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How should vocational teachers develop their competence? A systematic review

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ABSTRACT
The world's economic growth and industrial transformation require a significant number of high-quality technical personnel urgently. Consequently, vocational education is rapidly evolving worldwide dedicated to cultivating high competent graduates. The effectiveness of vocational education is heavily reliant on the proficiency of its instructors. Therefore, enhancing the competence of vocational teachers has become the core issue at present. The purpose of this systematic review is to investigate the components of effective competence development for vocational teachers. Specifically, it aims to identify the key competence that vocational teachers should develop. Based on the analysis of journal articles published in the past ten years, we find that vocational teachers should continue to study professional knowledge, expand interdisciplinary knowledge, improve teaching ability, adopt an international perspective, enhance their industry-education integration, innovation, and research abilities. We also found that social factors, school factors, and personal factors will have an impact on the development of vocational teachers' competencies.

Keywords: Vocational Teacher Competence, Competence Development, Vocational Education

1) INTRODUCTION

With the progress of industrial technology and the rapid development of emerging industries and technologies, the demand for high-quality technical skills workers is increasing. Consequently, there is a growing need for highly skilled professionals with advanced knowledge and expertise. Vocational education should address these challenges by offering a more comprehensive understanding of professional disciplines and broader skills training to meet the dynamic needs of various industries. This will help in training graduates who are equipped to meet the future demands [1], [2]. With the continuous improvement of the quality of vocational education in various countries, employers are increasingly favoring vocational education graduates[3]. Here is no difference in salary between vocational education graduates and general education graduates, and vocational education graduates have advantages in the early stages of their careers [4].China has initiated a pilot program for vocational education at the undergraduate level and intends to expand vocational education to the graduate level in the future[5]. In this context, teachers have become the key to cultivating the quality of graduates in vocational education. This implies that teachers must adapt their competence to meet the latest development requirements. It is necessary for teachers to continuously improve their competence[6].

At present, numerous innovations and reforms have been implemented in the field of vocational education to enhance the continuous development of vocational teachers' competence. The work of professional teachers is based on dual professionalism, and they should keep their teaching and professional skills up to date[7]. China's Ministry of Education has promoted projects such as national teacher training, teaching ability competitions, skill competitions, and the construction of a national teaching resource database, which have effectively enhanced the abilities of vocational teachers in China[8]. However, it is worth noting that at present, financial support for general education exceeds that allocated to vocational education. High vocational colleges in major city centers have superior infrastructure, resources, funds, and teacher quality compared to those in smaller city areas. This situation leads to regional imbalance and conflicts of interest in vocational education, which impedes

the development of teachers' abilities [9]. Therefore, to enhance teachers' capabilities, it is essential to boost their job satisfaction, provide guidance for professional development, establish a conducive growth environment, and reform the management policies of higher vocational colleges[10]. For teachers transitioning from general undergraduate education recipients to vocational education teachers, it is essential to focus on developing technical abilities and adjusting their mode of thinking [11].

In recent years, there has been growing research on the competence of vocational teachers. This is due to the critical role that teachers' competence plays in shaping the quality of education and the future earnings of graduates. Based on these studies, vocational teachers' competence can be summarized into four aspects: teaching ability, professional ability, industry-education integration, scientific research, and innovation ability. To determine which capabilities vocational teachers should develop in the future, the purpose of this study is to investigate the research on vocational teachers' competence in published journal articles and to explore the components of effective capacity development for vocational teachers.

This paper's contributions include:

(a) Summarizing research achievements in four key areas: teachers' teaching ability development, professional development, industry-education integration ability, and scientific research and innovation ability, as in **Figure 1**.

(b) Engaging in research and discussions on the role of generative artificial intelligence in assisting teaching.

(c) Delving into feasible strategies for enhancing the training of vocational teachers.

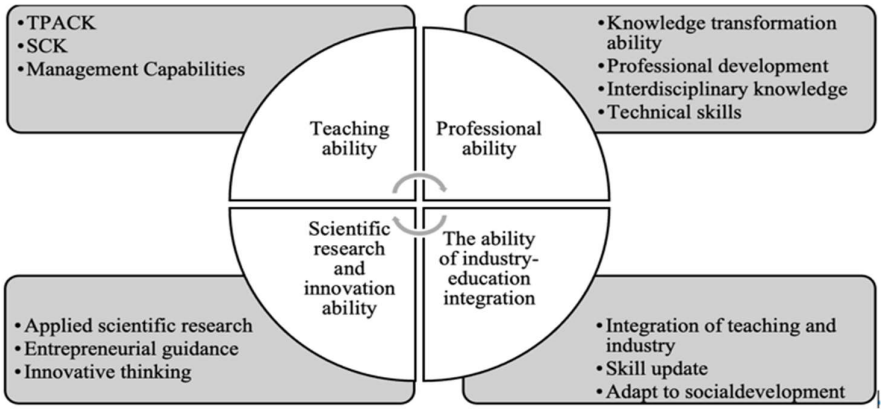

Figure 1 The content of competence Development of Teachers in Vocational Colleges

