

KEY COMPETENCIES FOR TVET TEACHERS IN THE AGE OF INDUSTRY 4.0: ADAPTING TO TRANSFORMATIVE CHALLENGE

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ABSTRACT

Vocational teachers in Technical and Vocational Education and Training (TVET) organizations play a vital role in the vocational technical education landscape of the country. The professional development of these teachers is essential for acquiring the necessary knowledge and competency skills. This article delves into the competency elements required to effectively navigate the challenges presented by the Fourth Industrial Revolution among vocational teachers in Malaysia. The literature review serves as a roadmap for understanding the competency elements that vocational teachers need to adapt to in order to tackle the current challenges in the industrial sector. This conceptual paper, drawn from the literature review, contributes to the theoretical advancement of competencies by focusing on the key elements central to the development of TVET teachers' competencies: knowledge, skills, and attitudes. These elements serve as crucial benchmarks for producing competent and professional instructors capable of addressing the challenges of the Fourth Industrial Revolution era in Malaysia.

Keywords: *competence, tvet vocational teachers, technical vocational education and training (pltv), industrial revolution 4.0*

INTRODUCTION

The Fourth Industrial Revolution signifies a boundary-free world (Ningsih, 2019) that requires adaptation, particularly in the domain of technical and vocational education. The evolution of technical and vocational education systems is swiftly progressing towards attaining a nation with sustainable economic development. The positive implications concerning economic, social, technological, and global environmental aspects (United Nations Educational Scientific and Cultural Organization [UNESCO], 2017) resulting from this transformation are essential for national development to align with the mainstream flow of IR 4.0. The education ministry has strategically orchestrated the implementation of these changes to empower every phase of execution. The introduction of the Technical and Vocational Education and Training (TVET) Transformation Plan in 2011 was devised to formulate a holistic national platform for TVET, with a primary goal of promoting a skilled labor force to address the demands and progress of the industrial sector within the country.

As part of the TVET transformation, vocational colleges underwent rebranding, marking a pivotal shift in revitalizing the nation's technical and vocational education system. To conclude the

national transformation process, significant emphasis must be laid on enhancing the capacity of vocational teachers to proficiently deliver the curriculum, ensuring a seamless process and enhancing targeted learning outcomes. Vocational teachers, acknowledged as catalysts of change in Professional Learning and Training for Vocational Teachers (PLTV) (Chinedu, Wan Mohamed & Ajah, 2017), play a central role in shaping the development of graduates from TVET vocational colleges (Junita & Wan, 2018).

With the advancements in technology, the learning environment enabling students to thrive in the era of 4.0 has led to a transition from conventional learning paradigms to technology-driven education (Mohd Rokeman et al., 2024; Lane, 2019; Hong & Yoon, 2018). The integration of this technology is set to impact nearly every academic facet, including program development, the enhancement of teacher knowledge and qualifications, and the very learning process itself (Lane, 2019). Hence, it is crucial to highlight the competency of Technical and Vocational Education and Training (TVET) teachers in facilitating the integration of technology and innovation into the educational framework. The competency of vocational teachers encompasses the teacher's personality, general knowledge, practical knowledge, and pedagogical expertise. A teacher's attitude significantly influences student development, with teachers serving as positive role models for student learning in the classroom (Vansteelandt, Mol, Caelen, Landuyt, & Mommaerts, 2017).

The need for competence serves as a critical benchmark for vocational college teachers to ensure appropriate and relevant approaches and strategies for advancement. The competency of vocational teachers not only impacts the quality of teaching but also contributes to the personal growth of educators in alignment with the needs of TVET students. The day-to-day learning practices in the classroom are influenced by the past and present experiences of teachers (Handayani, Ali, Wahyudin, & Mukhidin, 2020). The 4.0 revolution poses a challenge to vocational teachers, urging them to instill soft skills and equip students with 21st-century competencies. Educational programs and training should be tailored to adapt to the developments in Industry 4.0, enhancing the efficiency and professionalism of teachers.

Teachers can practice these skills collaboratively with students after mastering them. This literature review aims to analyze the competency gap based on the concepts of knowledge, skills, and attitudes of vocational teachers in the era of global industrialization 4.0 (Minghat et al., 2020; Mohd Rokeman et al., 2024). Through the discussions in this literature review, it is poised to provide comprehension and guidance to researchers in the field of competencies, inspiring them to delve deeper into competencies in the era of the Fourth Industrial Revolution (Mohd Rokeman et al., 2024) and contribute to the professional development of TVET educators in Malaysia.

