



Research on Teaching Reform of Engineering Drawing Course Based on Outcome-based Education

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Abstract. Engineering drawing is an important foundational compulsory course in the field of robotics engineering major. The Outcome-based Education concept was integrated into the teaching. The problem in traditional engineering drawing course teaching was analyzed, the course content was optimized, the teaching objectives was established, the course evaluation system was constructed, and the teaching effectiveness was improved. The self-learning ability of students was improved, and the ability of students to think actively was improved. The proposed method provides certain reference suggestions for the optimization of the engineering drawing course.

Keywords: engineering drawing; Outcome-based Education; teaching reform.

1 Introduction

The new engineering discipline is based on the new economy and new industries, emphasizing the practicality, intersection, and comprehensiveness of disciplines. The new engineering focuses more on the close integration of new technologies and traditional industrial technologies. Engineering drawing is an important foundational compulsory course in the field of robotics engineering major. The engineering drawing course is the foundation for students to learn subsequent professional courses. The teaching quality of this course will greatly affect the professional skills, comprehensive quality, and employability of students.

However, there are still various problems in engineering drawing courses in universities, the situation of students in learning and applying the course is not excellent [1-3]. The traditional teaching mode and assessment method of engineering drawing courses cannot meet the requirements of new engineering construction. Traditional methods cannot fully stimulate enthusiasm and enthusiasm of students for learning, and are not conducive to cultivating innovative and logical thinking.

OBE (Outcome-based Education, OBE) is an educational philosophy, which the learners are the center and learning outcomes are the guide. It is an educational approach that follows the principle of reverse design [4]. The learning of students is the center of the OBE education philosophy, and the goal is to achieve learning outcomes.

completed by students. The teaching philosophy has received widespread attention from colleges [5-7].

Zhang L. have conducted research on the goals, needs, processes, evaluation, and continuous improvement of learning outcomes in the mechanical drawing course using the OBE education concept [8]. The teaching reforms of engineering drawing course were carried out by Gao C. et al, including optimizing course content, setting teaching objectives, and constructing a course evaluation system, and the teaching effectiveness was improved [9]. Based on the positioning of school, professional talent training positioning, and socio-economic development needs, an applied undergraduate course system called Engineering Drawing and Computer Drawing was constructed by Zhong X. et al. [10].

However, the existing teaching reforms are mostly based on the characteristics of the curriculum and teaching experience. The problem in traditional engineering drawing course teaching was analyzed, the teaching models based on OBE was explored, and the practical application abilities of students was improved.

2 Current teaching situation of engineering drawing courses

2.1 Multiple teaching contents

The content of engineering drawing course is heavy, mainly divided into descriptive geometry and mechanical drawing. The course has strict requirements for the mastery of theoretical knowledge and practical practice. It is necessary to set up a certain number of practice lectures and drawing assignments. Taking Shandong University of Management as an example, the theoretical course of this course has a total of 32 class hours.

2.2 Poor professional foundation of students

The engineering drawing course is scheduled for the first semester of college. The understanding of professional knowledge of students is lack. And the understanding of the shape, function, and processing process of various mechanical components students is insufficient. All of these will reduce the interest of students in learning. As the difficulty of the course increases, the teaching effect of the course is not satisfactory.

2.3 Lack of process assessment

There are many teaching knowledge points in the engineering drawing course. The current assessment methods mainly rely on final exams. The examination on the mastery of knowledge during the learning process was not conducted. of the effective communication between students and teachers is insufficient.

3 Teaching Reform of Engineering Drawing Course

3.1 Reconstructing teaching objectives

The original teaching objectives of the engineering drawing course simply focused on mastery and learning of basic drawing principles of students. The supporting ideology for the graduation requirements of students is insufficient. The course teaching objectives, graduation requirements of student, and the building goals of new engineering disciplines are linked. The specific role of course teaching objectives in professional training programs of student is clarified. The contribution of course teaching objectives to achieving graduation requirements is clarified. According to the training objectives of the robotics engineering major, the Correspondence Matrix between Mechanical Drawing Course and Training Requirements for Robot Engineering Major is shown in Table 1.

