

Teaching reform of modern control theory course based on SPOC

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Abstract: "Modern control theory" is a course focusing the linear system, it is a basic professional course of the system and control discipline. This course shows some characteristics of sound theoretical basis, more mathematical formula derivation, cumbersome operation, etc. Therefore, this paper combines the advantages of "small-scale" and the proprietary of "SPOC" into the teaching process of modern control theory, integrates and optimizes the teaching resources and teaching content under the network environment, constructs a virtual simulation platform. Using the rain classroom and superstar learning Apps for flipped classroom teaching, forms a unique mixed teaching mode of "SPOC" + flipped classroom. Our investigations show that driven by the mixed teaching mode of "SPOC", flipped classrooms, Apps and virtual experiments, the learning initiatives of students are significantly strengthened, their innovations and team cooperation abilities are continuously improved. Meanwhile, we optimize the teaching contents and then acquire excellent teaching effect are acquired.

Key words: SPOC; Modern control theory; Flipped classroom; Experimental teaching reform

1. Introduction

MOOC is a research hotspot of the classroom teaching reform in Colleges and universities. However, as a large-scale online open course, MOOC show some disadvantages when they are applied to the small-scale classroom teaching in Colleges and universities. Now a more interesting small-scale proprietary online course, i.e., SPOC, are developed from MOOC, SPOC could serve dozens to hundreds of students in a small scale, and can used in classroom teaching by combining targeted teaching resources with flipped classroom. Therefore, MIT, Colorado State University, Tsinghua University and other domestic and international universities have carried out extensive researches of SPOC + flipped classroom, and have obtained excellent teaching effect.

Modern control theory is a core professional course in the field of system and control science. This course mainly studies linear systems from the perspective of time domain and complex frequency domain. It is a highly theoretical and comprehensive course, teachers should carry out a lot of mathematical formula derivations and complex calculations in the process of teaching, so it is hard for most students to understand those knowledges only in a short classroom time. In addition, teachers and students in some colleges and universities do not pay attention to the experimental teaching of this course, have not yet carried out the experimental practice of the course, or lack of comprehensive experimental projects combined with practice. Some college students simply completed the validation simulation experiment arranged by the teacher, and did not explore the corresponding relationship between the experimental project and the theoretical content of the classroom, which affected the improvement of students' learning initiative and practical ability. To solve these problems, this paper combines the advantages of traditional classroom teaching and online teaching, integrates the "small-scale, proprietary" of "SPOC" into the modern control theory curriculum system, optimizes the teaching resources and teaching content under the network environment, constructs a network virtual reality simulation platform, and applies it to flipped classroom teaching with rain classroom and superstar learning link as information tools, The unique mixed teaching mode of "SPOC" + flipped classroom has been formed, which has stimulated students' creativity, optimized the teaching content, and achieved good teaching results.

2. Specific links and implementation of teaching reform

The mixed teaching mode of modern control theory course based on "SPOC" includes five links: pre preparation, "SPOC" teaching resource construction, flipped classroom teaching implementation, virtual simulation experiment platform construction and course assessment.

2.1 Foundation preparation

First, master the basic situation of students, courses, teaching conditions and so on. By analyzing the students' professional background, courses learned, learning habits, learning methods, psychological characteristics and other information. Secondly, according to the talent training plan and the course syllabus, analyze the knowledge points taught, check the scores of the related courses linear algebra and automatic control principle that students have learned in the early stage, and determine the corresponding teaching objectives according to the characteristics of the students in this course selection. For cognitive knowledge such as introduction and overview, self-study in the form of "SPOC" can be adopted; while theoretical, comprehensive and deductive knowledge need to be taught offline on the blackboard. Virtual simulation experiment and engineering design case teaching can adopt the "SPOC" mode of online learning to better consolidate the effect of classroom teaching; Experimental and practical teaching content is also very important, which is of great significance to cultivate students' practical ability and innovation ability. Third, according to the overall teaching objectives, it is divided into phased objectives, and according to the phased objectives, specific teaching contents and teaching methods are designed. Fourth, build an efficient and stable hardware platform and network environment for hybrid teaching to ensure the smooth development of Hybrid Teaching.

2.2 Construction of "SPOC" teaching resource database

1. Collect the existing high-quality MOOC teaching video resources of colleges and Universities

Colleges and universities have provided free teaching video resources of open courses and resource sharing courses on network

platforms such as University of China MOOC and love course. These teaching video resources have been tested in practice and have good reference value. For example, the teaching video of modern control theory produced by Associate Professor Wang Jianquan of Zhejiang University and the teaching video of linear system theory produced by Professor Zhao Qianchuan of Tsinghua university can be used as an effective supplement to the classroom teaching of modern control theory.

