The reform and practice of 3D printing courses guided by design thinking

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Abstract: With the continuous development of 3D printing technology, combining it with design thinking and applying it to the field of education have become a research hotspot. This research aims to explore the reform and practice of 3D printing courses guided by design thinking. Firstly, the problems existing in the current 3D printing course and the insufficient application of design thinking in the course are analyzed. Then, a design thinking-oriented 3D printing course reform strategy is proposed. Finally, through case analysis, the effectiveness of 3D printing course reform and practice guided by design thinking are verified. This study provides useful reference and practical experience for the reform of 3D printing courses.

Key words: 3D printing technology; design thinking; curriculum reform; teaching strategies

1 Introduction

With the rapid development of science and technology and the increasing changes in society, the field of education is facing unprecedented challenges. As a disruptive manufacturing technology, 3D printing technology has gradually penetrated into various fields, providing new opportunities for educational reform. At the same time, design thinking, as a human-centered innovation method, has gradually attracted attention from the education community. Combining 3D printing technology with design thinking not only helps students innovate, but also cultivates their comprehensive qualities to solve real-world problems. Therefore, this study aims to explore the reform and practice of 3D printing courses guided by design thinking, in order to provide useful references and practical experience for the development of 3D printing technology education in China.

2 The concept and significance of 3D printing courses guided by design thinking

The 3D printing course guided by design thinking is an educational model that combines design thinking and 3D printing technology. 3D printing technology is increasingly widely used in the field of education, which has brought many innovations and changes to education [1]. 3D printing technology allows students to learn and understand complex concepts such as mathematics, physics, biology and engineering more intuitively. Through 3D printing, students can transform abstract concepts into concrete objects, thereby increasing their learning interest and effectiveness. At the same time, 3D printing technology also provides teachers with new teaching methods and resources, such as making teaching models, demonstration experiments, etc. In addition, 3D printing technology can also cultivate students' ability to innovate, be hands-on and work as a team. In the 3D printing course, students can design and produce their own creations that stimulate their creativity and imagination. Meanwhile, 3D printing requires multidisciplinary knowledge, such as

computer programming, mechanical design, material science, etc., which helps to improve students' comprehensive quality and skills.

Design thinking is a human-centered approach to innovation that emphasizes solving real problems, focuses on user needs, and finds innovative solutions. In the field of education, design thinking is widely used in curriculum design, teaching methods, and learning environments. By introducing design thinking, educators can develop students' ability to innovate, solve problems, and work as a team. For example, in STEM (science, technology, engineering, and mathematics) education, design thinking can help students apply theoretical knowledge to real-world problems, thereby improving their practical ability and ability to innovate. At the same time, design thinking can also be used to improve the educational environment and resources, such as designing humanized teaching spaces and innovative teaching tools.

3D printing courses are important for developing design thinking. 3D printing technology itself is an innovative technology that stimulates students' curiosity and interest, thereby cultivating their sense of innovation. 3D printing courses require students to master multidisciplinary knowledge, such as computer programming, mechanical design, material science, etc., which helps to improve students' comprehensive quality and ability. 3D printing courses can also develop students' hands-on skills, teamwork skills, and problem-solving skills. In the 3D printing course, students are required to design and produce their own work, which requires them to be hands-on, innovative, and problem-solving [2]. 3D printing courses often require students to work in teams, which helps develop their teamwork and communication skills.

3 The problems of the current 3D printing course

Although 3D printing courses are becoming more widely used in education, there are still some problems in the actual operation process. First, the lack of curriculum resources, including high-quality teaching materials, case studies and corresponding technical support, is an important issue. Second, the quality of the teaching force is uneven, and some teachers may lack sufficient professional knowledge and skills to effectively teach 3D printing technology. Third, some schools may lack adequate hardware facilities, such as 3D printers and related software tools, which limits the curriculum.