Table 1. Correspondence Matrix between Mechanical Drawing Course and Training Requirements for Robot Engineering Major

Graduation requirements	Ability requirements
Engineering knowledge	high
Professional norms	high
Analyzing problem	high
Solving problems	high
Engineering ethics	high
Scientific research	medium
Communication skills	medium
Project management	low

The teaching objectives of the course are determined based on the requirements of the course and the training of the robotics engineering major. Teaching objectives include knowledge objectives, ability objectives, and quality objectives, as shown in Table 2.

Table 2. Teaching Objectives of Engineering Drawing Course

Number	Teaching objectives
1	Master drafting norms and standards, and have the ability to correctly apply drafting tools.
2	Master the basic knowledge and drawing methods of orthographic projection drawing, master the drawing methods of basic and composite bodies, and cultivate spatial thinking and analytical abilities.
3	Master the drawing method of sectional views, cultivate engineering perspectives and innovative thinking. Apply course knowledge and principle technology to robot engineering practice and design new products.
4	Ability to draw and read part and assembly drawings.
5	Cultivate teamwork and communication skills of students.

3.2 Optimize teaching content and methods

The professional skills required by the enterprise were understood, the course teaching contents were revised based on the goals of new engineering construction. The practical engineering cases of enterprises were integrated into drawing related knowledge. The teaching content could adapt to the needs of new technological development, the spatial thinking ability students was improved. And it can effectively combine theoretical teaching with practical teaching in the course.

On the basis of the original core content, combines typical Chinese craftsman engineering cases, the hot topics in the field of robotics engineering added into the course. The course teaching content was enriched. According to the characteristics of each chapter of engineering drawing, the teaching content was divided into three modules: drawing basics, basic skills, and mechanical drawing.

Teaching methods and means are important measures to stimulate students' interest in learning and achieve teaching objectives. In order to achieve better teaching objectives, starting from the learning situation and combining with the characteristics of the teaching content, various teaching methods were adopted, such as inspiration, case studies, project analysis and problem driven. And the active classroom atmosphere was formed and the amount of teaching information was increased. The reorganization and optimization of the main contents are shown in Table 3.

Table 3. Reorganization and Optimization of Engineering Drawing Course Content

Teaching content	Key points of teaching content	Teaching method
Drafting essentials	National standard for cartography	Project-based
	Expression method of mechanical components	Problem driven
Basic skill	Basic knowledge of projection	Heuristic teaching
	Projection characteristics of points, lines, and surfaces	Problem driven
	Projection of basic stereoscopic	Problem driven
Mechanical drawing	Expression of standard and commonly used parts	Case-based
	Basic knowledge of part drawings	Case-based
	Basic knowledge of assembly drawings	Project-based

Problem driven teaching method utilizes the curiosity of students, teaching content was planned by problems, and the teaching processes was designed based on exploring problem-solving solutions. Similarly, heuristic teaching aims and focuses on inspiring thinking of students, which the enthusiasm and initiative of students in learning was enhanced effectively.

Case-based teaching method is the teaching by the practical engineering cases. The ability of analyze and solve practical production problems was improved. And the team collaboration and communication skills were improved also.

Project-based teaching method is the entire process in which students independently complete all aspects of a project, including requirement information collection, scheme

design, implementation, and evaluation. The global awareness of students could be cultivated by this method, the mastery of knowledge was enhanced, and the application effectiveness was improved.

3.3 Reform evaluation methods

The original course evaluation method of mechanical drawing mainly relied on the acquisition of knowledge and skills as the standard, and the evaluation and assessment of comprehensive quality and ability of students is lack. It is contrary to the OBE teaching philosophy. The engineering drawing teaching evaluation system based on the OBE concept mainly evaluates the completion of teaching objectives and the mastery of teaching tasks. And the engineering literacy and problem-solving ability of students is evaluated comprehensively. Therefore, it is necessary to enrich the assessment methods and establish a feedback channel between teaching and learning. The regular evaluations are added, mainly including abilities and qualities, learning attitudes, and so on.