2. Making “SPOC” teaching video according to the needs of flipped classroom

Flipped classroom teaching cannot choose knowledge points that are too difficult or too simple. Knowledge points with moderate difficulty are convenient for discussion and exhibition. Knowledge points with moderate difficulty also facilitate the production of video content within 10-30 minutes. The teaching of modern control theory has many knowledge points, which are relatively independent, and the teaching time is moderate, which is suitable for making short videos. However, because these knowledge points are not easy to understand, we need to deepen our impression and enhance our mastery through mutual discussion. For example, the state space expression of the control system, the first and second methods of Lyapunov on stability discrimination, and the pole placement of linear feedback control system synthesis are all teaching knowledge points suitable for flipped classroom. There are many important concepts and knowledge points in the course of modern control theory. Because these knowledge points are difficult to understand thoroughly in class at once, most students need to use the “SPOC” video to watch again or preview in advance to really master the key knowledge points. “SPOC” teaching video can be specially recorded and generated, or can be edited and generated according to the actual lecture video in the recording and broadcasting classroom.

2.3 Implementation of flipped classroom teaching based on rain classroom and superstar learning

Flipped classroom teaching mode refers to a teaching form in which students use their time outside the classroom to independently learn online learning video, reduce teachers’ classroom teaching time, and teachers use classroom time to guide students to answer questions and discuss. Flipped classroom requires students to increase learning time outside the classroom. During classroom teaching time, students have more autonomy in learning, and teachers become guides, solvers and assistants. Rain classroom app and superstar learning app are excellent online learning software for smart teaching. By designing rich classroom activities such as online check-in, questionnaire, question answering and discussion in superstar learning or rain class, applying the “student-centered” teaching concept to flipped classroom teaching can better mobilize students to participate in the course discussion, better cultivate students’ interest in learning, and further exercise students’ ability of cooperation and innovation.

1. Course creation and allocation of research groups

Make full use of “superstar learning link” in classroom teaching. The curriculum chapter setting, curriculum outline, teaching plan, discussion contents of each chapter of PPT and comprehensive design projects can be completed by using the construction of “superstar learning link”. Before class in the new semester, the teacher will group the automation majors in this semester according to their student numbers. All the contents of this course will be studied, discussed, selected and implemented in groups. The grouping situation shall be announced by the teacher on the “superstar learning link” in advance, and the main content of research teaching and teaching implementation plan shall be published.

2. Teaching scheme design

(1) Use a variety of ways to review before class. For example, 10 minutes before each class, complete the discussion and review of the key content of the previous class. After the discussion at each sub level, the teacher will summarize and comment according to the specific situation of the question group and the answer group. Other students can then score through the learning forum. Finally, the teacher will verify the score of the students in the question group and the answer group.

(2) Carry out project or project-based research on key contents, and issue research tasks to each group of students. The project indicators are divided into basic content and expanded content, and each group can flexibly choose the expanded content. After the completion of the project, the rationality and accuracy of the completion of each group project will be verified through class presentation, comprehensive questions, group mutual evaluation, teacher evaluation and other activities.

(3) For the cutting-edge content of the relevant chapters of modern control theory, discussion topics can be arranged in advance. Students can use their spare time to consult and sort out data on an individual basis. In class, the cutting-edge content introduction and free discussion sessions are conducted irregularly, and the introduction method is selected by students themselves.

2.4 Construction of virtual experiment platform

According to the characteristics of modern control theory course, such as strong theory, more mathematical formula derivation, cumbersome operation, and students’ difficulty in understanding. We use the powerful MATLAB software and web server to build the network virtual experiment platform of “modern control theory”. Through the virtual experiment platform, students can use the interactive virtual simulation experiment of linear system theory, which increases the interest of students’ learning, deepens students’ understanding and consolidation of knowledge points, conveniently and efficiently carries out experimental teaching, and effectively improves the effect of experimental teaching.

According to the requirements of the modern control theory experiment syllabus, the virtual simulation experiment platform has designed the system matrix diagonal standard form, the system matrix Jordan Standard form, the Lyapunov stability criterion, the polynomial form of the transfer function to the state space expression, the zero pole model of the transfer function to the state space expression, and the transformation of the state space expression to the transfer. The linear system is decomposed according to controllability, the linear system is decomposed according to observability, the pole assignment is carried out by state feedback, and the observer is a virtual experiment

project. Through the virtual experiment platform of modern control theory, the functions of explaining the experimental content, inputting the mathematical model, simulating the experimental project and displaying the results in real time can be realized. As a virtual simulation environment for students' after-school experiment and verification, the virtual experiment platform enables students to complete the scheduled experimental teaching projects in the way of human-computer interaction, effectively assists classroom teaching and experimental teaching, promotes the reform and innovation of experimental teaching in the "SPOC" environment, and achieves good teaching results.