METHODOLOGY

This literature review employs a method of analyzing previous studies by scrutinizing documents from various sources, including journals, conference proceedings, seminars, magazines, newspapers, books, articles, websites, and online journals. This approach allows for a critical analysis of articles to gain a clear understanding of the research issues (Arksey & O'Malley, 2005).

The narrative review method is well-suited and relevant to the objectives of this article. The detailed discussion of the topic covers the existing issues within a particular field, examining them from the perspectives of models, recent findings, and future directions of the issue (Mahmud, 2021). This comprehensive approach provides a holistic understanding of the topic under investigation.

The use of the narrative review method allows for a detailed investigation of the relevant literature, assisting in the identification of significant trends, gaps, and promising pathways for further exploration. Through a meticulous evaluation of the existing research, the review can provide a sophisticated and comprehensive viewpoint on the research issue, which enriches the general comprehension of the discipline.

LITERATURE REVIEW

a. Concept of Competence

The proficiency of educators can be exemplified by the enhancement and refinement of knowledge, skills, and attitudes, demonstrated through deliberate and accountable actions in fulfilling their roles as teachers. Competence in TVET teachers also entails integration within the framework of knowledge, skills, values, and attitudes (Ismail, Nopiah, Rasul & Leong, 2017) to address intricate and ever-evolving scenarios (Zarifian, 2001), producing TVET graduates who are proficient and align with industry requirements. As per the International Board of Standards for Training, Performance, and Instruction (2006), competence is defined as possessing the requisite knowledge and attitudes for executing tasks and cultivating a robust skill set rooted in accomplishments.

Enhancing the skill level of TVET educators will lead to improved outcomes in their field. They have the ability to carry out tasks and duties in the classroom using more systematic and innovative methods. The competence of teachers plays a crucial role in achieving educational goals (Vansteelandt, Mol, Caelen, Landuyt, & Mommaerts, 2017). Therefore, TVET instructors need to fully acquire new skills to develop graduates who fulfill current industry requirements (Wagiran et al., 2019). Teacher proficiency refers to the capability of educators to achieve educational goals in the learning process (Ningsih, 2019). Vocational teachers are responsible for imparting knowledge, values, and spiritual development to integrate academic maturity and cognitive attitudes, especially in light of modern technological advancements (Lase, 2019). Thus, TVET teachers must enhance their proficiency aspects and abilities to adjust to new technologies in alignment with global advancements.

b. Concept of the Fourth Industrial Revolution 4.0

The concept of the Fourth Industrial Revolution (Industry 4.0) represents a system that integrates and applies the virtual world to industrial requirements through the features of digital technology applications (Prasetyo & Sutopo, 2018; Merkel, 2017; Schlechtendahl et al., 2015; Wuriyanto, 2018; Hermann et al., 2016; Liffler & Tschiesner, 2013). The era of the Fourth Industrial Revolution signifies a period of digital technological advancement involving the diminishing human physical roles in most daily activities (Wafi, 2019). This phase of the Fourth Industrial Revolution signifies a new paradigm where technological equipment, such as machines and robots, can autonomously adapt and integrate into daily tasks to cater to human needs and preferences. The integration of technology in this era encompasses the utilization of various systems like Cyber-Physical Systems (CPS), Industry 4.0, Advanced Management Programs, the Internet of Things (IoT), or Industrial Internet (Rifkin, 2014).

Klaus Schwab (2015) delves into the transformative potential of the Fourth Industrial Revolution in reshaping and expediting our work processes and daily interactions. The influence of this revolution extends to communication and manufacturing technologies, where technological tools contribute to the effectiveness and cost-efficiency of industrial processes. In the realm of 21st-century learning, there is an adaptation in response to evolving skills, as discussed by Kusumah (2019). This adjustment encompasses various factors, including innovative learning and skills, proficiency in diverse knowledge and skills, critical problem-solving, effective communication and collaboration, as well as fostering creativity and innovation. Additionally, digital literacy skills, encompassing information literacy, media literacy, and computer technology literacy, play a critical role. Simultaneously, there is an emphasis on other skills related to career and life, such as flexibility, adaptability, initiative, social and cultural interaction, productivity, accountability, as well as leadership and responsibility (Trilling & Fadel, 2009).

