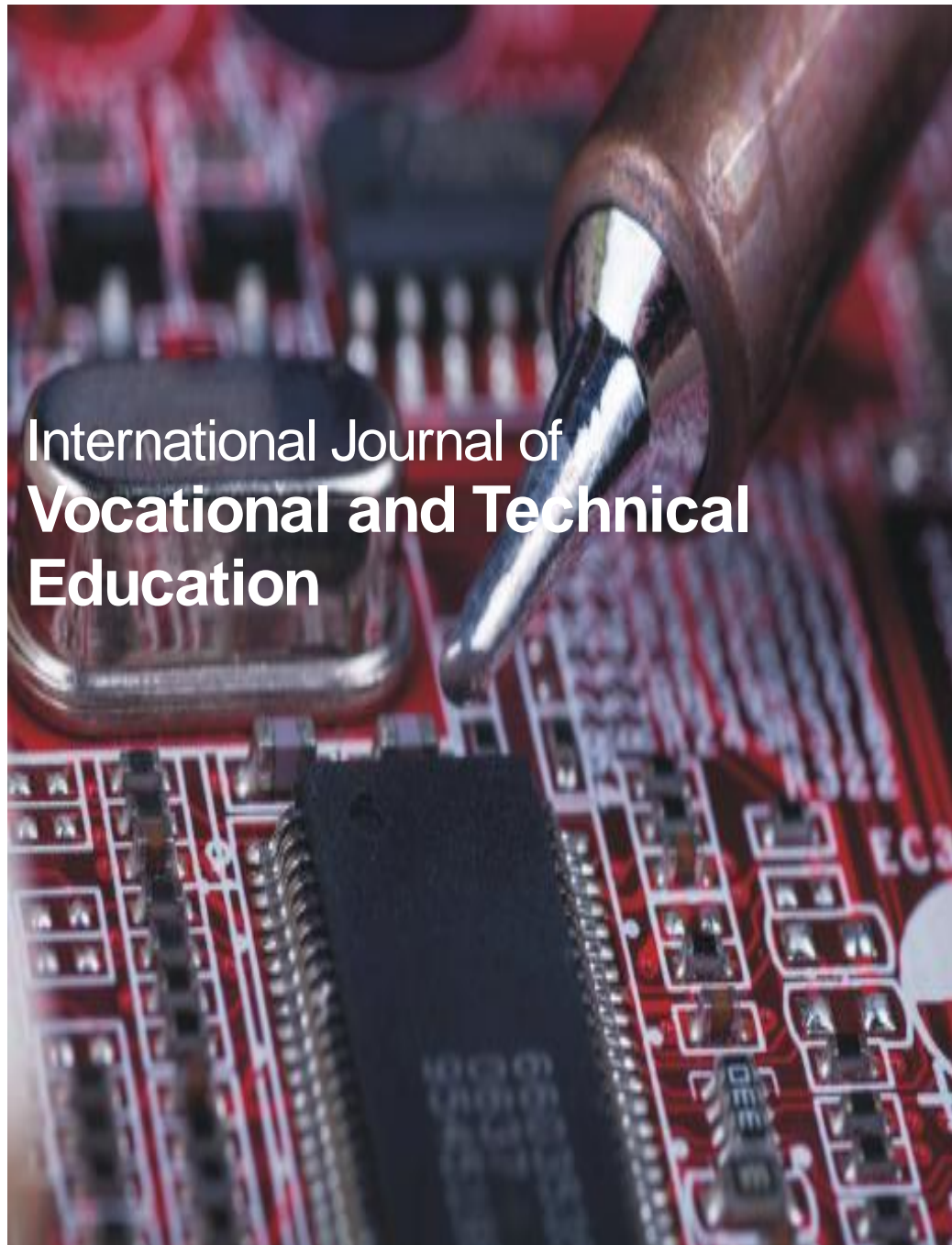


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Review

TVET, economy and sustainable development

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Technical and vocational education and training (TVET) has long been recognized as a key driver of economic growth and sustainable development. TVET programs provide individuals with the skills and knowledge needed to succeed in the modern economy, while also helping to bridge the gap between education and employment. In this paper, the literature was reviewed on the role of TVET in promoting sustainable development and economic growth, with a focus on its potential to address issues of poverty, inequality, and unemployment. The challenges and opportunities facing TVET systems were also discussed in different countries, and provide recommendations for policy makers seeking to support the development and expansion of TVET programs.

Key words: TVET, sustainable development, economy.

INTRODUCTION

Technical and vocational education and training (TVET) refers to educational and training programs that focus on providing students with practical skills and knowledge that are relevant to specific trades, occupations, or vocations. TVET programs typically include a mix of classroom instruction, hands-on training, and experiential learning opportunities, and may be offered at the secondary, post-secondary, or higher education level. These programs are designed to prepare students for careers in a wide range of fields, including manufacturing, construction, engineering, and healthcare, hospitality, and information technology. TVET programs are often seen as an important means of providing individuals with the skills and knowledge they need to enter the workforce and succeed in their chosen careers [African Union, Strategy to Revitalize Technical and Vocational Education and Training (TVET) in Africa, Meeting of the Bureau of the Conference of Ministers of Education of the African Union (COMEDAF II+) 29th – 31st May 2007;

Pavlova, 2009].

