Region - Educational Research and Reviews, 2023, Volume5, Issue5
DOI: 10.32629/rerr.v5i5.1475
ISSN Online: 2661-4634
ISSN Print: 2661-4626

Curriculum reform and innovation for CNC lathe and milling processing certificate under the "1+X" certification system

Yuming LIANG

Maoming Vocational and Technical College, Maoming 525000, China

Abstract: With the development of smart manufacturing, CNC lathe and milling processing technology play an increasingly vital role in modern manufacturing. The "1+X" certification system offers a new pathway for vocational education to cultivate highly skilled professionals. This paper focuses on the curriculum system of the CNC lathe and milling processing certificate and explores strategies for curriculum reform and innovation under the guidance of the "1+X" certification system. By examining the existing curriculum system and analyzing the discrepancies between industry demands and the current teaching situation, specific reform measures are proposed. Additionally, in line with the concept of industry-education integration, innovative approaches to curriculum content and teaching methods are explored, as well as ways to leverage information technology for improving teaching efficiency and quality. The research shows that by optimizing curriculum structure, updating teaching content, improving teaching methods, and enhancing practical components, it is possible to significantly enhance students' skills and innovation capabilities, better meeting the needs of enterprises in the context of Industry 4.0.

Key words: 1+X certification system; CNC lathe and milling processing; curriculum reform; teaching innovation; industry-education integration

1 Introduction

With the continuous advancement of Industry 4.0 and the widespread application of smart manufacturing, CNC lathe and milling technology have become core technologies in modern manufacturing. The pressing issue for the industry is the need for highly skilled technical personnel. The implementation of the "1+X" certification system offers a new solution to address this challenge. This paper aims to explore how, under the "1+X" certification system, the curriculum for the CNC lathe and milling processing certificate can be reformed and innovated to better align with the requirements of talent development in the new era of manufacturing.

2 Analysis of the current curriculum system

2.1 Industry demands and the current state of curriculum setup

The manufacturing industry is currently undergoing unprecedented changes, with the rise of smart manufacturing demanding that technical operators not only possess traditional mechanical knowledge but also understand the operation and maintenance of automated and digital equipment. For professionals in CNC lathe and milling processing, this entails

not only mastering CNC programming and operational skills but also having the ability to solve complex problems. However, the existing curriculum systems often lean heavily towards imparting foundational knowledge and lack the cultivation of advanced skills, resulting in a significant gap between the curriculum and the urgent requirements of businesses for highly skilled CNC professionals.

2.2 Analysis of teaching content and methods

In the current educational system, teaching content often lags behind the developments of the era and technological updates. The cases in textbooks are often disconnected from practical applications, and teaching methods tend to be traditional, primarily focused on lectures and demonstrations, with insufficient emphasis on hands-on skills and innovative thinking. Furthermore, the current assessment system places more emphasis on testing theoretical knowledge and lacks comprehensive testing of students' practical operational abilities, failing to fully reflect students' overall vocational competence [1].

2.3 Discrepancies in student skill development and real-world needs

The current curriculum system has certain limitations in cultivating students' capabilities. Firstly, there is inadequate cultivation of problem-solving skills and innovative thinking, leaving students often unable to address non-standard issues that arise in actual production. Secondly, the curriculum lacks the integration of interdisciplinary knowledge, resulting in students having a limited understanding of related fields, which affects their ability to adapt to complex work tasks. Lastly, the alignment of practical teaching components with the actual production environment of businesses is insufficient, and students lack enough practical opportunities to comprehend and master the new technologies and processes of modern CNC lathe and milling processing [2].

Through the analysis of the existing curriculum system, we can identify a series of issues. The rapidly evolving industry and continuous technological updates necessitate that the education system responds swiftly, especially in today's world where smart manufacturing is becoming increasingly dominant. However, the current curriculum setup typically focuses excessively on theoretical knowledge and overlooks the cultivation of advanced skills and innovative capabilities. The outdated teaching content and methods, combined with the disconnect from practical applications, along with the inadequate assessment of students' hands-on abilities and problem-solving skills, make it challenging for students to meet the industrial sector's demand for highly skilled professionals upon graduation. In summary, educational curriculum reform is urgently required to bridge the gap between students' capabilities and industry demands.

3 Curriculum reform and teaching innovation strategies

3.1 Integrating industry technological trends

In the wave of Industry 4.0 and the rise of smart manufacturing, the pace of development in the manufacturing industry has been unprecedented. Particularly, CNC lathe and milling processing technology are evolving rapidly. To ensure that the education of CNC technology professionals is in sync with industry demands, educational institutions must closely monitor and integrate the latest industrial technological trends. This is not just about updating course content but also about a transformation in teaching philosophy and methods.