COMPETENCY ELEMENTS IN THE FOURTH INDUSTRIAL REVOLUTION 4.0 (IR 4.0)

Many studies investigate the competency aspects that vocational educators must acquire to adjust to the Industry 4.0 environment (Ramdhani & Adawiyah, 2023; Ana et al., 2020; Jafar et al., 2020; Zulkifli, 2020; Irwanto, 2019). Scholars in this field have customized various competency frameworks to improve the competency abilities of vocational teachers (Ana, 2020). According to Jafar (2020), educators in the TVET sector during the Industry 4.0 era require proficiency in five key areas: technical expertise, non-technical capabilities, personal traits, motivation and self-development, and mental and physical well-being. Specifically, teaching should integrate pedagogical knowledge with modern technology to have a substantial impact on educational outcomes (Ertmer & Ottenbreit-Leftwich, 2010).

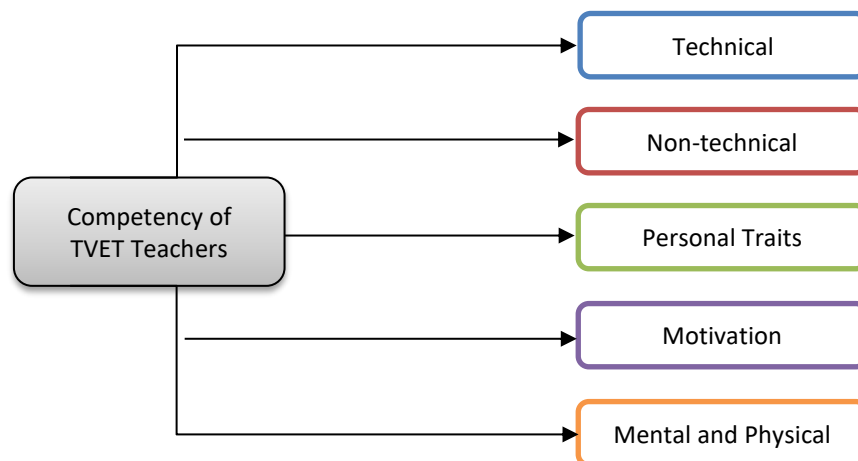


Figure 2: Conceptual Framework of TVET Teacher Competency Adaptation in the Era of the Fourth Industrial Revolution 4.0 (adapted from Jafar et al., 2020)

a. Technical Competency

The technical competencies outlined in this study are directly related to the role of TVET teachers in the teaching and learning processes during the Industry 4.0 era. These competencies encompass mastery of the subject, lesson planning, teaching delivery, assessment of teaching, classroom management, student motivation and facilitation, student career development, and technology application. These skills constitute a vital foundation for success in the Industry 4.0 era (Ismail et al., 2018), involving instructional planning and delivery, classroom management, student guidance, technology application, and mastery of modules relevant to current industry needs.

Technical skills encompass specialized knowledge and expertise in a particular field (Colley, James, Diment, & Tedder, 2003; Zopiatis, 2010), representing a combination of both knowledge and practical abilities (Abdullah et al., 2018). In the context of TVET, these skills allow teachers to effectively guide students towards practical application of their knowledge and to prepare them for real-world industry demands. Moreover, TVET teachers can leverage technological resources (Almerich et al., 2016), along with appropriate materials and tools, to enhance the learning process (Wagiran et al., 2019; Rofiq et al., 2019). This includes integrating digital learning tools and platforms to create more engaging and interactive learning experiences. However, given that students today are exposed to technological sources, such as smartphones, from an early age, TVET teachers must proactively design enjoyable, engaging, and effective learning activities (Zulkifli, 2018). The integration of digital learning in vocational components (Smolyaninova & Bezyzvestnykh, 2019; Mohd Rokeman & Che Kob, 2023), including mobile and online learning, can create an interactive learning platform for vocational students.