Technical and vocational education and training (TVET) plays a crucial role in promoting economic development and sustainable development. Here are a few ways in which TVET can contribute to these goals:

- 1) TVET provides individuals with the skills and knowledge they need to enter the workforce and be productive members of society. This helps to increase labour productivity and competitiveness, which can drive economic growth and development (Kibet and Kibet, 2019).
- 2) TVET programs can help to address skills shortages and mismatches in the labour market, which can lead to increased employment and economic opportunities for individuals and communities (Kibet and Kibet, 2019).
- 3) TVET can help to improve social mobility and reduce poverty by providing disadvantaged individuals with the skills and knowledge they need to access better-paying jobs and improve their economic prospects (Kibet and

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Kibet, 2019).

4) TVET programs can also contribute to sustainable development by helping to train individuals in trades and occupations that are in demand in the green economy, such as renewable energy and sustainable agriculture. This can help to reduce reliance on fossil fuels and promote environmentally-sustainable practices (Paryono, 2017a).

5) TVET can also promote gender equality by providing women and men with equal access to education and training opportunities, which can help to reduce gender-based barriers to employment and improve economic opportunities for all (Fien et al., 2010).

The purpose of this paper is to explore the relationship between TVET, economy, and sustainable development. Technical and Vocational Education and Training (TVET) plays a vital role in the economy and sustainable development.

TVET is a type of education and training that focuses on providing students with the practical skills and knowledge needed to perform a specific trade or occupation. This type of education is often seen as an alternative to traditional academic education, and it can be useful for those who want to enter the workforce immediately after completing their education. In terms of the economy, TVET can contribute to economic growth and development by providing a skilled workforce. When individuals have the necessary skills and training to perform a specific job, they can be more productive and contribute to the overall economic growth of a country. In addition, TVET can help to reduce unemployment and underemployment by providing individuals with the skills they need to find work in their chosen field.

TVET can also play a role in sustainable development by helping to promote social and economic inclusion. By providing individuals with the skills they need to enter the workforce, TVET can help to reduce poverty and improve the standard of living for those who may have otherwise been unable to find work. In addition, TVET can contribute to the development of a green economy by providing individuals with the skills and training needed to work in environmentally-friendly industries and technologies (Maclean et al., 2013; Rosenberg et al., 2020; Lotz-Sisitka et al., 2017).

TVET and Economic Development (Michaud, 2018; Pavlova, 2009)

Technical and vocational education and training (TVET) plays a crucial role in the development of a skilled labour force, which can contribute to economic growth in several ways:

1) TVET programs provide individuals with the practical skills and knowledge they need to enter the workforce and be productive members of society. This helps to

increase labour productivity and competitiveness, which can drive economic growth and development.

2) TVET can help to address skills shortages and mismatches in the labour market, which can lead to increased employment and economic opportunities for individuals and communities. When there is a sufficient supply of skilled workers, businesses can operate more efficiently and effectively, which can drive economic growth (Pavlova, 2014).

3) TVET programs can also help to foster innovation and entrepreneurship by providing individuals with the skills and knowledge they need to start and grow their own businesses. This can create new economic opportunities and contribute to economic growth (Pavlova, 2014).

4) TVET can also help to improve social mobility and reduce poverty by providing disadvantaged individuals with the skills and knowledge they need to access better-paying jobs and improve their economic prospects. This can help to reduce income inequality and contribute to more inclusive economic growth (Pavlova, 2014).

5) TVET programs can also contribute to the development of a highly skilled labour force by providing ongoing professional development and training opportunities for existing workers. This can help to keep workers up-to-date with the latest industry trends and technologies, which can improve their productivity and competitiveness (Ervasti and Kupila, 2013).

There are many examples of successful technical and vocational education and training (TVET) programs that have contributed to economic development in various countries around the world. Germany has a well-developed and highly respected TVET system that emphasizes practical, hands-on training and close collaboration between schools and industry. The German TVET system has been credited with helping to create a highly skilled and productive labour force, which has contributed to the country's economic success. Japan has a long tradition of emphasizing vocational education and training and has a well-developed system of technical schools and vocational colleges that provide students with the skills and knowledge they need to succeed in the workforce. The Japanese TVET system has played a key role in the country's economic growth and development (Devine, 2020).

Singapore has a highly developed and successful TVET system that emphasizes close collaboration between schools, industry, and government. The Singaporean TVET system has helped to create a skilled and adaptable labour force, which has contributed to the country's economic growth and competitiveness. Switzerland has a well-developed and highly respected TVET system that emphasizes practical, hands-on training and close collaboration between schools and industry. The Swiss TVET system has been credited with helping to create a highly skilled and productive labour force, which has contributed to the country's economic success (Renold et al., 2016).