While the use of design thinking in education is gaining traction, its application in 3D printing courses is still inadequate. The teaching content of design thinking is often overlooked, and many courses only focus on technical operations and neglect the cultivation of design thinking. Design thinking teaching methods need to be improved, and many teachers still use traditional teaching methods that do not stimulate students' innovative thinking. The evaluation system is not perfect with too much emphasis placed on technical achievements, and the evaluation of the design thinking process is ignored. In the process of cultivating students' design thinking skills, there are some challenges. First, students' basic knowledge is weak, especially for the application of 3D printing technology and related software, which limits the development of their design thinking ability [3]. The second is that students are not motivated enough to learn. If there is a lack of interesting projects and challenges, students may lose interest in 3D printing courses. Third, the imperfection of the evaluation system is also an important problem. Too much emphasis on technical achievements, and neglecting the evaluation of the design thinking process may limit the development of students' design thinking ability.

4 The design thinking-oriented 3D printing curriculum reform strategy

4.1 Course content optimization strategies

Course content is the core of education and plays an important role in cultivating students' design thinking skills. First of all, pay attention to the combination of theory and practice. The course content should fully reflect the theoretical knowledge of design thinking and the practical application of 3D printing technology, so that students can deepen their understanding of design thinking through practical operation on the basis of mastering theory [4]. To this end, some

practical cases and projects can be designed, so that students can use design thinking to analyze and make decisions in the process of solving practical problems.

Second, strengthen the integration of interdisciplinary knowledge. Design thinking itself encompasses knowledge of multiple disciplines, such as art, engineering, science, etc. Therefore, the course content should fully integrate these interdisciplinary knowledge, help students build a diversified knowledge system, and improve their innovation ability. For example, in 3D printing courses, knowledge in the fields of architectural design, mechanical manufacturing, biomedicine and other fields can be introduced, allowing students to stimulate innovative thinking in the collision of multi-domain knowledge. Again, focus on flexibility and adaptability of the curriculum. Course content should adapt to the age, interests, and abilities of students to meet the needs of different students. To this end, courses of different difficulty and levels can be designed, allowing students to choose the right course according to their actual situation. At the same time, teachers are encouraged to adjust and optimize the course content according to the actual teaching situation to improve the effectiveness of the curriculum. Finally, pay attention to the development of the times and technological progress. With the development of science and technology, the knowledge of 3D printing technology and related fields is constantly updated. Therefore, the course content should be updated and adjusted in a timely manner to ensure that students have the latest technology and knowledge. At the same time, teachers are encouraged to pay attention to industry trends and cutting-edge technologies, introduce the latest technological achievements into the curriculum, and stimulate students' interest in learning and innovation.

4.2 Strategies for teaching method reform

In order to better develop students' design thinking skills, the reform of teaching methods is crucial. First, heuristic and project-based teaching methods are employed. In the teaching process, teachers should focus on guidance and inspiration, and encourage students to actively explore and learn [5]. Project-based teaching can be adopted to allow students to learn around practical problems and tasks, and cultivate students' design thinking ability through hands-on practice. At the same time, teachers should pay attention to the individual differences of students and provide personalized guidance and support to stimulate the potential of each student.

Second, strengthen practical operation and hands-on ability training. 3D printing technology has a strong practical and operational nature, therefore, the teaching process should pay attention to students' hands-on operation, so that they can master knowledge and skills in practice. Teachers can set a series of hands-on tasks that allow students to experience the process of design and manufacturing by operating a 3D printer, thus developing their practical skills and innovative spirit.

Third, use modern educational technology to improve teaching effectiveness. Modern education technology, such as online teaching platforms and multimedia teaching resources, can provide rich resources and convenient means for teaching. Teachers can use these technological means to provide students with rich learning resources, expand their knowledge horizons, and improve teaching effectiveness.

Finally, focus on the development of teamwork and communication skills. Design thinking often requires interdisciplinary and cross-domain collaboration, so the teaching process should focus on developing students' teamwork and communication skills. Teachers can organize students to work in small groups to communicate, share, and learn in teamwork, and cultivate their teamwork and collaboration skills.

4.3 Evaluation system improvement strategy

The evaluation system has an important guiding and motivating role in the educational process.

Establish diversified evaluation criteria. The evaluation system should pay attention to the all-round development of students, not only to students' technical achievements, but also to their performance in the process of design thinking, such

as innovation ability, problem-solving ability, teamwork ability, etc. In addition, attention should be paid to the development of students' learning attitudes, learning methods and learning outcomes, so as to form a comprehensive and objective evaluation system.

