Multi-dimensional teaching mode for introduction to aerospace

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Abstract. With the development of aerospace technology, the demand for aerospace knowledge is becoming more and more urgent. Many Aerospace and non-aerospace colleges have offered the course of Introduction to Aerospace. Introduction to Aerospace is a general course. Different from general humanities courses, besides its wide coverage and large amount of information, it also has strong engineering characteristics, such as including many advanced structures and cutting-edge science and technology. The course is intended to the first-year undergraduate students. These students come from different majors, such as liberal arts, science and engineering, and their educational backgrounds, specialties and levels are quite different. How to make all the students can better learn the course content is a great challenge. After years of exploration and practice, the multi-dimensional teaching mode of "Classroom teaching + On-site teaching + Virtual simulation experiment + MOOC (Massive Open Online Courses) teaching + Mobile APP" for Introduction to Aerospace has achieved good teaching effect. Combining with the on-site teaching, students can better understand the theoretical content. Students show great enthusiasm for this kind of on-site teaching. They observed carefully and raised many questions they wanted to know. This teaching mode can encourage students to have a better understanding of the content.

In the virtual experiment, the following six stealth technologies are fully demonstrated: the basic principle of stealth, understanding the stealth technology, the overall layout of stealth aircraft, the recognition and test of stealth aircraft, the penetration confrontation experiment and the air combat confrontation experiment of aircraft. The virtual experiment enables students to approach the cutting-edge technology in a more vivid and immersive way.

MOOC is rich in content, and has the characteristics of using spare time to learn at anytime and anywhere. Students can learn relevant contents according to their own interests, and thereby expanding their knowledge and broadening their horizons.

Mobile APP is a kind of course practice software. By using mobile APP, students can learn and consolidate the knowledge points anytime, and the learning effect is significantly improved.

The multi-dimensional teaching mode of "classroom teaching + on-site teaching + virtual
simulation experiment + MOOC teaching + mobile APP” of Introduction to Aerospace is a useful exploration for general education courses. Through years of practice, the teaching effect is good. Keywords: General education course, Multi-dimensional teaching mode, On-site teaching, Virtual simulation experiment, Mobile APP

1. Introduction
With the development of aerospace technology, the demand for aerospace knowledge is becoming more and more urgent. Many Aerospace and non-aerospace colleges have offered the course of Introduction to Aerospace. Introduction to Aerospace is a general course. Different from general humanities courses, besides its wide coverage and large amount of information, it also has strong engineering characteristics, such as including many advanced structures and cutting-edge science and technology. The course is intended to the first-year undergraduate students. These students come from different majors, such as liberal arts, science and engineering, and their educational backgrounds, specialties and levels are quite different. How to make all the students can better learn the course content is a great challenge. After years of exploration and practice, the multi-dimensional teaching mode of ”Classroom teaching + On-site teaching + Virtual simulation experiment + MOOC teaching + Mobile APP” for Introduction to Aerospace has achieved good teaching effect.

2. “Classroom teaching + On-site teaching”— enhance the practical experience
The engineering concepts of junior undergraduates are very weak, especially for the students of liberal arts, their imagination about complex engineering structures are even worse. If only using the traditional classroom teaching mode, the students can only learn by rote, and it is difficult for them to really understand and master what they have learned. In order to turn abstract teaching into visualized teaching, on-site teaching is a good method [1]. According to the requirements of the course, the corresponding on-site lessons are arranged in each chapter. Combining with the on-site teaching, students can better understand the theoretical content (Figure 1). Students show great enthusiasm for this kind of on-site teaching. They observed carefully and raised many questions they wanted to know. This teaching mode can encourage students to have a better understanding of the content.

![Figure 1. On-site object teaching](image)

3. “Classroom teaching + virtual simulation experiment”— touch the leading technology
Aerospace technology involves many advanced science and technology. The principles of this high technology are abstract and complex. It is difficult for students to fully understand them by classroom teaching alone. For example, aircraft stealth technology is a necessary technology for the advanced
fighter aircraft at present, so the stealth technology and design are the important contents of the course. However, due to its extremely expensive cost and highly sensitive technology, it is impossible to use physical aircraft for on-site teaching in teaching. As a result, there is no way to see the real aircraft, no way to see the structure details, no way to reproduce and duplicate the combat scenes. So we developed a virtual simulation experiment named "Virtual Simulation Experiment of Cognition and Design of Stealth Aircraft". In the virtual experiment, the following six stealth technologies are fully demonstrated: the basic principle of stealth, understanding the stealth technology, the overall layout of stealth aircraft, the recognition and test of stealth aircraft, the penetration confrontation experiment and the air combat confrontation experiment of aircraft. The virtual experiment enables students to approach the cutting-edge technology in a more vivid and immersive way. Combining the theoretical knowledge acquired in classroom teaching and experiencing through virtual simulation experiment, the students are deeply impressed by what they have learned.

Figure 2 is a part of the scene of "Virtual Simulation Experiment of Cognition and Design of Stealth Aircraft", which has been recognized as a national "Golden Course". The teaching mode of "classroom teaching + virtual simulation experiment" makes up for the shortcomings of the long renewal cycle of physical objects and the lack of advanced aircraft, and the teaching effect is very good.

4. “Classroom Teaching + MOOC Teaching”— expand knowledge and broaden horizons
The course "Introduction to Aerospace" has a large amount of information and covers many fields such as structure, materials, power, electronics and so on. Due to the limitation of classroom teaching hours, many contents cannot be taught in the classroom. In order to develop students' horizons, we can combine the MOOC for online learning. MOOC is rich in content, and has the characteristics of using spare time to learn at anytime and anywhere [2]. At present, we have built two MOOC courses for "Introduction to Aerospace" (Figure 3). Among them, "Introduction to Aerospace" MOOC is suitable for junior undergraduates, and "Aerospace Technology" MOOC is suitable for senior undergraduates and
graduates. The course is extensive in content, and from shallow to deep. Students can learn relevant contents according to their own interests, and thereby expanding their knowledge and broadening their horizons.

Figure 3. "Introduction to Aerospace" MOOC

5. “Classroom Teaching + Mobile APP” — improving learning effect
Introduction to Aerospace is a general course with the characteristics of large amount of information, more knowledge points and less hours. It is difficult for students to digest and master the course content in a short time. Therefore, students often have the problems of misconceptions and forgetting along with learning. Students cannot grasp the course content well, and lack self-confidence and sense of acquisition for the knowledge. To solve this problem, the course group converted the course knowledge points into more than 1000 questions, and developed a corresponding mobile APP application software for everyone to practice (Figure 4). By using mobile APP, students can learn and consolidate the knowledge points anytime, and the learning effect is significantly improved.

Figure 4. Mobile APP practice software
6. Summary

The multi-dimensional teaching mode of "classroom teaching + on-site teaching + virtual simulation experiment + MOOC teaching + mobile APP" of Introduction to Aerospace is a useful exploration for general education courses (Figure 5).

![Multi-dimensional teaching mode](image)

Through years of practice, the teaching effect is good. It has been awarded as Beijing Excellent Course, National Excellent Course, National Video Open Course, National Excellent Resources Sharing Course and National Excellent Online Open Course. The teaching level of the course is in the leading position in the similar courses in China.

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