Australia has a well-developed TVET system that includes a range of vocational education and training programs that are delivered by both public and private providers. The Australian TVET system has helped to create a skilled and adaptable labour force, which has contributed to the country's economic growth and development (Kanwar et al., 2019).

There are several challenges and barriers to the effective implementation of technical and vocational education and training (TVET) programs for economic development (Mao et al., 2016):

Funding

One of the main challenges facing TVET programs is a lack of adequate funding. Many TVET programs struggle to secure sufficient resources to cover the costs of instructional materials, equipment, faculty salaries, and other expenses (Paryono, 2017b).

Quality

Ensuring the quality of TVET programs can be a challenge, particularly in developing countries where resources may be limited. Quality issues can include inadequate facilities and equipment, untrained or poorly qualified instructors, and a lack of industry engagement (Paryono, 2017b).

Relevance

Another challenge is ensuring that TVET programs are relevant to the needs of the labour market and that they provide students with the skills and knowledge they need to succeed in their chosen careers. This requires close collaboration between schools, industry, and government to ensure that TVET programs are responsive to changing economic and labour market needs (Caves et al., 2021).

Access

Many individuals, particularly in developing countries, face barriers to accessing TVET programs, including financial barriers, geographic barriers, and cultural barriers. Ensuring that TVET programs are accessible to all members of society is an important challenge (Pavlova, 2014).

Stigma

In many societies, vocational education and training is often viewed as a less desirable option compared to a

traditional university education. This can lead to a stigma surrounding TVET programs, which can make it difficult to attract and retain high-quality students and faculty (Schröder, 2019).

TVET and sustainable development (Chitewere, 2017)

Technical and vocational education and training (TVET) can contribute to sustainable development by promoting green skills and environmental awareness in several ways. Some examples include:

- 1) TVET programs can teach students about sustainable practices and technologies in fields such as renewable energy, eco-friendly construction, and sustainable agriculture. This can help to create a workforce that is equipped with the skills and knowledge to contribute to the transition to a more sustainable economy.
- 2) TVET programs can also focus on teaching students about environmental conservation and the importance of preserving natural resources. This can help to raise awareness about the importance of sustainability and encourage students to adopt environmentally-friendly practices in their personal and professional lives.
- 3) By providing practical, hands-on training, TVET programs can help students to develop the skills and knowledge needed to work in green industries or to start their own environmentally-conscious businesses. This can help to drive the growth of the green economy and contribute to the transition to a more sustainable society.

There are many examples of technical and vocational education and training (TVET) programs that align with the Sustainable Development Goals (SDGs). Some examples include:

Renewable energy

TVET programs that focus on teaching students about renewable energy technologies, such as solar panels and wind turbines, can contribute to SDG 7 (Affordable and Clean Energy) by helping to create a workforce that is equipped with the skills and knowledge needed to support the transition to renewable energy sources.

Sustainable agriculture

TVET programs that teach students about sustainable farming practices, such as permaculture and agroforestry, can contribute to SDG 2 (Zero Hunger) by helping to create a workforce that is equipped to produce food in an environmentally-friendly and sustainable way.

Eco-friendly construction

TVET programs that teach students about sustainable

construction practices, such as the use of recycled materials and energy-efficient design, can contribute to SDG 11 (Sustainable Cities and Communities) by helping to create a workforce that is equipped to build in a way that is environmentally-friendly and sustainable.

Environmental conservation

TVET programs that teach students about environmental conservation and the importance of preserving natural resources can contribute to SDG 15 (Life on Land) by raising awareness about the importance of sustainability and encouraging students to adopt environmentally-friendly practices in their personal and professional lives.

There are several challenges and barriers to the integration of sustainable development principles in technical and vocational education and training (TVET) programs. Some of these challenges include:

Limited resources

TVET programs often have limited resources, including funding and staff, which can make it difficult to integrate sustainable development principles into their curricula and operations (UNESCO, 2021).

Limited awareness

Many stakeholders within the TVET sector, including students, teachers, and policymakers, may have limited awareness about the importance of sustainability and the role that TVET can play in promoting sustainable development (Pavlova, 2014).

Limited alignment with industry needs

Some TVET programs may not be aligned with the needs of industries that are focused on sustainability, which can make it difficult for students to find employment in these sectors (UNESCO, 2015; Green Skills Inc., <https://greenskills.org.au/> (accessed 10th October 2022)).

Limited collaboration with other sectors

TVET programs may not have strong connections with other sectors, such as the private sector or civil society, which can make it difficult to incorporate sustainable development principles into their operations and curricula (UNESCO, 2015; Green Skills Inc., <https://greenskills.org.au/> (accessed 10th October 2022)).

Limited access to quality training

In some cases, TVET programs may not have access to high-quality training materials or experienced instructors,

which can make it difficult to provide students with the skills and knowledge needed to work in sustainable industries (UNESCO, 2015; Green Skills Inc., <https://greenskills.org.au/> (accessed 10th October 2022)).

A successful TVET program that promotes both economic development and sustainable development (Green Skills Inc., <https://greenskills.org.au/> (accessed 10th October 2022))

One example of a successful TVET (Technical and Vocational Education and Training) program that promotes both economic development and sustainable development is the "Green Skills" program in Australia. The program was developed by the Australian government in partnership with industry, education and training providers, and community organizations.