Effective pedagogy aligned with the concept of lifelong learning (Wagiran et al., 2019; Ismail et al., 2018) emphasizes delivery skills that incorporate technological elements in learning materials and instruction, coupled with online assessment and evaluation (Ally, 2019; Ismail et al., 2018) for vocational modules. This methodology ensures that students receive more than just technical skills; they also cultivate the flexibility and digital literacy needed to succeed in a rapidly evolving workplace. The focus on lifelong learning motivates students to consistently pursue fresh information and abilities, thereby enhancing their readiness for achievement in the dynamic realm of Industry 4.0.

b. Non-technical Competency

Beyond technical skills, non-technical competencies, often referred to as "soft skills" (Abdullah et al., 2019), are equally crucial for TVET teachers in the digital era. These skills encompass values and life skills that facilitate the acquisition of technical competence and foster holistic development in students. Non-technical skills include creativity, critical thinking, analytical abilities, collaboration, communication, ethics, innovation, leadership, lifelong learning, professional development, research, and social and cultural awareness. By cultivating both technical and non-technical skills, TVET teachers can foster professionalism in their field, adapting their approach to the evolving demands of the digital age (Wagiran, 2019).

The integration of the digital realm into teaching and learning necessitates a proactive approach by educators, incorporating technology widely into their instruction (Hatlevik, 2017; Wagiran et al., 2019; Ally, 2019). This involves utilizing technological creativity (Wagiran et al., 2019; Ally, 2019; Almerich et al., 2016), fostering innovation (Wagiran et al., 2019; Ally, 2019; Almerich et al., 2016), and promoting critical thinking (Abdullah et al., 2016). For instance, teachers can leverage technology to create new teaching materials (Rofiq et al., 2019), considering technological features to enhance the learning process (Almerich et al., 2016; Ally, 2019) and address the specific needs of students (Wagiran et al., 2019). This dynamic approach ensures that technology is not simply a tool but a catalyst for deeper learning and engagement, empowering students to thrive in the increasingly digital world.

c. Competency in Personal Traits

The third construct pertains to personal attributes, specifically the characteristics and qualities of a TVET (Technical and Vocational Education and Training) teacher. These personal attributes encompass emotional control, flexibility, humanity, openness, risk-taking, and role modeling, serving as essential traits for TVET teachers in the era of Industry 4.0. Additionally, TVET teachers must maintain professionalism, exhibit a pleasant personality to reflect their daily conduct, and demonstrate high competency (Roszdi, 2016).

The personality of TVET teachers should be friendly (Ally, 2019), sociable (Wagiran et al., 2019), calm and confident (Wagiran et al., 2019; Symanyuk, & Pecherkina, 2019), while also expressing enthusiasm during the teaching and learning process (Ally, 2019). Furthermore, teachers should be adept at adapting to advancements and developments in digital technology (Rofiq, 2019) to meet the needs of students (Ally, 2019), aligning with the current changes in the education landscape. Moreover, TVET teachers need to maintain an open mind and be prepared to face challenges and risks (Wagiran et al., 2019). Despite the world's reliance on digital technology, equal emphasis should be placed on personal values such as humanity, culture, and human capital in teaching and learning (Indrawan, & E. Lay, 2019). Therefore, TVET teachers should embody positive personal attributes as examples for students and provide quality education and support for learners (Wagira et al., 2019; Ally, 2019).

d. Motivation Competency

Motivation is a critical factor that profoundly influences an individual's attitudes, thoughts, and actions in pursuit of success and professional development. As Symanyuk and Pecherkina (2016) highlight, motivation is the driving force that empowers teachers to construct their own trajectory for professional growth. In the context of the 4.0 Revolution, the components of teacher competence encompass self-concept, self-development, and self-control (Wagiran et al., 2019). These intrinsic attributes are fundamental to the success of TVET teachers, as they are driven by their self-perception, emotions, and aspiration for personal development (Symanyuk & Pecherkina, 2016). Maintaining high motivation levels is crucial for TVET teachers, and this requires cultivating a strong self-concept encompassing self-confidence, self-improvement, and a positive professional identity (Thongkam, Suwanjan, & Papat, 2019). These attributes empower teachers to take ownership of their own professional development, enhancing their ability to inspire and guide students effectively.