First and foremost, close collaboration with the industry becomes a significant focus of educational reform. Through means such as corporate internships, lectures, and workshops, educational institutions can gain a more direct understanding of the latest industry requirements, which allows for the adjustment of curriculum settings to expose students to cutting-edge technologies and processes [3]. Curriculum should include knowledge modules related to advanced CNC machining systems, such as programming and operation of multi-axis CNC machine tools, providing students with opportunities for interaction with high-end equipment to enhance their understanding and mastery of advanced manufacturing technologies.

Secondly, the application of CAD/CAM software is a core component of modern CNC technology education. The curriculum should encompass skill development, starting from basic graphics drawing to complex product design, and from part programming to full-process simulation of manufacturing. This not only ensures that students are proficient in software operations but also fosters learning and growth through case-driven teaching, enabling students to address real-world problems.

Furthermore, for advanced machining techniques involving complex surfaces, educational institutions should provide ample practical opportunities for students to understand and master advanced machining technologies like complex surface machining and five-axis simultaneous machining through hands-on practice. These techniques are not only widely used in industries such as aerospace and mold manufacturing but also serve as important benchmarks for assessing the overall technical competence of CNC technology professionals [4].

Additionally, the incorporation of automation and robotics technology into the curriculum is essential. Content related to the design and management of automated production lines, programming and operation of industrial robots, integration, and optimization of smart manufacturing systems, among others, empower students to comprehend not only the operation of individual machine tools but also the workings of the entire production system, thereby laying a strong foundation for their future careers.

In summary, by integrating industry technological trends, a three-year university curriculum can construct a progressive curriculum system that exposes students to the latest industry dynamics during their study period, enabling them to evolve into highly skilled professionals capable of adapting to future technological developments and market changes.

3.2 Strengthening practical skill training

In the education of CNC lathe and milling processing technology, strengthening practical skill training is crucial for students to master the core technical skills of their profession. The inclusion of more practical components helps students bridge the gap between theoretical knowledge and practical application, enhancing their ability to address real-world challenges [5]. Therefore, curriculum reform should prioritize the expansion of laboratory experiments, internships, and practical training to ensure students have ample opportunities to learn and practice in an environment that closely mimics actual workplace conditions.

Establishing on-campus training facilities equipped with modern CNC machine tools, measuring instruments, and computer-aided design and manufacturing software provides students with a platform for hands-on practice. In such an environment, students can not only practice routine lathe skills but can also undertake more complex machining tasks like multi-axis machining and precision machining. Through practical operation, students can intuitively understand the machining process and gain deeper insights into machining parameters and process flow [6].

Moreover, collaboration with local businesses and the establishment of off-campus training facilities offer another effective avenue for strengthening practical skills. Within corporate settings, students can participate in real production projects, honing their practical operational skills and gaining exposure to company culture and workflow. This experience cultivates their spirit of excellence and teamwork.

With advancements in technology, modern teaching methods such as Virtual Reality (VR) and Augmented Reality (AR) have found widespread applications in technical education. These technologies simulate real working environments and complex technical processes, offering a risk-free learning platform. Students can repetitively practice operational procedures in a virtual environment until they achieve proficiency. Through VR and AR technology, students can gain deeper insights into operational processes without direct contact with actual machine tools and can anticipate and prevent

potential errors.

In addition, the curriculum should include practical training components related to production management and quality control. Students should learn how to ensure product quality during the manufacturing process and acquire knowledge of various measurement tools and methods. These practical activities provide students with operational experience at every stage of the product life cycle.

In conclusion, by increasing laboratory and on-site training and employing new technological means for skills training, practical skills can be effectively strengthened. This helps students build a bridge from theory to practice, establishing a solid foundation for their future careers.

3.3 Enhancing student innovation and comprehensive qualities

In the rapidly evolving manufacturing industry, innovation has become a key differentiator between leading companies and others. As a result, the school curriculum must be adjusted to cultivate students' innovation capabilities to meet the challenges of the future industry. One direction for curriculum reform is designing a series of specialized modules that emphasize a practice-oriented approach, encouraging students to develop creative thinking and problem-solving skills through practical experience. For instance, participation in modern multi-axis machining technology competitions or innovative product design projects enables students to apply theoretical knowledge in practice and learn how to address and overcome new challenges during hands-on operations.

