Research on the Application of Mixed Teaching in Interchangeability and Measurement Technology Course

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Abstract: Interchangeability and measurement technology is a required course for mechanical design and manufacturing and automation, mechanical and electronic engineering. It is also an essential professional basic course in the curriculum system to support graduation requirements. In order to fit the results-oriented education concept, this paper combines with the problems faced in the teaching of interchangeability and measurement technology, implements the mixed teaching reform combining online and offline, and adopts the multi-evaluation system, inspire the students to learn the autonomy.

Keywords: Interchangeability and Measurement Technology; Hybrid; Multiple Assessment; Degree of Achievement of Curriculum Objectives

1. The Current Teaching Situation of Interchangeability and Measurement Technology

Interchangeability and Technical Measurement is a fundamental course in the field of mechanical engineering. Durying the student's regular college course career, it is a precision language for the design, manufacturing, and measurement of mechanical components is derived from "mechanical drawing" and "mechanical design", "mechanical manufacturing technology", and "graduation design". The course mainly focuses on the precision design of mechanical products, aiming to cultivate students' ability to inspect and judge products and components. In terms of course characteristics, the course has many specialized terms, symbols, abstract concepts, no derivation of formulas, or very difficult to understand content. According to the observation and analysis of the teaching process, students generally feel that it is easy to learn at the beginning, but as they deepen their learning, they will learn more defined concepts, code symbols, various standards, and content that needs to be memorized, leading to confusion and a lack of proactive thinking about knowledge, for example, tolerance zones and fits, same name fits, general and special rules, tolerance item annotations, maximum (minimum) entity boundaries, maximum (minimum) entity effective boundaries, and other abstract and difficult to understand contents[1,2]. In the teaching process, due to the rigid constraints of class hours, there is less explanation of theoretical knowledge in engineering application examples, and the attention to the emotional value gained by students is low. In terms of examination and assessment methods, the process evaluation indicators are not perfect enough, and the support for comprehensive evaluation of students and continuous improvement of courses is insufficient.

The first reason for this is that the teaching process places too much emphasis on explaining and mastering theoretical knowledge, lacks engineering examples, and students lack motivation to learn. The second is excessive reliance on classroom learning, which leads to unreasonable planning for students' extracurricular learning. The third is that the process evaluation is not targeted enough, the evaluation system is not perfect enough, and there is a lack of specific quantitative standards for the educational observation points closely related to the curriculum, such as professional ethics, safety awareness, and social responsibility.

2. Clarify Teaching Objectives and Integrate Teaching Content

In response to the above issues, the course is guided and provided with professional certification as an opportunity, with the goal of cultivating mechanical professionals as the

starting point, benchmarking against the graduation requirements of students, and further clarifying the teaching objectives of the course. The goal of knowledge and skills is to enable students to apply basic theoretical knowledge such as commonly used dimensional tolerances and fits, geometric tolerances, surface roughness, and interchangeability principles of mechanical parts, accurately express geometric quantities related to mechanical accuracy in engineering drawings, correctly identify and judge tolerances and fit parameters in components, and be able to process and analyze measured data to obtain effective conclusions, By establishing an engineering perspective of integrating theory with practice and solving relevant practical engineering problems in the field of mechanical manufacturing engineering, a foundation is laid for engaging in mechanical precision design work. The value goal is to inspire students' scientific thinking and reasoning, establish a rigorous scientific research attitude, cultivate their spirit of actively exploring laws and scientific courage to face difficulties, and help students form correct values. As shown in Table 1.

Table 1. Training Objective Requirements for Course Achievement

Engineer knowledge	problem analysis	Design/Develop Solutions
Master the basic knowledge of mechanical and electronic engineering, and have the ability to apply it to solve mechanical and electrical engineering problems;	Being able to analyze the influencing factors of complex engineering problems in the field of mechanical engineering, verify the rationality of solutions, and obtain effective conclusions	Being able to comprehensively apply professional knowledge to optimize design solutions for complex engineering problems in the field of mechanical engineering, reflecting innovative awareness;

In order to better support the graduation requirements, the course knowledge has been modularized and integrated into five modules: Introduction module, Dimensional Precision Design module, Geometric Precision Design module, Surface Profile Precision Design module, and Typical Component Precision Design (Rolling Bearings, Cone Joint, thread Joint). The content is progressive and more in line with the cognitive laws of students. On the one hand, the course content closely follows the three core modules of dimensional accuracy design, geometric accuracy design, and surface contour accuracy design, highlighting key points and focusing on solving confusing or closely related terms. On the other hand, teachers use various teaching methods such as heuristic, case-based, and discussion to help students clearly understand the organization and relevance of the course, pay attention to using tolerance related standards to design part accuracy, and use measuring instruments to test parts to solve practical engineering problems, laying a solid foundation for subsequent professional courses and even future work.