The Green Skills program aims to build the skills and knowledge of workers in the clean energy and sustainability sectors, with a focus on meeting the needs of small and medium-sized enterprises (SMEs). It provides training and education in areas such as renewable energy, energy efficiency, and waste management.

The program has several key features that contribute to its success in promoting both economic development and sustainable development. First, it is demand-driven, meaning it is designed to meet the specific needs of employers in the clean energy and sustainability sectors. This helps to ensure that the skills and knowledge developed through the program are relevant and in-demand in the job market, which can help to increase employment opportunities for program graduates.

Second, the Green Skills program focuses on building the capacity of SMEs to adopt clean energy and sustainability practices. This not only helps to promote the use of clean energy and sustainability practices in these companies, but also supports the overall economic development of the region by helping these businesses to grow and thrive.

Finally, the program also has a strong focus on sustainability, with a goal of helping to reduce greenhouse gas emissions and protect the environment. This aligns with the principles of sustainable development and helps to ensure that the program is contributing to a more sustainable future for all.

There is evidence that the Green Skills program has had a positive impact on both economic development and sustainable development in Australia.

In terms of economic development, the program has contributed to the growth and development of the clean energy and sustainability sectors in Australia, which has created employment opportunities for program graduates (Green Skills Inc., <https://greenskills.org.au/> (accessed 10th October 2022)). According to the Australian government, the clean energy sector has experienced

strong growth in recent years, with employment in the sector increasing by more than 20% between 2015 and 2019. The Green Skills program has played a role in building the skilled workforce needed to support this growth (Green Skills Inc., <https://greenskills.org.au/> (accessed 10th October 2022)).

In terms of sustainable development, the program has helped to promote the adoption of clean energy and sustainability practices in small and medium-sized enterprises (SMEs), which has contributed to the reduction of greenhouse gas emissions and the protection of the environment. In addition, the program has focused on building the capacity of SMEs to adopt these practices, which has helped to ensure that these businesses are able to continue to operate in a sustainable manner over the long term.

There are several lessons that can be learned from the Green Skills program and best practices that other TVET (Technical and Vocational Education and Training) programs can follow:

Demand-driven approach

The Green Skills program was designed to meet the specific needs of employers in the clean energy and sustainability sectors, which helped to ensure that the skills and knowledge developed through the program were relevant and in-demand in the job market. Other TVET programs should consider adopting a similar demand-driven approach to ensure that the skills and knowledge they provide are relevant to the needs of the local job market.

Focus on small and medium-sized enterprises (SMEs)

The Green Skills program focused on building the capacity of SMEs to adopt clean energy and sustainability practices, which not only helped to promote the use of these practices in these companies, but also supported the overall economic development of the region by helping these businesses to grow and thrive. Other TVET programs should consider how they can support the growth and development of SMEs in their regions.

Sustainability focus

The Green Skills program had a strong focus on sustainability, with a goal of helping to reduce greenhouse gas emissions and protect the environment. Other TVET programs should consider how they can promote sustainable development and contribute to a more sustainable future.

Partnerships with industry, education and training providers, and community organizations

The Green Skills program was developed in partnership with industry, education and training providers, and community organizations. This helped to ensure that the program was relevant and responsive to the needs of the local job market and community. Other TVET programs should consider developing similar partnerships to ensure that they are able to meet the needs of the local job market and community.

Conclusion

This paper has discussed the role of TVET in promoting economic development and sustainable development. It has addressed the importance of a demand-driven approach to TVET, which ensures that the skills and knowledge provided are relevant to the needs of the local job market. In addition, the role of TVET in supporting the growth and development of small and medium-sized enterprises (SMEs) has been highlighted including the importance of sustainability in TVET and the role of TVET in promoting clean energy and sustainability practices and the benefits of partnerships between TVET programs, industry, education and training providers, and community organizations in promoting economic development and sustainable development. In the case study presented on the Green Skills program in Australia has exhibited a successful TVET program that has contributed to both economic development and sustainable development with important implications for policy and practice in the promotion of TVET for economic development and sustainable development.

There are several areas where further research on TVET, economy, and sustainable development could be valuable:

- 1) Evaluating the impact of TVET programs on economic development and sustainable development: More research is needed to understand the specific ways in which TVET programs contribute to economic development and sustainable development, as well as the factors that contribute to the success or failure of these programs in promoting these outcomes.
- 2) Developing best practices for TVET programs: Further research could help to identify the key features of successful TVET programs that contribute to economic development and sustainable development, and provide guidance on how these best practices can be replicated in other contexts.
- 3) Exploring the role of TVET in promoting the transition to a green economy: As the world transitions to a low-carbon, sustainable future, TVET programs have an important role to play in building the skilled workforce

needed to support this transition. Research could help to identify the specific skills and knowledge needed for the green economy, and how TVET programs can best support the development of these skills.