Furthermore, the curriculum should focus on cultivating critical thinking, problem-solving, and decision-making abilities. Through discussions, research projects, and case studies, students can explore unknown issues, learn how to analyze problems, compare the pros and cons of different solutions, and make optimal decisions. These soft skills are crucial for students preparing to enter the modern manufacturing industry, as they not only assist in addressing technical challenges at work but also prepare students for more significant roles in their careers.

To comprehensively enhance students' qualities, schools should also offer courses related to management and marketing. These courses help students understand market dynamics, master strategies for product promotion and brand building, and learn fundamental principles of organizational management. This interdisciplinary knowledge not only provides students with a deeper understanding of the technical field but also equips them to adapt better to dynamic work environments and lays a solid foundation for possible leadership positions in the future.

In summary, by increasing opportunities for innovative practical activities, enhancing the cultivation of soft skills, and expanding students' knowledge of management and marketing, a comprehensive curriculum system better equips students to face the challenges of the future workplace. It also promotes the enhancement of their overall qualities, preparing them to become industry innovators and leaders.

4 Teaching innovation and implementation

4.1 Practical approaches to industry-education integration

Amid the profound transformation in the global manufacturing industry, especially with the emergence of new trends in smart manufacturing and digital production, industry-education integration has become increasingly crucial. Through industry-education integration, educational adaptability and relevance can be effectively enhanced, providing students with skill development paths aligned with industrial advancement. Practical approaches to industry-education integration should encompass the following aspects:

First and foremost, university-industry collaboration should serve as the core of industry-education integration. Collaborations between educational institutions and enterprises allow for the joint development of curricula, the establishment of cooperative training bases, and the sharing of teaching resources. Under this university-industry

collaboration model, enterprises can directly participate in the design and implementation of curricula, provide real-world case studies, and guide students in solving practical problems. Furthermore, enterprises can offer internship opportunities, enabling students to learn on the job and work while they learn. Such experiences are crucial for students to comprehend complex engineering challenges and acquire knowledge of modern manufacturing technologies.

Secondly, the practice of the engineering and education integration model should be deeply promoted. Under this model, theoretical teaching is closely integrated with hands-on practice, and students can enhance their professional skills by participating in real engineering projects. For instance, by engaging in collaborative research and development projects between schools and enterprises, students can work under the guidance of teachers and enterprise engineers to solve actual engineering problems. This not only strengthens their practical abilities but also stimulates their innovative thinking.

Furthermore, the construction of a double-qualified teacher teaching team is a crucial aspect of achieving industry-education integration. Double-qualified teacher instructors possess both profound theoretical knowledge and extensive industry experience. They can bring the latest industrial technologies and management practices into the classroom, emphasizing the development of students' practical operational abilities and problem-solving skills. Double-qualified teacher instructors can lead students to participate in actual projects with enterprises and provide on-site guidance and feedback, allowing students to stay updated with industry trends and understand the direction of new technological developments.

Lastly, schools should establish a dynamic curriculum updating mechanism to regularly adjust teaching plans and content based on changes in industry and technological progress. Simultaneously, enhancing students' career planning and guidance is essential to help them better align with their future professional development.

Through these approaches, industry-education integration not only provides students with up-to-date skill development but also cultivates high-quality technical professionals who can quickly adapt to job requirements. Together, these efforts promote the development and innovation of the manufacturing industry.

4.2 The application of information technology in teaching

In the digital age, the application of information technology in education is becoming increasingly significant, bringing about revolutionary changes in traditional teaching methods. With the development of modern information technologies such as the internet, cloud computing, big data, and artificial intelligence, teaching methods have become more diversified, educational resources have become more abundant, and educational management has become more scientific.

The widespread adoption of online learning platforms has made "learning anytime and anywhere" a reality. Students can access various course resources through the internet, including video lectures, interactive tutorials, and online tests. This learning method offers high flexibility, catering to the needs of students with different learning styles and paces. Moreover, these platforms often come with tracking and assessment features, enable teachers to monitor students' learning progress and performance, and provide personalized guidance based on their performance.

Virtual simulation laboratories provide students with a safe environment for conducting high-risk experimental practices, which are crucial for improving students' practical skills. Through these simulation tools, students can practice experimental procedures without time and location constraints, repeatedly honing their skills until they become proficient.

The combination of digital textbooks with intelligent teaching systems presents complex concepts and processes in a visual and interactive manner, helping students better understand and remember. At the same time, intelligent teaching systems can offer customized learning paths and resources based on students' learning progress and understanding, effectively enhancing learning outcomes.