Adopt a variety of evaluation methods. The evaluation method should be as close as possible to the actual performance of the students, such as work display, team report, personal reflection, etc. Through diversified evaluation methods, we can have a more comprehensive understanding of students' design thinking ability, and also stimulate students' interest and motivation to learn.

Focus on process evaluation. Process assessment helps to keep abreast of students' learning and provide feedback for teaching. Teachers should pay attention to students' performance in the learning process, such as thinking methods, problem-solving skills, teamwork attitudes, etc., and give timely guidance and feedback to promote students' growth.

Introduce student self-evaluation and peer evaluation. Encouraging students to reflect and evaluate their own design thinking processes and learning outcomes can improve their self-awareness and self-evaluation skills. At the same time, through peer evaluation, students can learn from the strengths of others and discover their own shortcomings, thereby promoting mutual learning and common progress.

5 The practical case analysis of 3D printing curriculum reform under the guidance of design thinking

This case study is the practice of a middle school to carry out 3D printing curriculum reform under the guidance of design thinking. The middle school is located in Shanghai, China, with good hardware facilities and teachers. With the development of science and technology and the innovation of educational concepts, the school hopes to stimulate students' innovative spirit and practical ability by introducing 3D printing technology. This middle school was selected as a case study object, aiming to analyze the implementation process and method of 3D printing curriculum reform guided by design thinking through concrete practice. In the implementation process, the school adopted the following methods and strategies, according to the design thinking orientation, combining 3D printing technology with real life problems, setting a series of project tasks, which allowed students to use design thinking to analyze and make decisions in the process of solving practical problems. For example, the school launched the "3D Printing Creative Home Design" project, which required students to design an innovative and practical 3D printed home product based on their own life needs. Heuristic and project-based teaching methods were used to encourage students to actively explore and learn, which strengthened hands-on skills to ensure that students had enough time for 3D printing hands-on operations. In addition, modern educational technology was used, such as online teaching platforms, multimedia teaching resources, etc., to provide students with rich learning resources. In the implementation process, it established diversified evaluation criteria and focused on the all-round development of students, adopted a variety of evaluation methods, such as work display, team report, etc., paying attention to process evaluation, keeping abreast of students' learning status, and giving guidance and feedback. It also introduced students' self-evaluation and peer evaluation to promote mutual learning and common progress. After a semester of practice, the school has achieved remarkable results in the reform of the 3D printing curriculum: students' design thinking skills have been improved. Through project-based teaching and practical operation, students can use design thinking to solve practical problems, and their sense of innovation and practical ability have been enhanced. Students' teamwork and communication skills have also improved. In the group work project, students learned to cooperate and share, and developed team spirit and cooperation skills. Students' interest and motivation to learn have been stimulated. Through diversified evaluation methods and interesting project tasks, students' interest and motivation in learning 3D printing technology have increased. Through the analysis of this case, we have obtained some useful enlightenment and experience,

that curriculum content optimization and teaching method reform are the key to promoting 3D printing curriculum reform; the improvement of the evaluation system plays an important role in stimulating students' interest and motivation in learning, and teachers play an important role in curriculum reform. These experiences provide reference for further promoting the reform of 3D printing curriculum, and help promote the development of 3D printing technology education at the middle school level in China.

6 Conclusion

Through the research on 3D printing curriculum reform guided by design thinking, this study draws the following main findings and conclusions: curriculum content optimization and teaching method reform are the key to promoting 3D printing curriculum reform. Combining theoretical knowledge with practical operation helps to improve students' design thinking skills. The improvement of the evaluation system plays an important role in stimulating students' interest and motivation in learning. Using diversified evaluation standards and diversified evaluation methods, we can fully understand students' design thinking ability. Teachers play an important role in curriculum reform. Focusing on individual differences among students and providing individualized guidance and support help to unleash the potential of each student. For future research, we look forward to further exploring the specific application of design thinking in 3D printing courses to improve the innovation and practice of the courses. At the same time, it will deeply study the learning characteristics and needs of students of different ages and levels to provide more accurate guidance for the reform of 3D printing courses. In addition, we will also pay attention to the latest development of 3D printing technology in the field of education, so as to adjust the curriculum system and teaching strategies in time to promote the sustainable development of 3D printing technology education in schools of China.

Acknowledgments

Conflicts of interest

The author declares no conflicts of interest regarding the publication of this paper.

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