4) Examining the role of TVET in promoting gender equality and inclusion: TVET programs have the potential to promote gender equality and inclusion by providing opportunities for marginalized groups to access education and training. Research could explore the specific ways in which TVET programs can support the empowerment of women and other marginalized groups.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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Full Length Research Paper

Innovation and implementation of "introducing enterprises to education" to cultivate precision machining technology talents

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Introducing enterprises to education is an effective way to deepen the integration of industry and education. This article explores the implementation of "enterprise-integrated education" in the cultivation of precision machining technology talents. This includes establishing a collaborative teaching team, incorporating enterprise engineers into professional basic and practical training courses, offering interest classes, excellent classes, and precision engineering classes for precision machining. The objective is to amalgamate theoretical instruction with practical application and foster industry-academic collaboration, thereby mastering multi-axis machining technology. The teaching mode of "introducing enterprises into teaching" was evaluated through a questionnaire survey, revealing that it received positive recognition and high satisfaction from students in terms of its implementation effect.

Key words: Vocational education, industry-education integration, cultivation model, talent cultivation.

INTRODUCTION

From the promulgation of the "Vocational Education Law of the People's Republic of China" in May 1996 to its revision in April 2022, as well as the "Implementation Plan for National Vocational Education Reform" (consisting of 20 articles on vocational education) in 2019, all these reflect the national level's emphasis on vocational education and policy support. Among these, the "Opinions on Deepening the Reform of Modern Vocational Education System Construction" in 2022 emphasized the need to adhere to promoting production through education, assisting teaching through production, integrating production and education, promoting cooperation between production and education, and

facilitating the formation of a modern vocational education structure and regional layout that is compatible with market demand and industry structure. Vocational education is not merely employment-oriented, nor is it a form of "low-level education". It should be closely linked to industrial transformation and regional development (General Office of the Chinese Communist Party, 2022).

At the national level, vocational education primarily focuses on hierarchical and long-term development. In 2014, the "Decision of the State Council on Accelerating the Development of Modern Vocational Education" proposed exploring the development of undergraduate-level vocational education, marking its first mention in a

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national normative document. Since 2019, the Ministry of Education has approved upgrades for selected higher vocational colleges to become undergraduate vocational schools and has implemented relevant policies. Currently, the positioning of undergraduate vocational education in society and its differentiation from specialized vocational education and undergraduate general education are unclear. Furthermore, further research is needed to deepen our understanding of talent cultivation in undergraduate vocational education.

Higher vocational education is a crucial battleground for cultivating high-quality technical and skilled talents, as well as great craftsmen. The laboratory and training rooms are pivotal sites for practical instruction. Although the quantity and quality of training facilities in vocational colleges have significantly improved, there are still deficiencies in construction and management that result in inadequate training rooms, failing to meet the demands of practical teaching and technical training (Zhang, 2021). Currently, relying solely on vocational colleges to establish large-scale high-end precision machining training bases is challenging. This requires not only the construction of advanced equipment hardware but also the development of a comprehensive curriculum. However, most teachers in vocational colleges teach practical training courses part-time and lack experience in enterprise management and frontline operations, resulting in insufficient operational procedures and skills. As a result, the quality level of practical training project development is relatively low, indicating the need for improvement.

Currently, common models for implementing "introducing enterprises into education" include inviting enterprise experts to collaborate in establishing talent training plans, co-authoring textbooks, and jointly constructing training bases (Gao and Tang, 2021; Li and Zhong, 2021). There are various methods of execution, such as "targeted class training" (Wang, 2019), order-based talent training (Tan, 2020), or specific course-specific development (Guo, 2019). To cultivate precision machining technology talents, high-end precision machining training bases are crucial. Without the participation of enterprises in construction and management, it is difficult to achieve practical results. Therefore, we should further emancipate our minds and increase the implementation of "introducing enterprises into education" (Liu, 2020; Wang, 2019).

Wu Xuemin, the party secretary of Nanjing Vocational University of Industry Technology, pointed out that school-enterprise cooperation should evolve into school-enterprise integration. While consolidating the theoretical foundation, undergraduate vocational education should also emphasize the cultivation of technical abilities to address practical problems. The trained talents should be better adapted to the technical skill requirements of high-end positions. In undergraduate vocational education, professional settings should aim at "two high-ends",

namely high-end industries and high-end skills (Wu, 2023).

Deepening the integration of industry and education is a necessary educational approach for cultivating vocational talents. Currently, research on this integration primarily focuses on policy and mechanism levels. One effective approach to deepen and refine this integration is by incorporating enterprises into education. Against the backdrop of vigorously advocating intelligent manufacturing development, Chinese manufacturing faces both opportunities and challenges. Talent support is essential to achieve the upgrading of the industrial structure and the goals of "Made in China 2025" and "Industry 4.0". Cultivating high-end precision machining technology talents is particularly important in promoting the development of the intelligent manufacturing industry. Therefore, it is necessary to change the traditional teaching mode, enable students to adapt to corporate culture, and master corporate technology as soon as possible, thus shortening the cycle from graduation to becoming high-end technical talents. This is also the ultimate dream and benefit of employers. This article takes the innovative perspective of cultivating precision machining technology talents and explores the specific implementation of "introducing enterprises into education" from various micro links as an entry point.