In the digital age, teacher competence necessitates a strong self-concept, self-development, and self-control. These elements are critical for TVET teachers to adapt to the evolving needs of the 4.0 Revolution and provide transformative learning experiences. By fostering self-awareness and a growth mindset, teachers can sustain high motivation levels and deliver quality education that equips learners for the demands of the digital age. This holistic approach to teacher competence, grounded in self-directed growth, is essential for TVET educators to remain engaged, innovative, and responsive to the needs of their students within the rapidly changing landscape of the 4.0 era.

e. Mental and Physical Competency

The final construct of teacher competence in the 4.0 era is physical and mental fitness, representing the essential ability of TVET teachers to adapt to the evolving processes and demands of vocational education. This holistic dimension of competence is critical, as TVET education encompasses not only theoretical learning but also requires mental and physical endurance during practical, hands-on exercises (Ismail, 2018; Thongkam, Suwanjan, & Papat, 2019).

TVET teachers must possess the mental fortitude to work under pressure (Rofiqq et al., 2019), maintaining high spirits (Wagiran et al., 2019) and exhibiting confidence and emotional stability (Symanyuk & Pecherkina, 2016) as they guide their students through the rigors of vocational training. The physical demands of TVET, such as demonstration of techniques and participation in practical activities, necessitate a level of physical fitness and stamina on the part of the educator. This holistic readiness, encompassing both mental and physical well-being, empowers TVET teachers to model the behaviors and work ethic expected of their students, while also maintaining the energy and resilience required to navigate the evolving landscape of vocational education.

By cultivating physical and mental fitness, TVET teachers can better adapt to the dynamic nature of their profession, effectively managing the stresses and challenges inherent in their role. This, in turn, allows them to provide a high-quality learning environment, instill confidence in their students, and serve as inspiring role models for the next generation of skilled workers. The inclusion of physical and mental fitness as a key component of teacher competence underscores the multifaceted nature of the TVET educator's responsibilities and the importance of maintaining a holistic approach to professional development in the 4.0 era.

THE IMPORTANCE OF VOCATIONAL TEACHER COMPETENCIES IN THE ERA OF THE FOURTH INDUSTRIAL REVOLUTION (IR 4.0).

The emergence of the Fourth Industrial Revolution presents a pivotal opportunity to enhance the professionalism of TVET teachers by integrating technology-infused competency skills into the teaching and learning process. It is imperative for these educators to be proficient and flexible in

acquiring diverse knowledge, skills, and attitudes that are pertinent to the contemporary digital landscape.

Research indicates that the utilization of technology-enhanced learning methods may result in a favorable impact on the motivation and self-efficacy of educators in integrating technology into their instructional approaches (Nelson, 2017). Additionally, investigations have highlighted a notable correlation between foundational competencies, like instructional expertise, class supervision, data application, interaction, technology assimilation, and introspective approaches, and the perceived aptitude levels of upcoming instructors (Low, Ng, & Li, 2016). This aligns with the research of Ertmer and Ottenbreit-Leftwich (2010), which suggests that enhancing teacher competence is achieved through the integration of pedagogical context and extensive use of technology. However, Low, Ng, and Li (2016) further emphasize the importance of support systems that facilitate social support among new teachers, aiding in their retention within the educational system and enhancing the practical-theoretical alignment.

In the contemporary classroom environment, the effective delivery of learning content is crucial for engaging students and fostering a positive atmosphere. Zanella, Antonelli, and Bortoluzzi (2017) found that teacher commitment, influenced by interpersonal relationships, dedication, subject mastery, ethical behavior, and didactic pedagogy, is a key factor in student motivation and learning. Peklaj's (2019) research also identified essential competencies for creating an optimal learning environment and fostering key competencies for students' success in the rapidly evolving 21st-century society. However, Fadel's (2021) study highlighted that students' readiness and acceptance of technology application in learning during the Fourth Industrial Revolution are still at a moderate level, underscoring the need for TVET teachers to be adequately prepared to tackle the emerging challenges.

CONCLUSION

While technological advancements can enhance productivity and human job performance, the goal should not be to replace human labor with digital innovations. Instead, the integration of human efforts and technology can foster robust and high-quality work creativity. Vocational teachers, in particular, must leverage the opportunities arising from the digital technology landscape to adapt and incorporate them into their teaching and learning processes. Cultivating vocational teacher competencies aligned with technological advancements during the Industrial Revolution is crucial for enhancing efficiency. In the era of Industry 4.0, these competencies become invaluable for raising the quality of the workforce through high-caliber education. TVET teachers possessing the relevant competencies, especially in practical teaching, can contribute to the development of skilled workers aligned with the objectives of the national TVET system. This alignment corresponds to the nation's ambition to produce a greater number of skilled and semi-skilled workers. Consequently, stakeholders must be prepared for reskilling initiatives to ensure the sustained relevance of TVET teacher competencies in navigating the Fourth Industrial Revolution era.

