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Research on Finite Element Technology in the Development of Mechanics Course Resources

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Abstract: Mechanics course in vocational colleges faces challenges such as a lack of physical equipment, insufficient hands-on experience, difficulty in visualizing abstract concepts, and cost and safety concerns associated with physical experiments. This paper explores the application of finite element technology (FET) in overcoming these challenges and improving mechanics course teaching in vocational colleges. FET is a simulation-based method that can provide extensive hands-on experience, enhance visualization of abstract concepts, and offer a cost-effective and safe learning environment. The effectiveness of FET-based mechanics education has been demonstrated in numerous studies, and the outlook for FET-based mechanics education in vocational colleges is promising.

Keywords: Mechanics course; Vocational college; Finite element technology; Teaching; FET

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1. Introduction

Vocational education plays a vital role in supporting the economy and supplying talents for industries and enterprises. Therefore, it is crucial to continuously innovate the teaching methods of vocational education to ensure that they are up-to-date and relevant. Innovations in teaching models for vocational college courses require active exploration and experimentation. Mechanics is a crucial and rapidly evolving field that plays a vital role in various industries [1,2]. Mechanics courses are essential in the education of mechanical engineering students, providing them with a solid foundation in theoretical knowledge and practical skills. However, there are significant challenges in teaching mechanics courses in vocational colleges, including the lack of physical equipment, insufficient hands-on experience, difficulty in visualizing abstract concepts, and cost and safety concerns associated with physical experiments [3,4]. These challenges can hinder students' understanding of mechanical principles and their ability to apply theoretical knowledge practically. Finite element technology (FET) is an excellent example of an innovative teaching model that can potentially revolutionize mechanics course teaching in vocational colleges [5,6]. By providing a simulation-based approach to learning, FET can enhance students' understanding of abstract concepts.

2. Research status

Research in mechanics education has explored various aspects, including instructional strategies, curriculum design, and the integration of technology in teaching. Yue [7] integrated professional knowledge into classroom teaching, which sparked curiosity among students. Jiao [8] incorporated cutting-edge testing techniques into classroom teaching, which enhanced students' comprehensive skills and innovation abilities. Zhao [9] conducted a teaching experiment in which Engineering Mechanics was oriented towards

professional certification, which resulted in clarifying the learning objectives and improving the efficiency of classroom teaching. Chen [10] proposed a hybrid teaching model that combined online and offline methods, which made learning more convenient. Zhu [11] analyzed the problems in classroom teaching and recommended a capability-oriented teaching method for engineering courses that achieved positive results in practice. Su [12] discussed the need for teaching method reform in Engineering Mechanics from a talent training perspective and proposed effective measures to cultivate students' problem-solving abilities. While these approaches have their merits, there are still challenges in terms of providing practical experiences, visualizing abstract concepts, and managing costs and safety concerns. In recent years, there has been a growing interest in the application of FET in mechanics courses. This technology offers a computer-based approach to simulate mechanical systems and analyze their behavior, providing students with a virtual platform to explore complex mechanical phenomena, visualize abstract concepts, and conduct experiments in a safe and cost-effective manner. FET-based mechanics courses has been shown to enhance students' understanding of mechanical principles, improve their problem-solving abilities, and equip them with practical skills, which are qualities that are highly valued in the industry [5,6]. However, the extent of its application and its impact on mechanics courses in vocational colleges are still under research. Further research is needed to refine and improve FET-based mechanics courses and provide comprehensive training to educators.

Overall, the application of innovative teaching models like FET in mechanics education has the potential to revolutionize vocational education and supply talents for the industry [13,14].

3. Problems faced in mechanics courses

There are several problems in the teaching of mechanics courses in vocational colleges, including the lack of physical equipment, insufficient hands-on experience, difficulty in visualizing abstract concepts, and cost and safety concerns associated with physical experiments.

3.1. Lack of hardware equipment

The lack of physical equipment is a significant challenge in mechanics course teaching in vocational colleges. Due to budget constraints and limited resources, many vocational colleges struggle to provide students with access to sophisticated equipment and tools. This limitation restricts students' ability to perform physical experiments and gain practical experience, thus hindering their understanding of mechanical principles.