According to the new course content and assessment objectives, the in-class tests, unit tests, mid-term exam question banks, and final exam question banks were constructed and improved. The traditional assessment relies solely on homework to evaluate students' learning effectiveness, and various forms of process assessment such as classroom tests and unit tests were added. The classroom quizzes were supported by the digital teaching tool Rain Classroom. Unit test questions mainly consist of drawing questions, which focus on testing the operational and problem-solving abilities of students. A midterm exam was organized during the semester, which test the overall mastery of basic knowledge of students.

4 Conclusions

The teaching reform of engineering drawing courses based on the OBE teaching philosophy was conducted. The problem in traditional engineering drawing course teaching was analyzed, the course content was optimized, the teaching objectives was established, the course evaluation system was constructed, and the teaching effectiveness was improved. Students actively participate in learning, their abilities to solve complex engineering problems were improved, especially in engineering knowledge analysis, spatial problem analysis, and the use of drawing tools. The quality of talent cultivation in the field of robotics engineering could be improved.

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References

1. Zuo L, Zhu W, Wang Y, Wang Y, Yu X. (2024) Problems and Suggestions for Online Teaching in Special Period-Take the Course of Descriptive Geometry and Engineering Drawing as an Example. *Technology Wind*, 03: 60-62. 10.19392/j.cnki.1671-7341.202403020.
2. Gu M. (2024) Cultivation and Practice of Creative Thinking in Mechanical Drawing Courses. *Agricultural Machinery Using & Maintenance*. 02: 146-149.10.14031/j.cnki.njwx.2024.02.038.
3. Zhang J, Gao Y, Dong W. (2024) Exploration of Digital Teaching Mode for Mechanical Drawing Course. *The Guide of Science & Education*. 02:114-116. 10. 16400/ j. cnki. kjdk.2024.2.035.
4. Shen T, Steven L. (2016) On Outcome-Based Educational Theories. *Journal of Higher Education Management*.10:47-51. 10.13316/j.cnki.jhem.20160829.009
5. Song S, Meng Y, Zhao P. (2022) Exploration on the Reform of Teaching System of Engineering DrawingBased on the OBE Concept. *Farm Products Processing*. 11:110-112. 10.16693/j.cnki.1671-9646(X).2022.06.029.
6. Mufanti R, Carter D, England N. (2024) Outcomes-based education in Indonesian higher education: Reporting on the understanding, challenges, and support available to teachers [J]. *Social Sciences & Humanities Open*, 9:100873. 10.1016/J.SSAHO.2024.100873.
7. Adalla T, Espinar T, Ballado S. (2022) Outcomes-based Education Assessment Practices of UEP Collegiate Faculty Members: Basis for a Training Design [J]. *Asian Journal of Education and Social Studies*, 11-22. 10.9734/AJESS/2022/V29I130687.
8. Zhang L. (2023) Thinking on the Teaching of Mechanical Drawing Course Based on the Outcomes-Based Education Concept. *Journal of Lanzhou Institute of Technology*. 30: 151-155. CNKI: SUN: GCTX.0.2019-01-029.
9. Gao C, Wei Y, Dai J, Li R, Xiao C. (2021) Research on Teaching Reform of Engineering Drawing Course Based on OBE Concept. 34: 95-98+103. 10. 16160/ j. cnki. tsxyxb. 2021.06.016.
10. Zhong X, Liu P. (2022) Discussion and Practice of Applied Undergraduate CurriculumReform Based on OBE Concept-Take the Engineering Drawing and Computer Graphics as an Example. *Science & Technology Information*. 20:196-199. 10.16661/j.cnki.1672-3791.2105-5042-5200.

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