In addition, the course closely revolves around the fundamental question of "what kind of person to cultivate, how to cultivate, and for whom to cultivate", deeply explores patriotic elements closely related to knowledge points, and permeates engineering literacy, dedication, dialectical thinking, etc. into the learning of various modules such as tolerance fitting basic knowledge, mechanical component precision design, etc., transforming education into concrete and vivid cases. This not only clarifies the specific content of teaching and educating students, but also enhances their learning enthusiasm, which is conducive to the improvement of teaching quality.

3. Implementation of Blended Learning

Aiming at the above-mentioned problems, this course takes the training goal of mechanical specialty as the starting point, and further clarifies the knowledge goal, ability goal and quality emotion goal of the course for the graduation requirements of the target students. The knowledge capability objective is to enable students to apply basic theoretical knowledge such as common tolerances and fits for mechanical parts, geometric tolerances, Surface roughness, interchangeability principles, etc., the geometric quantities related to mechanical precision in engineering drawings can be accurately expressed, and the tolerance and matching parameters in parts can be correctly identified and judged, to set up the engineering viewpoint of combining theory with practice and solve the related practical engineering problems in the field of mechanical manufacturing engineering, so as to lay a foundation for the work of mechanical

precision design. The goal of quality emotion is to inspire students' scientific thinking and reasoning, to set up strict scientific research attitude, and to cultivate students' active research spirit and scientific courage, help students form correct values [3].

At this stage, the traditional classroom teaching, learning time, place fixed, teaching process is simply through multimedia courseware, blackboard and computer three-dimensional solid model to show. The multimedia teaching stay time is short in the brain. This situation causes the students have not a deep understand and memory time is not enough, and teachers can use the teaching time is limited, unable to meet the current teaching goals. Based on this reality, the course takes advantage of online learning without time and space constraints, using modern information technology to support classroom teaching. Taking the learning pass as the main learning platform, the online resources are constructed and perfected. It mainly includes learning-guide, Courseware, Exercise Bank, Engineering animation video, extracurricular expansion, etc [4-5] and .it provides the precondition for the implementation of online and offline mixed teaching.

Under the mixed teaching mode, teachers need to plan and integrate the curriculum content, students finish the study of related knowledge ahead of time. So teachers will focus on difficult knowledge content and education. In the classroom, students and teachers can fully interaction and exploration. At the same time, students will also be extended to the course of study before and after class. The mixed teaching of interchangeability and measurement technology includes the following three aspects.

(1) Pre-class link: make good use of online learning resources and do a good job of course subtraction. Before the class, the teacher according to the degree of mastery of knowledge, such as easy-to-learn, easy-to-understand basic knowledge to guide students to self-study, and send a learning task list. Students can learn through the pass, WeChat Group, QQ Group, and other ways to receive a learning notice, and in the prescribed time to complete the video watching knowledge points and other learning tasks. For the problems encountered in autonomous learning, can be on the platform of the discussion area with students or teachers to discuss. Finally, through the completion of the learning platform test, the teacher can be helped to master the students' preview, help online teaching condition, to develop students' self-learning, lifelong learning ability.

(2) In-class link: in the course of class, the teacher changes the original one-way output mode, improves and optimizes the link of class teaching, and trains the students' ability of finding, putting forward, analyzing and solving problems, do a good job of course addition. By adopting the methods of project-based teaching and turning over the classroom, teachers become the organizers of the classroom, at the same time, the discussion and practice links are increased. Teachers carefully design the classroom teaching links, research-based learning is developed. In the course of teaching, the beginning of classroom teaching is to explain or discuss the problem before the class settled up in the learning platform as a teacher to answer questions from students. Then the teacher through the way to answer the questions of students, to start the teaching activities of this section of the curriculum. During this process, the teacher organizes students to randomly group and briefly discuss the pre class self-learning content on the Learning Platform. Through interactive communication, the teacher exercises students' communication and self-learning abilities with others. Finally, the teacher answers any questions that arise during the discussion and summarizes the classroom discussion.

When explaining the knowledge of dimensional accuracy design in class, project-based teaching is adopted using a low-speed shaft of a certain reducer as an example. The structural characteristics, usage requirements, and dimensions of each journal have been determined, and dimensional tolerances need to be designed and marked. During the project implementation process, the total tasks that need to be completed are decomposed into specific small tasks, ultimately achieving the completion of this project [6]. According to the basic learning situation of the students, the teacher divides them into reasonable groups, usually consisting of 5-6 people, with one team leader appointed to coordinate the work division of each member in the group, discuss design

plans, etc. While students attempt to complete project tasks, teachers set targeted thinking and discussion questions to guide students in completing project analysis. For example, the thinking content includes the calculation, table lookup, and variation patterns of standard tolerances and basic deviations; Notes on dimensional tolerance annotation; the relationship between accuracy level, processing method, and applicable occasions; Principles and methods of selection and coordination. Finally, the teacher summarizes and analyzes to enable students to obtain correct perspectives and systematic knowledge.