3. Practical teaching effect

In recent years, Shandong University (Weihai) has carried out practical teaching of modern control theory course based on "SPOC" mixed teaching mode among automation majors. Driven by the mixed teaching mode of "SPOC", flipped classroom, learning pass and virtual experiment, students' learning initiative has been significantly strengthened, students' innovation consciousness and team cooperation ability have been continuously improved, the teaching content has been optimized, and the interaction between teachers and students has moved towards a virtuous circle, achieving good classroom teaching effect. Students have a more solid grasp of the knowledge of modern control theory, and their engineering awareness and control system design ability have been significantly improved.

4. Concluding remarks

In order to better enable students to master the content of modern control theory course, and better improve students' innovation ability and control theory design and application ability, this paper carries out teaching reform research and innovative practice teaching of modern control theory course based on "SPOC" integrated flipped classroom, app, virtual simulation experiment and other mixed teaching modes. The research practice shows that driven by the mixed teaching mode of "SPOC", flipped classrooms, Apps and virtual experiments, the learning initiatives of students are significantly strengthened, their innovations and team cooperation abilities are continuously improved. Meanwhile, we optimize the teaching contents and then acquire excellent teaching effect are acquired.

References:

- [1] Songyang Lao,Xiaoping Jiang,Mingrui Lao The impact of SPOC on Higher Education in the post it era [j]. Journal of higher education research, 2013, 36 (03):6-8
- [2] Zhibin Jiang Exploration and practice of MOOC mode in China [j]China University teaching, 2018, (01): 28-30
- [3] Wang Yu. Review of global MOOC development in 2019 [j]China distance education, 2021, (05): 68-75
- [4] Guirong Wang,Ye Tian Research on the construction principle and mechanism of quality MOOC in Local Undergraduate Universities under the background of "Internet + education" [j]Journal of Harbin University, 2019,40 (04): 123-126
- [5] Cheng Zeng,Peicai Guo Innovative design of the teaching mode of College Students' innovation and entrepreneurship course based on SPOC [j] Theoretical research and practice of innovation and entrepreneurship, 2022,18 (9): 160-164
- [6] Shuangqun Wang,Lihua Zeng. Exploration on the hybrid teaching mode of "MOOC + SPOC + flipped classroom" in Ideological and political theory course [j]Ideological and theoretical education, 2019 (6): 68-73
- [7] Ye Qin Kang"Post MOOC era" of online education - SPOC analysis [j]Tsinghua university education research, 2014,35 (01): 85-93
- [8] Jiawei Zhang,Dandan Li,Guocheng Zhang, et al Research and exploration of Hybrid Teaching Based on SPOC and rain classroom [j]Heilongjiang science2022,13 (17): 162-164
- [9] Shaohui Qiu,Xiangwen Zhang Research on the implementation path of "one body and six wings" of "SPOC + flipped classroom" teaching mode in Colleges and universities [j]Journal of Chizhou University2022,36 (04): 130-132
- [10] Zongyao Sun,Yu Shao,Mengmeng Yun On the teaching reform of "linear system theory" [j]Journal of Qufu Normal University (NATURAL SCIENCE EDITION), 2017,43 (04): 121-124
- [11] Bosen Chai,Yue Xiang,Shun Wang,Yanhui Jia,Lihui Wang Research on innovation and practice of "MOOC + SPOC" mixed teaching mode of mechanical design [j]Journal of Jilin Institute of education.2019, 35 (01): 56-59
- [12] Yanhua Liu The Enlightenment of engineering education professional certification concept on the reform of Finance Teaching in engineering colleges [j] Journal of Anhui University of Technology (SOCIAL SCIENCES EDITION)2016,33 (03): 61-62+64
- [13] Fengqi Yao,Hong Fang Application of MOOC in the teaching of modern control theory [j]Journal of Anhui University of Technology (SOCIAL SCIENCES EDITION)2016,33 (03): 63-64
- [14] Yuan Zhang,Hongyan Zhang The opportunity and function transformation of university library to help undergraduate education [j]Inner Mongolia Science and technology and economy, 2020, (08): 148-149
- [15] Zhiwei Yang,Ping Zeng,Guoming Tang,Kewei Yang. Research on teaching reform of modern optimization algorithm Course Based on MOOC [j] Computer engineering and science. 2018,40 (S1):6-11

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