INNOVATIVE PRECISION MACHINING TECHNOLOGY TALENT TRAINING MODEL OF "INTRODUCING ENTERPRISES INTO EDUCATION"

In order to realize the integration of industry and education, Nanjing Vocational University of Industry Technology and Beijing JingDiao Group have jointly established Beijing Jingdiao College and built a precision machining training base together. The hardware includes five-axis high-precision machining machines and automated production lines. As a leading precision machining enterprise in China, Beijing JingDiao Technology Group Co., Ltd. possesses significant technological advantages in the intelligent manufacturing industry chain, which provides favorable conditions for "enterprise introduction into education". In that case, a mixed team was composed of enterprise experts and college teachers. The professional courses are conducted by a diverse teaching team. Ongoing discussions have been held since 2020 regarding training standards, content, and instructional models.

In the teaching process, we incorporated enterprise engineering projects and production cases to collaboratively develop textbooks, loose-leaf workbooks, and task lists that cater to practical teaching needs. To enhance the practical operational skills of professional educators, Beijing JingDiao College has offered specialized training in professional competencies to enterprise personnel and relevant instructors from the

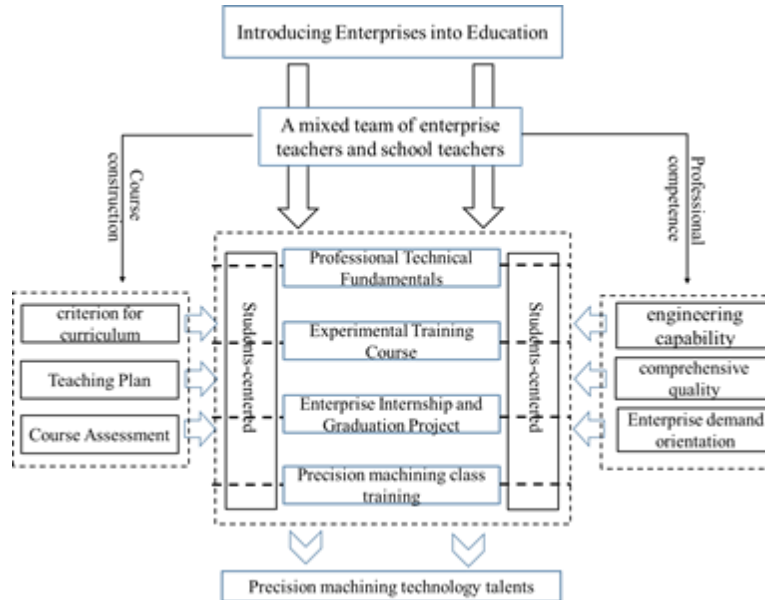


Figure 1. Models for talents cultivation of "Introducing Enterprises into Education" to cultivate precision processing technology talents.

School of Mechanical Engineering who are responsible for conducting hands-on training courses. This includes instruction on JDSoft SurfMill software as well as multi-axis machine tool operation. The mixed team collaboratively engages in practical and professional courses, seamlessly integrating corporate culture, advanced technology, management concepts, and job requirements into the classroom.

With a student-centered approach, we merge employment with education by taking enterprise job requirements into account when formulating professional plans and outlines. The mixed team jointly undertakes practical and professional courses, integrating corporate culture, advanced technology, management concepts, and job requirements into the classroom. We prioritize students as the center, combining employment with education, considering the job requirements of enterprises when formulating professional plans and outlines, and guiding teaching accordingly. The mixed team collaboratively engages in practical and professional courses, incorporating corporate culture, cutting-edge technology, management concepts, and job requirements into the classroom. By placing student development at the core, we integrate education and employment by incorporating enterprise job requirements into our professional plans and curricula, aligning our teaching methods accordingly. The models for talent cultivation are shown in Figure 1. Combining course construction with professional literacy cultivation, we carried out precision engineering class training with the goal of cultivating more outstanding talents in precision machining technology.

TEACHING MODE OF PROFESSIONAL BASIC TECHNOLOGY COURSES UNDER THE GUIDANCE OF "INTRODUCING ENTERPRISES INTO TEACHING"

For the professional courses in mechanical manufacturing and automation, the "Comprehensive Training of Product Manufacturing Process and Equipment" integrates knowledge and skills from courses such as "Mechanical Manufacturing Processes," "Machine Tool Fixture Design," and "Mechanical CAD/CAM Technology." The aim is to cultivate students' comprehensive abilities in completing processing process design, special fixture design, digital manufacturing, and CNC precision machining for actual machine elements. However, comprehensive practical training often faces challenges such as inadequate equipment or insufficient teacher expertise. By incorporating enterprises into the teaching process and inviting their engineers to participate and provide support, these obstacles can be effectively overcome. The teaching mode is shown in Figure 2. Theoretical teaching, skill training, and job practice are equally emphasized, providing students with sufficient online resources. Theoretical teaching and practical training align with professional standards and production needs.