3.2. Insufficient hands-on experience

Traditional mechanics education relies heavily on physical experiments to provide students with hands-on experience. However, due to constraints such as limited time and resources, students often have insufficient opportunities to engage in practical learning. This lack of hands-on experience hinders their ability to apply theoretical knowledge to real-world scenarios effectively.

3.3. Difficulty in visualizing abstract concepts

Mechanical principles often involve abstract concepts that can be challenging for students to visualize and comprehend. Students may struggle to grasp complex mechanical phenomena, such as stress distribution, deformation patterns, and failure modes, solely through theoretical explanations and equations. This difficulty in visualizing abstract concepts impedes students' understanding and hampers their ability to apply theoretical knowledge practically.

3.4. Cost and safety concerns

Physical experiments in mechanics courses can be costly and potentially hazardous. Setting up experiments, procuring equipment, and ensuring safety measures require significant financial resources and careful management. Moreover, student safety during physical experiments is a critical concern. The high costs and safety risks associated with physical experiments often limit the scope and depth of hands-on learning experiences.

4. Advantages of applying FET to mechanics course teaching

FET has emerged as a promising tool in mechanics course teaching in vocational colleges. By simulating mechanical phenomena and processes, FET can overcome many of the outstanding problems faced by traditional mechanics education, such as the lack of physical equipment, insufficient hands-on experience, difficulty in visualizing abstract concepts, and cost and safety concerns.

4.1. Overcoming hardware limitations

FET can overcome the limitations of physical equipment in mechanics course teaching. By using simulation software, students can perform experiments on virtual models that accurately simulate real-world scenarios. This capability enables students to explore a wide range of mechanical phenomena and processes that may not be feasible with limited physical equipment, thus enhancing their understanding of mechanical principles.

4.2. Enhancing practical learning

FET provides students with extensive hands-on experience in mechanics course teaching. Through simulation exercises, students can apply theoretical knowledge to real-world scenarios and gain practical skills that are highly valued in the industry. FET also allows students to perform experiments repeatedly and explore various design options, which enhances their problem-solving and critical thinking abilities.

4.3. Visualizing abstract concepts

FET enables students to visualize and comprehend abstract mechanical concepts effectively. Simulation software can generate high-quality visualizations that illustrate complex mechanical phenomena, such as stress distribution, deformation patterns, and failure modes. This function enhances students' understanding of mechanical principles and facilitates their ability to apply theoretical knowledge practically.

4.4. Cost and safety effectiveness

FET is a cost-effective and safe alternative to physical experiments in teaching mechanics courses. By using simulation software, students can perform experiments without the need for expensive equipment, hence reducing the overall cost of mechanics education. Moreover, simulation exercises eliminate the safety risks associated with physical experiments, ensuring that students can learn in a safe and controlled environment. Overall, the application of FET in mechanics courses in vocational colleges offers significant advantages over traditional mechanics education. By overcoming the problems faced in traditional mechanics education, FET can enhance students' understanding of mechanical principles, equip them with practical skills that are highly valued in the industry, and provide a cost-effective and safe learning environment.

5. Results and outlook

Numerous studies have been carried out on the effectiveness of FET in mechanics course teaching in vocational colleges, and the results are promising. Students who received FET-based mechanics education demonstrated superior performance in understanding mechanical principles and applying theoretical

knowledge practically. Moreover, students expressed high levels of satisfaction with FET-based mechanics education, citing the enhanced hands-on experience, improved visualization of abstract concepts, and cost and safety effectiveness as key benefits.

The outlook for FET-based mechanics education in vocational colleges is bright. The widespread availability of simulation software and the increasing demand for practical skills in the industry make FET-based mechanics education a valuable asset for vocational colleges. Further research is needed to refine simulation techniques, improve access to simulation software, and provide comprehensive training to educators.

6. Conclusions

FET has emerged as a powerful tool in mechanics course teaching in vocational colleges, offering a viable solution to the outstanding problems faced by traditional mechanics education. By simulating mechanical phenomena and processes, FET can overcome the limitations of physical equipment, provide extensive hands-on experience, enhance visualization of abstract concepts, and offer a cost-effective and safe learning environment. The effectiveness of FET-based mechanics education has been demonstrated in numerous studies, and the outlook for FET-based mechanics education in vocational colleges is promising. However, further research is needed to refine and improve FET-based mechanics education, and to provide comprehensive training to educators.