2) DEVELOPMENT OF TEACHERS' TEACHING ABILITY

The Technological Pedagogical Content Knowledge (TPACK) framework emphasizes the integration of technology, pedagogy, and content knowledge into the educational environment. At the same time, teachers' use of mobile technology and computational thinking is influenced by societal trends and expectations[12], [13]. The adoption and utilization of information and communication technologies (ICTs) in education are influenced by social factors[14]. This is evidenced by the direct and indirect impact of teachers' performance expectations, effort expectations, and external conditions on the use of ICT in teaching and learning[15] .

The ability of teachers to effectively teach directly influences the quality of education and training that students receive, as well as their preparedness for employment[17]. Additionally, teachers' capacity to teach plays a crucial role in creating a positive learning environment and promoting student success [18] Vocational college instructors with strong teaching abilities can effectively support and guide students' skill development, resulting in higher retention rates and overall student satisfaction[12]. Vocational college teachers must possess the skills to incorporate new technologies and teaching strategies into their instruction, guarantee that students acquire the most up-to-date knowledge and skills required in the job market, and enhance teachers' professional knowledge, practice, and performance through professional development classes and the utilization of various elements of technology acceptance models (Technological and Vocational Education and Training) [16].

The education sector is ill-equipped to handle the ethical and pedagogical integration aspects of these rapidly advancing generative AI tools until now. Schools should provide systematic training for teachers to develop a thorough understanding of the technical principles and generation mechanisms of generative AI, enabling them to effectively utilize it in relevant educational contexts[19] [20].

Nidhom research on the incorporation of augmented reality into Massive Open Online Courses (MOOCs) for vocational education supports the concept of Education 3.0[21]. Aldosari further highlights the potential of AI to

shape the future of vocational education and training, based on the AI Transformation for the Future of Higher Education[22]. The study "The impact of vocational education and training on decent job opportunities in ICT" offers valuable insights into the practical implications of integrating AI into vocational education[23]. Karakose et al. conducted a comparative analysis of the impact of digital leadership and technology integration on teachers[24]. Lozano emphasized the potential revolution in education resulting from the impact of ChatGPT, particularly in terms of developing the competencies necessary to shape students' future careers. This study highlights the transformative impact of ChatGPT on students' skill development, which is essential for their future careers[25].

3) TEACHERS' PROFESSIONAL ABILITY DEVELOPMENT

Vocational college teachers need to develop professional skills related to creativity and critical competencies, with a strong foundation in subject knowledge[26], [27]. School culture and collaboration play an important role in facilitating teacher development, and school management has a significant influence in creating a supportive and collaborative environment that helps teachers grow and ultimately benefits students.

School culture and collaboration play an important role in facilitating teacher development, and school management has a significant influence in creating a supportive and collaborative environment that helps teachers grow and ultimately benefits students[29]. In addition, Sedov discussed trends in the development of technical education and advanced vocational training, highlighting the necessity of an interdisciplinary approach to address the evolving requirements of vocational education within the framework of technological progress[28]. New technologies augment the Technology-Enhanced Learning (TEL) in vocational education, presenting both challenges and opportunities. Therefore, teachers need to adapt to an interdisciplinary pedagogical perspective [30], [31]. International exchanges and cooperation in vocational education can enhance the standard and quality of vocational education and nurture global talents. Therefore, teachers need to possess the necessary expertise for internationalization[29].

Society's emphasis on lifelong learning and technology-enhanced learning shapes the system for teachers to address the challenges of education in the 21st century[31],[32]. The development of vocational education curricula should adapt to new technologies and opportunities, while also considering the expectations of future generations of students[28],[33]. Vähäsantanen considers teacher learning to be a key factor in teaching quality and school development, emphasizing the central role of teachers' professional identity in their work[34]. This emphasizes the importance of school management in creating an environment that supports the development and growth of teachers' professional identity. In addition, the ability to make evaluative judgments about one's own and others' work is essential for lifelong learning and effective practice. Scheer suggests that personalized and effective professional development is crucial for teacher growth[35].

Hegarty showed that collaborative activities involving teachers and students can be effective in improving academic outcomes and promoting participation[13]. Research highlights the importance of providing teachers with opportunities for professional development, expert support, and feedback, which are essential to foster collaboration and improve teaching effectiveness[33].