Multi-axis CNC linkage machining technology represents the pinnacle of CNC machining capabilities. Currently, the teaching cases used in the course of Multi-axis CNC Linkage Machining Technology in this specialty are all derived from or abstracted from actual enterprise cases. These cases retain elements that reflect the characteristics of multi-axis machining and precision

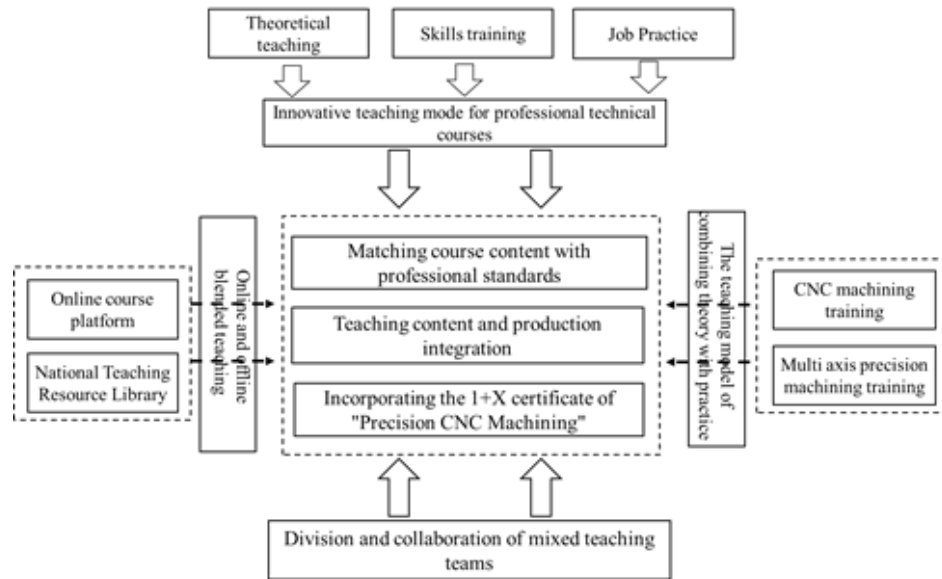


Figure 2. Teaching mode of mixed team.

machining to better meet classroom teaching requirements. Additionally, the courses in this major are challenging and highly practical. Under the organization of a mixed teacher team, progressive talent training programs such as precision machining interest classes, excellent classes, and precision engineering classes are carried out. This ensures that students can effectively manage their time for optimal learning. After the training, students proficiently master the utilization of 5-axis CNC programming software and the operation skills of 5-axis machining centers. They also make significant progress in fixture design, tool application, and process parameter optimization. They successfully integrate theory and practice, skillfully applying their process knowledge in practical situations.

To enhance the connection between professional basic courses and practical courses, specialized classes like "Mechanical CAD/CAM Technology" and "Mechanical CAM" use a blended teaching approach. Instructors from both sides collaborate on course preparation, evaluation, and assessment. Through theoretical knowledge and practical training, these students establish a solid foundation for the 1+X certificate, skills competitions, and employment. With a combination of theoretical knowledge and practical training, these students establish a strong foundation for obtaining the 1+X certificate, participating in skills competitions, and seizing employment opportunities.

METHODOLOGY

Survey questionnaire on the effectiveness of teaching models

To foster high-end precision machining and manufacturing talents,

the mixed teaching team has undertaken exploration and innovation in the teaching approach. We carried out a questionnaire survey to assess the effectiveness of the "introducing enterprises into teaching" model. This survey involved 60 students who recently received professional courses from enterprise instructors, along with practical training in CNC machining and precision manufacturing. The primary questions of the questionnaire are outlined in Table 1.

RESULTS

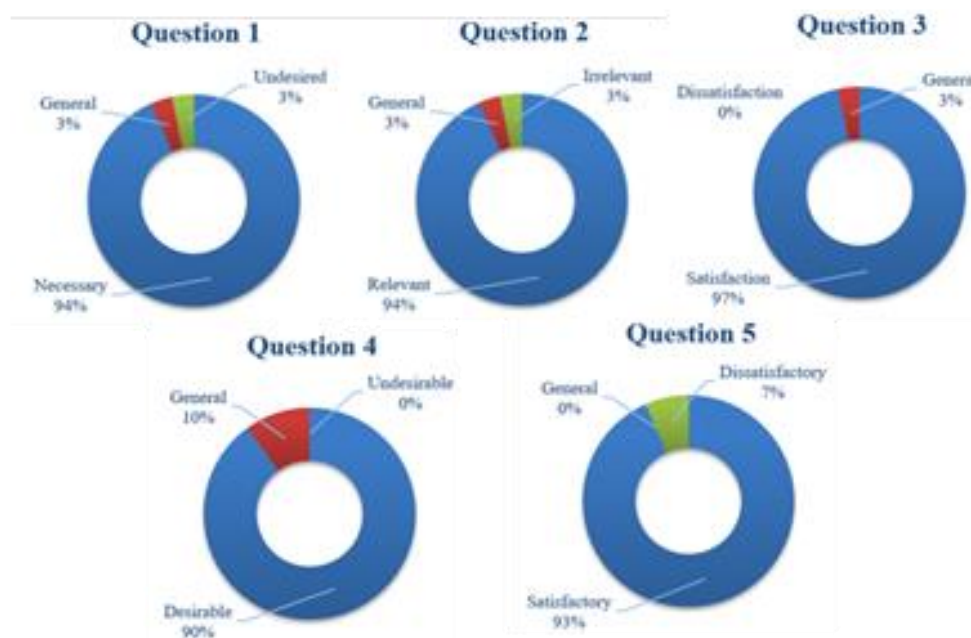
Based on the questions in Table 1, the percentage results of option selection were used to generate Figure 3. The outcomes of the survey questionnaire indicate that the teaching model of "introducing enterprises into teaching" has been well received by most students and has achieved a high level of satisfaction. The knowledge and skills imparted by enterprise experts have laid a solid foundation for their future engagement in the precision manufacturing industry. As many as 90% of students expressed their desire to continue participating in practical courses on "introducing enterprises into teaching." However, there are still very few students who have chosen different options, and this outcome might be related to their level of interest in and recognition of the major.

