarize, implementing a wisdom teaching with teachers directing, students acting, and catechism support to achieve flipping. This ecological teaching mode based on "Internet+" adopts multi-platform hybrid teaching and integrated design before, during and after class, so that students are supported in the whole process of learning and teachers are guaranteed in all aspects of teaching, so that the effect of multi-dimensional hybrid teaching can be realized.

### 3.3. Ecological Assessment and Evaluation

Develop course objectives and achievement thresholds, motivate students' learning commitment with a reasonable and effective evaluation system, change the closed-book exams that only assess students' mastery of knowledge, and add various forms of examination on students' ability to apply knowledge to analyze problems, solve problems and innovate, such as comprehensive class attendance, the quality of completing exercises, writing learning experiences, subject papers, open-ended assessments, online learning examination, etc. Theoretical grade = final closed-book examination (50%) + ordinary time grade (30%) + half-term examination grade (20%). Regular grade = class attendance, homework, classroom performance, online independent learning, etc. Semi-termly exam grade = closedbook (or open-book) exam grade. Lab exam score = lab operation exam (40%) + lab theory exam (open book 20%) + usual operation skills (10%) + lab report (20%). Mid-class evaluation (offline): Evaluation of classroom performance by means of peer evaluation and teacher comments. Midterm evaluation (offline): evaluation by understanding, interviewing students and communication between course team teachers. End-of-term (online) evaluation: evaluation through questionnaires, online interactive messages and comments and teaching and learning evaluations from the faculty system. This multi-dimensional and flexible ecological assessment and evaluation mechanism can not only objectively examine students' mastery of all aspects of the course, but also stimulate students' motivation and interest in independent learning and achieve the emotional, knowledge and ability goals of this course.

## 4. Initial Results and Shortcomings of the Construction of the Ecoteaching Model

After continuous exploration and practice, the construction of the ecological teaching mode of "Fundamentals of Mechanical Design" course in Zhaoqing University, for example, has achieved obvious results. The focus is to innovate the teaching content system, optimize and reconstruct the teaching content, integrate the elements of Civic and Political Science into the curriculum, achieve the emotional and quality objectives, and at the same time adhere to the standard of both sexes, study the graded teaching, adjust the teaching content according to the different teaching objects and teaching objectives of different majors, teach according to the learning, teach according to the material, the content has both breadth and depth, reflect the differentiation and personalized teaching, and update the teaching resources and teaching content in real time to keep up with the times. The teaching resources and teaching contents are updated in real time to keep up with the times. It also innovates the form of assessment and adopts a multi-dimensional, flexible and diversified assessment and evaluation mechanism to achieve emotional, knowledge and ability goals. The highlights are the richness of teaching resources, the flexibility of teaching modes, the hybrid teaching of online and offline, the application of MOOC and classroom flipping, etc., which innovate the relationship between teaching and learning, change the traditional teaching of a single form of teachers desperately speaking and students passively listening, and change the teaching relationship from the traditional teacher-centered to student-centered.

In the process of practice, we also found some shortcomings and problems, such as students' lack of correct understanding of the importance and necessity of learning this course; the uneven foundation of students from different majors and different places of origin; many course

contents and few hours of study, so it is difficult to master the knowledge system of this course comprehensively and deeply; the lack of supporting equipment and funds for intelligent teaching; the hybrid teaching and interaction between online and offline requires teachers to spend a lot of time and energy. It also requires students' self-awareness and autonomy in learning. In the future, it is necessary to further explore how to better stimulate students' interest in learning, cultivate their conscious learning habits and independent learning ability, how to carry out personalized and differentiated teaching more effectively, how to fully apply Internet and online resources, how to connect and integrate online and offline teaching and learning, how to connect theoretical teaching and experimental teaching, so as to build a more ecological "Fundamentals of Mechanical Design" course. "Fundamentals of Mechanical Design" course will be taught in a more ecological way.

## 5. Conclusion

This paper summarizes, describes and plans for the past, present and future of the teaching of "Fundamentals of Mechanical Design" course in Zhaoqing University from the basic concept, main ideas, main methods, implementation paths and preliminary results and shortcomings of the ecological teaching mode of "Fundamentals of Mechanical Design" course. In the past, the current situation and the future of the teaching of "Fundamentals of Mechanical Design" course in Zhaoqing University, we summarize, describe and plan. Inheritance and innovation in the exploration and construction of efficient, harmonious, intelligent, dynamic and sustainable improvement of the "Internet +" "Fundamentals of Mechanical Design" course teaching ecology, for the new situation of undergraduate talent training to provide a powerful support of "Fundamentals of Mechanical Design" course in the new situation.

## Acknowledgments

This work was supported by '2020 Zhaoqing University Quality Engineering and Teaching Reform Project (No. zlgc202052).

## References

- [1] Chen Baosheng. Speech at the National Conference on Undergraduate Education in New Era [J]. China Higher Education,2018,(Z3):4-10.
- [2] Yang Songhua, Liu Xiulian. Research on the basic curriculum system of mechanical design based on the cultivation of innovation ability [J]. Value Engineering,2017,(18):228-229.
- [3] Lu Hao, Wang Wei. Design and practice of thinking and teaching of "Fundamentals of Mechanical Design" course [J]. Education Teaching Forum, 2020, (30): 81-82.
- [4] Qi Xuemei, Zhang Jian, Zhang Jingdong. "Fundamentals of Mechanical Design" course assessment reform and practice [J]. Journal of Mudanjiang University,2016,25(8):168-170.
- [5] Dai Qingwen. Exploring the diversification of teaching content and teaching mode of "Fundamentals of Mechanical Design" course [J]. Industrial and Information Technology Education, 2018,(11):59-62.
- [6] Su Naiquan, Chang Xiaoxiao, Zhou Ruiqiang, et al. Exploration on the construction of "Fundamentals of Mechanical Design" course for "new engineering" [J]. Education and Teaching Forum, 2020, (52): 208-209.
- [7] Guo, R.S., Wei, Xuan-Yan; Huang, Chen-Hua. Fundamentals of Mechanical Design (5th edition) [M]. Beijing: Tsinghua University Press,2021.08.
- [8] Lin Xiujun, Wu Songshan, Lu Wenge, Cheng Siyuan. Experimental guide to "Fundamentals of Mechanical Design" (2nd edition) [M]. Beijing: Tsinghua University Press, 2019.06.