4) DEVELOPMENT OF TEACHERS' ABILITY TO INTEGRATE INDUSTRY AND EDUCATION

In the context of integrating industry and education, vocational colleges must proactively undertake educational transformation. They should prioritize the development of practical skills, application abilities, and practical professional knowledge. Teachers must continuously enhance their teaching abilities and overall teaching levels to better align with social development, drive school transformation, and meet the demand for skilled professionals in society [36]

In the context of integrating industry and education, the vocational education teaching system should be based on vocational competency requirements, with the aim of enhancing practical teaching and promoting active learning[37]. As the primary developer and implementer of teaching activities within the context of industry-education integration, if teachers persist in using traditional teaching methods, focus excessively on theoretical knowledge, and neglect the development of students' practical skills, they will be unable to effectively integrate theoretical and practical teaching. This will lead to students' inadequate retention and comprehension of knowledge, failing to meet the demand for skilled professionals, and hindering the cultivation of technically proficient individuals suited to the industry-education integration landscape.

In the context of integrating industry and education, professional teachers need to continuously improve and develop their skills. Vocational teachers require a diverse set of professional skills and knowledge, including the capacity to communicate using the same terminology as workers in the specific occupational field. This is essential for successful interaction and for effecting changes in workplace practices[38]. The survey on the professional development of vocational and technical teachers indicates that teachers' technical proficiency in the industry and their content knowledge has significantly increased, leading to the enhancement of practical skills and expertise [29]. In the context of modern vocational education, social factors such as the uneven

distribution of teachers and collaboration with the community affect teacher capacity development and the quality of vocational education[39], [40]. Social training, community outreach programs, and vocational education play a vital role in enhancing teachers' practical and application skills. The evidence provided by Andresen suggests that practice-based learning promotes the development of teachers' professional identity and agency, further emphasizing the impact of experiential learning on teacher development[31]. The digitization of modern education offers opportunities for teacher training and collaboration, addresses the social tensions associated with digitization, and emphasizes the importance of social adaptation in the context of education [41]. Social trends in technical education and labor training have an impact on the perception of vocational education and the advancement of technical education[28]. The influence of the learning model on vocational education is associated with the attainment of competency standards, encompassing attitudes, knowledge, and skills that are responsive to social development and underscore collaboration with the community[40]. The use of technology-enhanced learning environments in vocational education promotes teacher-led approaches and collaborative activities, enhances work-based learning, and highlights the role of technology in fostering social interaction and community engagement[30]. In addition, the utilization of ICT approaches for teacher professional development emphasizes the significance of digital resources in promoting collaboration and enhancing the social and communication skills of educators[42].

In practical work, vocational teachers integrate theoretical knowledge with hands-on experience and combine teaching content with scientific research. This approach is beneficial for enhancing their professional ability, improving the quality of teaching, and holds great significance for the transformation of vocational schools. The advancement of technical education and advanced vocational training underscores the necessity for educational institutions and instructors to adjust to new technologies while considering the expectations of future generations, emphasizing the evolving nature of social and technological requirements in vocational education[28]. The integration of adaptive social media skills trainers and virtual reality in vocational education offers innovative methods to enhance the development of social media skills and bolster the professional capabilities of technology teachers. This emphasizes the fusion of technology and social skills within an educational[43].The collaborative organization of teacher training programs is seen as a means to enhance employability and empower future educators, highlighting the diverse range of career opportunities in the field of education[44].

5) DEVELOPMENT OF TEACHERS' SCIENTIFIC RESEARCH AND INNOVATION ABILITY

The research capacity of vocational and technical teachers is a crucial topic in the field of education[45]. Research activity of a teacher is a mechanism for the teacher's self-development as a researcher, which allows him to effectively solve emerging professional problems based on general provisions borrowed or created by him[46]. Currently, the distinction between the scientific research focus of higher vocational colleges and undergraduate colleges in terms of research foundation and functional orientation is unclear. Vocational colleges differ from undergraduate colleges in that they cultivate application-oriented talents. Therefore, they need to define their own scientific research positioning, establish a scientific research orientation that aligns with the characteristics of vocational colleges, and propose targeted directions for scientific research. This approach will effectively enhance the scientific research capabilities of teachers in higher vocational colleges. The capacity of vocational teachers to conduct scientific research directly influences the quality of TVET and training offered to students. The integration of digital competence and academic literacy in an educational setting can enhance students' research and academic inquiry skills[47].

Salleh discusses the influence of school support and access to technology resources on teachers' attitudes toward technology. The study demonstrates that school management significantly shapes teachers' beliefs about technology-rich teaching through professional development workshops[48]. This emphasizes the importance of school management providing the necessary support and resources to improve teacher development in the context of integrating technology. Teachers with higher levels of education, particularly those with graduate degrees, generally have stronger research capabilities. The emphasis on improving the research skills of prospective teachers in the contemporary education system highlights the significance of vocational education in cultivating research and academic competencies[46]. The scientific research conducted by teachers in vocational colleges is multidisciplinary, encompassing subject knowledge research, enterprise project research, and teaching research. The development of teachers' professional competence in vocational education schools reflects the significance of modern technologies and pedagogical expertise in academic research[32]. Scientific research can enhance the scope and depth of teaching. Teachers can integrate scientific research findings into their teaching to address practical challenges in fostering professional skills and to supply the society with qualified professionals.