DISCUSSION

This paper discusses the implementation mode of "integrating enterprises into education" and provides an illustrative example for developing the talent training approach in vocational education, specifically focusing on

Table 1. Questionnaire question and corresponding options.

Numbers	Questionnaire question	Options, number of students who have selected this option		
1	Is it necessary to introduce enterprise experts to participate in classroom teaching?	Necessary, 56	General, 2	Undesired, 2
2	Does the knowledge and skills taught by enterprise experts meet the requirements for engaging in precision manufacturing related professions?	Relevant, 56	General, 4	Irrelevant, 0
3	What is the overall evaluation of the implementation of the course task of "introducing enterprises into education"?	Satisfaction, 58	General, 0	Dissatisfactory, 0
4	Do you wish to continue implementing the "Introducing Enterprises into Education" practical course in the next session?	Desirable, 54	General, 6	Undesirable, 0
5	Are you willing to work in the mechanical manufacturing industry after graduation?	Willing, 56	Uncertain, 0	Unwilling, 4

**Figure 3.** Results of survey questionnaire on the implementation effect of the teaching mode of "introducing enterprises into education".

cultivating precision machining technology talents. The objective is to nurture skilled professionals in vocational education who can meet the demands of high-level manufacturing roles. Enterprise teachers within the mixed teaching team not only deliver vocational skills training to school educators but also actively participate in teaching foundational professional courses and practical training sessions. By doing so, the establishment of a mixed teaching team facilitates the timely introduction of new technologies into educational institutions, enabling

continuous updates to teaching content and fostering a group of teachers with robust practical abilities and extensive experience. For students, the involvement of enterprises provides exposure to cutting-edge technology, allowing them to learn through hands-on applications. This greatly enhances their learning enthusiasm and boosts teaching efficiency, a correlation consistent with the findings of the student survey questionnaire. The integration of practical teaching into real-world production within schools elevates students'

skill levels and learning progress. Simultaneously, for enterprises, it enhances their visibility and societal contributions while nurturing and creating a pool of potential employees.

However, it's crucial to acknowledge the limitations of enterprise teachers. While they possess practical technical skills, it's important to note that they might lack formal professional training and exhibit certain deficiencies in educational methodologies. Hence, the provision of training programs for enterprise teachers becomes essential. Furthermore, establishing an effective government policy framework and a viable standard system, including a performance evaluation mechanism that encompasses production-education integration standards, is necessary. Strengthening laws and regulations related to industry-education integration and enhancing the implementability of relevant provisions is vital. Establishing a well-functioning cooperation mechanism for industry-education integration, taking into account the interests of both educational institutions and enterprises, is also imperative.

Additionally, vocational colleges should incorporate diversification, three-dimensionality, and openness into the structure of their educational systems while constructing the teaching evaluation mechanism. In future research, our focus will extend to tracking and investigating graduates who work in the mechanical manufacturing industry. This will help us establish a closed-loop system of talent cultivation and application, shaping a replicable talent cultivation model.

Conclusion

Advancing vocational education through deepening the integration of industry and education, as well as implementing the "introduction of enterprises into education," is crucial. This article explores innovative approaches to incorporating enterprises into education for the purpose of cultivating precision machining technology talents. By forming a mixed teaching team and providing training in multi-axis machine tool machining operations to departmental teachers, the practical skills of full-time educators have been enhanced. Enterprise engineers are actively involved in teaching professional foundational courses and practical training, achieving a seamless bridge between theoretical knowledge and hands-on application. Simultaneously, courses of different levels such as precision machining interest classes, excellence classes, and precision engineering classes are offered to progressively enhance students' proficiency in Multi-axis machining technology. This prepares them for involvement in 1+X certificate examinations, skills competitions, and future employment prospects. A questionnaire survey on the implementation impact of the "Introducing Enterprises into Education" model revealed that it has garnered high praise and recognition.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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