Graduates with high, efficient, and effective work skills are characteristics of future skilled labor in the country that will integrate seamlessly with the growth of technologically created tools, such as robots or automation. This integration can enable tasks to be executed more quickly, easily, and efficiently, ultimately enhancing the productivity and output of industrial services and products. In summary, while technological advancements can enhance productivity, the focus should be on integrating human efforts with technology to foster robust and high-quality work creativity, particularly in the context of vocational education. Cultivating TVET teacher competencies aligned with technological advancements is crucial for producing skilled workers and preparing the workforce for the demands of the Fourth Industrial Revolution.

BIODATA

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Conflicts Of Interest

The manuscript has not been published elsewhere and is not under consideration by other journals. All authors have approved the review, agree with its submission and declare no conflict of interest on the manuscript.

REFERENCES

- Abdullah, Z., Hoque, K. E., Ramlan, N. H., & Shafee, S. (2019). Designing the Structural Model of TVET Lecturers' Professionalism and Generic Skills Based on an Empirical Study in Malaysia. *SAGE Open*, 9(3), 1–18.
- Abdullah, A. H., Yaman, S. K., Mohammad, H., & Hassan, P. F. (2018). Construction Manager's Technical Competencies in Malaysian Construction Projects. *Engineering, Construction and Architectural Management*, 25(2), 153–177.
- Almerich, G., Orellana, N., Suárez-Rodríguez, J., & Díaz-García, I. (2016). Teachers' Information and Communication Technology Competences: A Structural Approach. *Computers and Education*, 100, 110–125.
- Ally, M. (2019). Competency Profile of the Digital and Online Teacher in Future Education. *International Review of Research in Open and Distance Learning*, 20(2), 302–318.
- Ana, A., Kustiawan, I., Ahman, E., Zakaria, S., Muktiarni, M., Dwiyantri, V., ... & Kahoerunnisa, I. (2020). Defining Vocational Teacher Competencies in Industry 4.0 from the Perspective of Policymakers. *Journal of Engineering Education Transformations*, 34(Special Issue).
- Arksey, H., & O'Malley, L. (2005). Scoping studies: Towards a Methodological Framework. *International Journal of Social Research Methodology*, 8(1), 19-32. <https://doi.org/10.1080/1364557032000119616>
- Chinedu, C. C., Wan Mohamed, W. A., & Ajah, A. O. (2018). A Systematic Review on Education for Sustainable Development: Enhancing TVE Teacher Training Programme. *Journal of Technical Education and Training*, 10(1).
- Colley, H., James, D., Diment, K., & Tedder, M. (2003). Learning as Becoming in Vocational Education and Training: Class, Gender and The Role of Vocational Habitus. *Journal of Vocational Education and Training*, 55(4), 471-498.
- Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher Technology Change: How Knowledge, Confidence, Beliefs, and Culture Intersect. *Journal of Research on Technology in Education*, 42(3), 255-284.
- Fadel, N. S. B. M. (2021). Penerapan Kemahiran Insaniah dalam Kalangan Bakal Guru Tvet Bagi Menghadapi Revolusi Industri 4.0.(Master Thesis. Universiti Teknologi Malaysia).
- Handayani, M. N., Ali, M., Wahyudin, D., & Mukhidin, M. (2020). Green Skills Understanding of Agricultural Vocational School Teachers Around West Java Indonesia. *Indonesian Journal of Science and Technology*, 5(1), 21-30.
- Hatlevik, O. E. (2017). Examining the Relationship Between Teachers' Self-Efficacy, Their Digital