The application of big data analysis techniques in teaching allows for detailed recording and analysis of students' learning behaviors. Through data analysis, teachers can identify students' weaknesses and difficulties, making it possible to adjust teaching methods accordingly in a timely manner. Artificial intelligence technology can simulate the role of a teacher, providing students with 24/7 question-and-answer and tutoring services.

In conclusion, the application of information technology has significantly enriched the content and forms of education, improving teaching efficiency and quality. It has optimized the allocation of educational resources and provided students with a more personalized and interactive learning environment. Future teaching models will increasingly rely on information technology, and the digital transformation of education will continue to deepen to meet the evolving needs of society and the economy.

4.3 Exploring innovative talent development models

In response to the rapidly evolving industry demands and challenges brought about by industrial transformation, the cultivation of innovative talents has become one of the most pressing issues in the field of education. With continuous technological advancements and a diversifying market, schools must design talent development models that not only foster students' core skills but also unleash their innovative potential.

Firstly, Project-Based Learning (PBL) has gained recognition as a novel teaching model, adopted by an increasing number of schools. Through real-world project practices, PBL integrates theory with practice, stimulating students' creativity and problem-solving abilities. In this model, students are required to think independently, work collaboratively, and devise innovative solutions to project challenges.

Secondly, the design of interdisciplinary courses is an integral part of cultivating innovative talents. In this course model, students can gain knowledge from different fields, such as engineering, business, design, and technology, providing them with a broader perspective and more solutions for addressing complex problems in the future. Through this approach, education is not merely about knowledge dissemination; it's also about nurturing innovative capabilities.

The establishment of a lifelong learning system ensures the sustainability of talent development. In this system, learning extends beyond traditional schooling to one's entire career. Online courses, distance education, vocational training, workshops, and seminars are vital tools that support individual continuous learning and career growth. The flexibility and accessibility of this learning model encourage the concept of lifelong learning and support individuals in adapting and developing in an ever-changing professional environment.

Furthermore, the establishment of partnerships is a key element in cultivating innovative talents. Collaboration between schools and enterprises ensures the real-time updating of course content to align with the latest industry trends and skill requirements. Such partnerships extend beyond curriculum design to include internship opportunities, mentorship programs, and actual work experiences, enabling students to engage with real-world work scenarios.

In summary, to cultivate innovative talents capable of addressing future challenges, education models must undergo fundamental innovation and reform. This requires close collaboration between schools, businesses, and government departments to collectively build an ecosystem that supports innovation and lifelong learning. Through such a system, we can provide students with the necessary resources and support to help them find their place in a constantly changing world and realize their full potential.

5 Conclusion

Under the guidance of the "1+X" certificate system, curriculum reform and innovation for the CNC milling and turning processing certificate can effectively enhance teaching quality and students' skill levels. Through the optimization of curriculum structure, innovative updates to teaching content and methods, and the deep implementation of industry-

education integration models, more high-quality and skilled professionals that meet the demands of the Industry 4.0 era can be cultivated. Future teaching efforts should continue to focus on technological advancements and industry developments, further dynamically adjust the curriculum system, and innovate teaching models, in order to achieve optimal talent development.

Acknowledgments

Fund Project: Research on Curriculum Reform under the "1+X" Certificate System - Take CNC Milling Certificate as an Example.

Conflicts of interest

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

References

[1] Tao XQ. 2020. Exploration of modular teaching methods in the "1+X" certificate system for CNC technology and programming. *Science and Technology Wind*, 32:22-23.

[2] Su GN. 2023. Research on the reform of the "CNC machining technology and programming" course under the "1+X" certificate system. *Paper Technology and Application*, 51(01):71-75.

[3] Zeng XB. 2021. Analysis of the alignment between course content and occupational standards under the "1+X" certificate system - taking CNC milling and turning occupational skills standards as an example. *Modern Vocational Education*, 13:136-137.

[4] Shi YX. 2021. Curriculum reform for CNC milling and turning processing based on the "1+X" certificate system. Changchun Normal University. 5:66.

[5] Yuan Q. 2023. Research on the current situation of the "1+X" certificate system in applied undergraduate colleges. *Shanxi Youth*, 19:82-84.

[6] Su TT. 2023. Exploration of the promotion path of the "1+X" certificate system in Laos - taking the certificate in logistics management as an example. *Journal of Taiyuan Urban Vocational and Technical College*, 10:59-61.