In conclusion, the application of FET in mechanics course teaching in vocational colleges is a valuable asset that can enhance students' understanding of mechanical principles, equip them with practical skills that are highly valued in the industry, and provide a cost-effective and safe learning environment.

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Disclosure statement

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Author contributions

J.M and S.W. conceived the idea of the study and wrote the first draft of the paper. W.H. revised the format of the article.

References

[1] Wang S, 2019, Significance, Characteristics and Implementation Measures of the Implementation Plan of National Vocational Education Reform. Journal of Shijiazhuang Vocational and Technical College, 31(3): 4–10. https://doi.org/10.3969/j.issn.1009-4873.2019.03.002

[2] Wang S, Peng F, Li M, 2022, Enhancing the Problem-Solving Skills of Vocational Students through Skills Competition. Journal of Contemporary Educational Research, 6(12): 9–15. https://doi.org/10.26689/jcer.v6i12.4546

[3] Deliktas B, 2011, Computer Technology for Enhancing Teaching and Learning Modules of Engineering Mechanics. Computer Applications in Engineering Education, 19(3): 421–432.

https://doi.org/10.1002/cae.20321

[4] Wang S, 2022, The Current Situation and Teaching Exploration of Engineering Mechanics in Vocational Colleges. Scientific and Social Research, 4(3): 6–12. https://doi.org/10.26689/ssr.v4i3.3695

[5] Wang S, Wang X, Peng F, 2023, Teaching Practice of Engineering Mechanics Based on Finite Element Method. Proceedings of IEEE 12th International Conference on Educational and Information Technology (ICEIT), 262–267. https://doi.org/10.1109/ICEIT57125.2023.10107893

[6] Wang S, Wang X, Peng F, 2023, Teaching Practice of Engineering Mechanics Based on Finite Element Analysis. Proceedings of 11th International Conference on Information and Education Technology (ICIET), 103–108. https://doi.org/10.1109/ICIET56899.2023.10111408

[7] Yue JF, Zheng LP, Li JJ, 2022, Discussion on Teaching Design of Engineering Mechanics for Polymer Specialty. Chinese Polymer Bulletin, 2022(4): 74–78. https://doi.org/10.14028/j.cnki.1003-3726.2022.04.009

[8] Jiao ZH, Cui ZL, Yuan QP, 2022, Application of SHPB Testing Technology in Mechanics Experimental Teaching of Mining Engineering. Experimental Technology and Management, 39(3): 205-208. https://doi.org/10.16791/j.cnki.sjg.2022.03.037

[9] Zhao J, Gu JF, Zhang CY, 2020, Teaching Reform of Engineering Mechanics Based on Engineering Education Professional Certification. Journal of Luoyang Institute of Science and Technology, 30(2): 94–96. https://doi.org/10.3969/j.issn.1674-5043.2020.02.020

[10] Chen L, 2022, Application of Hybrid Teaching based on Superstar Learning in Engineering Mechanics Class. Journal of Yunnan Open University, 24(1): 50–54. https://doi.org/10.3969/j.issn.2095-6266.2022.01.008

[11] Zhu Q, Ji P, Chen H, 2022, Research on the Courses Teaching of Engineering Mechanics under the Background of New Engineering. Popular Science & Technology, 24(4): 154–156 + 163. https://doi.org/10.3969/j.issn.1008-1151.2022.04.040

[12] Su M, Xiong CJ, Zhang TL, 2020, Teaching Method Reform of Engineering Mechanics under the Background of Engineering Certification. Shandong Chemical Industry, 49(3): 111–112. https://doi.org/10.3969/j.issn.1008-021X.2020.03.049

[13] Wang S, Peng F, Zhen X, 2023, Finite Element Modeling and Simulation of Torsion Experiment and Teaching Practice in Vocational Colleges. Proceedings of the 2023 14th International Conference on E-Education, E-Business, E-Management and E-Learning, 82–86. https://doi.org/10.1145/3588243.3588280

[14] Wang S, Zhu Q, Zhen X, 2022, Application of Modeling and Simulation Technology in Teaching Practice of Engineering Mechanics. Proceedings of the 2022 5th International Conference on Education Technology Management, 110–116. https://doi.org/10.1145/3582580.3582598