(3) After class session: Effectively utilizing information technology to enhance students' after-school practice, challenging homework was arranged for students, and situational, story based, non-standard answer exercises and exams were introduced, making learning more warm, enjoyable, and creative. The specific approach is to utilize students' spare time after class to answer questions and clarify doubts, and promptly solve their knowledge difficulties and learning difficulties. On the other hand, by establishing a teaching assistant team to regularly release online information and communicate online, and the learning outcomes can be timely consolidated. Teachers select some students as teaching assistants, which not only cultivates their sense of responsibility but also stimulates their learning enthusiasm.

In addition, by comparing and analyzing the content of our school's metalworking internship with the knowledge of this course, we can identify the combination of the two and improve the learning effectiveness of students. One of the tasks in the metalworking internship is to have students process and manufacture a small hammer, and the process of processing the hammer involves reading drawings, measuring, and inspecting, all of which are closely related to the course of Interchangeability and Measurement Technology. When machining hammer handle parts on a regular lathe, the main teaching objective is to enable students to understand the composition of the lathe and the machining surfaces that can be achieved, read and follow the drawings, select appropriate machining schemes, and independently complete the machining process. Finally, have students measure and inspect the processed parts, and write a report to help them understand which part of the operation caused the shape and position tolerances after processing, as well as the impact of errors on the product. At the same time, select specialized measuring instruments to measure surface roughness and analyze the effects of different factors. In this way, through metalworking internships, students can combine their learning with real-life processing scenarios, experience the learning process of combining theory and practice, and gain a sense of achievement.

Finally, when completing a chapter, collect online statistical data, analyze relevant data on the utilization of teaching resources by students, and timely grasp the dynamic process of learning. The overall teaching process has formed a student-centered closed loop, a blended teaching model that combines precise lectures and discussions, achieving seamless connections between pre class preview, in class learning guidance, and post class consolidation. This has improved the interactivity of teaching and student autonomy, and solved the contradiction between students' increasing innovative awareness and insufficient application of theoretical knowledge.

4. Diversified Assessment and Evaluation System

In addition to the design of learning activities, another aspect that blended learning needs to focus on is learning evaluation. In the reform process of the courses on interchangeability and measurement technology, in addition to assessing students' mastery of knowledge and skills, more emphasis is placed on their literacy and ability goals, achieving full process monitoring of learning status and learning outcomes [7]. Therefore, the course assessment adopts a combination of process evaluation and summative evaluation. In the process of teaching implementation, process evaluation accounts for 40%, and the assessment method extends from a single professional dimension to multiple dimensions such as professional competence, safety awareness, and social responsibility. It mainly includes group discussions, project assignments, PPT presentation and presentation, online testing. Among them, group discussions cultivate students' ability to

cooperate and communicate; Project assignments cultivate students' ability to use modern tools and better adhere to professional ethics and ethics; Online testing cultivates students' innovative abilities in analyzing and solving problems related to interchangeability and measurement technology; PPT presentation and presentation, classroom notes to cultivate students' lifelong learning ability, communication and collaboration skills; The proportion of each section is: 10% for group discussions, 20% for project assignments, 20% for chapter tests, 10% for classroom notes, 15% for PPT presentations and presentations, and 25% for healthy emotions reflections. The specific score evaluation method is: process assessment multiplied by 40%+final assessment multiplied by 60%=total score of 100%. Therefore, the learning effectiveness of students can be directly or indirectly measured digitally, and their achievement of learning goals can be assessed through diversified evaluation methods.

The Interchangeability and Measurement course was implemented through blended learning in the 2021 mechanical major teaching, and compared with the 2020 mechanical major that did not use blended learning. The achievement of course objectives was calculated using a combination of qualitative and quantitative evaluation methods. Practice has shown that after implementing the blended learning model, students have significantly improved their professional knowledge, abilities, qualities and emotions.

5. Summary

In this paper, by combing the current teaching situation, course nature and learning characteristics of the courses of interchangeability and technical measurement, and benchmarking the training objectives of professional talents, we have adopted the organic integration of traditional teaching mode and the Internet, and implemented mixed teaching; When teachers formulate teaching activities, more engineering cases and discussions are introduced, making students become practitioners who actively raise, explore, and solve problems, improving the fun of learning and the applicability of knowledge for students. When formulating a process oriented assessment plan, adhere to basic principles such as diversity and motivation, and strive to comprehensively and objectively reflect learning outcomes. The course of Interchangeability and Measurement Technology has undergone two cycles of teaching practice and comparison. Although implementing blended learning has increased the workload of teachers to a certain extent, it can timely discover imperfect teaching activities in the teaching process, grasp the learning situation in a timely manner, and adjust subsequent teaching strategies, which is beneficial for improving the achievement of teaching objectives.

Acknowledgments

This paper is supported by Research and Practice Project on Education and Teaching Reform of Xuchang University in 2023 (No. XCU2023-YB-52).

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