6) DISCUSSION AND CONCLUSIONS

The enhancement of teachers' competence in higher vocational schools is influenced by personal, social, and

school factors. Personal factors such as education, experience, and professional identity are the foundation for advancement. External factors, such as economic growth and education policy, play a role in creating conditions that can promote or hinder the development of capabilities. In addition, factors in the school environment, such as management, training, and culture, provide necessary support and resources for teachers' professional growth, as shown in Figure 2. Initiatives such as enhancing qualifications, organizing skills competitions, and improving daily teaching practices can promote the competence development of teacher. It is important to appoint school leaders who prioritize teacher development. By recognizing these diverse influences and implementing targeted strategies, higher vocational schools can empower teachers to effectively prepare students for success in their chosen fields.

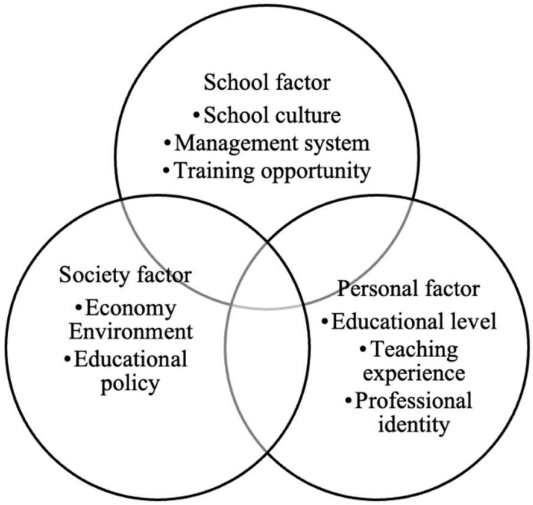

Figure 2 Factors affecting the Development of Teachers' competence in Vocational Colleges.

The professional expertise of vocational teachers encompasses disciplinary knowledge, interdisciplinary understanding, international perspective, and educational theory. These elements are crucial for effective teaching and student development. Disciplinary knowledge forms the foundation of teachers' professional expertise, while interdisciplinary knowledge is increasingly recognized as a crucial skill for teachers alongside their disciplinary knowledge. This professional knowledge enables teachers to better comprehend and address complex issues, and it can be enhanced through interdisciplinary training and instruction. In addition, international teaching experience can help teachers broaden their horizons and deepen their understanding of the concept of international education. Educators' proficiency in educational theory, particularly in the Technical Pedagogical Content Knowledge (TPACK) framework, is crucial for effectively integrating technology into teaching, enhancing knowledge, and improving vocational education. Digital teaching can help address the key and challenging issues in vocational education and ensure the attainment of teaching objectives.

Lifelong learning, professional identity, initiative, and creativity are crucial for teachers' professional development. However, the effectiveness of teacher training programs is often unsatisfactory. This is because the training programs organized by higher vocational schools do not fully consider the needs of the industry. The ability to seamlessly integrate production and education is a key skill for vocational educators. In vocational education, teachers should not only possess practical skills, application acumen, and professional knowledge but also be proficient in the terminology used by industry practitioners. Social training, community participation, and outreach activities are essential to enhance teachers' capacity to integrate industry and education. The scientific research ability of vocational and technical teachers is crucial to ensuring the quality of vocational education. Scientific research conducted by vocational colleges encompasses not only subject knowledge research but also enterprise project research, teaching research, and other areas. Teachers' innovative scientific research abilities play a crucial role in enhancing teachers' professional skills, improving teaching standards, and fostering students' innovative thinking and practical skills.

The ethical issues surrounding the use of GenAI tools need to be monitored, and teachers must be trained to use these tools skillfully. In order to address these challenges, the education sector should establish a code of ethics for the use of GenAI in education and enhance oversight of its implementation. Educational institutions should offer comprehensive training on GenAI tools to empower teachers with the necessary skills to utilize them effectively. In addition, teachers should actively explore the integration of GenAI tools into their teaching practices to continuously enhance their teaching abilities.

After summarizing the relevant research, this paper proposes a development path for vocational teacher

competence. We proposal that vocational teachers' competence development should include three steps, as shown in Figure 3:

(a)Improve teachers' professional knowledge.

(b)Improve teachers' practical skills.

(c)Combination of theory and practice

Figure 3 The path planning of teachers' competence development in vocational colleges.

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