- Competence, Strategies to Evaluate Information, and Use of ICT At School. *Scandinavian Journal of Educational Research*, 61(5), 555–567. doi:10.1080/00313831.2016.1172501.
- Hermann, M., Pentek, T., & Otto, B. (2016). Design Principles for Industries 4.0 Scenarios. *The 49th Hawaiian International Conference on Systems Science*.
- Hong, S. K., & Yoon, S. C. (2018). A Study on the Development of Teacher Competency Standards in Digital Textbook Environment. *9th International Conference on Information and Communication Technology Convergence: ICT Convergence Powered by Smart Intelligence, ICTC 2018*, 291–296.
- Indrawan, P. A., & E.Lay, A. (2019). Guidance and Counselling Teachers' Competency Perspective in the Era of Industrial Revolution 4.0. *International Journal of Innovation, Creativity and Change*, 5(3), 147–161.
- International Board of Standard for Training, Performance, and Instruction. (2006). Instructor Competencies. Retrieved from <http://ibstpi.org/instructor-competencies/>
- Irwanto, I. (2019, May). Kompetensi Guru Vokasional SMK Di Era Revolusi Industri 4.0. In *Prosiding Seminar Nasional Pendidikan FKIP*, 2(1), 182-204.
- Ismail, K., Nopiah, Z. M., Rasul, M. S., & Leong, P. C. (2017). Malaysian Teachers' Competency in Technical Vocational Education and Training: A Review. In Abdullah et al. (Eds.), *Regionalization and Harmonization in TVET*. London: Taylor & Francis Group.
- Ismail, A., Hassan, R., Abubakar, A., Hussin, H., Mat Hanafiah, M. A., & Asary, L. H. (2018). The Development of TVET Educator Competencies for Quality Educator. *Journal of Technical Education and Training*, 10(2), 38–48.
- Jafar, D. S. A., Saud, M. S., Hamid, M. Z. A., Suhairom, N., Hisham, M. H. M., & Zaid, Y. H. (2020). TVET teacher professional competency framework in industry 4.0 era. *Universal Journal of Educational Research*, 8(5), 1969-1979.
- Junita S. & Wan M. R. W. A. (2018). Kompetensi dalam Menentukan Profesionalisme Guru Vokasional di Malaysia: Cabaran ke arah Pembangunan Profesionalisme Guru TVET.
- Kementerian Pendidikan Malaysia. (2018). *Laporan Tahunan 2017: Pelan Pembangunan Pendidikan Malaysia 2013-2025*. Putrajaya: Kementerian Pendidikan Malaysia.
- Kusumah, W. (2019). Menyiapkan Guru dan Dosen di Era Revolusi Industri 4.0 dalam <https://www.kompasiana.com/wijayalabs/5dd36340d541df29bf6153c2/menyiapkan-guru-dosen-di-era-revolusi-induatri-4-0> Diakses 30 November 2019.
- Klaus, S. (2016). *The Fourth Industrial Revolution*. Geneva: World Economic Forum. ISBN 1944835008.
- Lase, D. (2019). Education and Industrial Revolution 4.0, 10(1), 48–62.
- Liffler, M., & Tschiesner, A. (2013). The Internet of Things and the Future of Manufacturing. *McKinsey & Company*.
- Low, E. L., Ng, P. T., & Li, C. (2016). The Contribution of Teacher Education in Singapore to the Development of Teacher Competencies and Identity. Retrieved from https://repository.nie.edu.sg/bitstream/10497/18633/1/NIE_research_brief_16_007.pdf.
- Mahmud, A. (2012). Konsep dan model penilaian dalam pelaksanaan kurikulum. *Prosiding Seminar Penyelidikan Pendidikan dan Pembangunan Sumber Manusia* (pp. 28-29).
- Merkel, A. (2017). Speech by Federal Chancellor Angela Merkel to the OECD Conference. [Online] Dari: http://www.bundesregierung.de/Content/EN/Raden/2014/2014-02-19-oecdmerkel-paris_en.html, [Diakses 20 Februari 2020].
- Minghat, A. D., Ana, A., Jamaludin, S., Mustakim, S. S., & Shumov, P. V. (2020). Identification of teaching competencies among TVET instructors towards the realization of 4th industrial revolution. *Научный журнал «Вестник НАН РК»*, (5), 233-240.
- Mohd Rokeman, N. R. & Che Kob, C. G. (2023). Work environment as a mediator of the relationship between job satisfaction and job performance: A literature review. *Jurnal Penyelidikan Sains Sosial (JOSSR)*, 6(21), 77 – 88.
- Mohd Rokeman, N. R., Che Kob, C. G., & Mohd Yaacob, M. N. (2024). Faktor-Faktor Yang Mempengaruhi Pelaksanaan OBE Di Kolej Vokasional Malaysia: Perspektif Kesiediaan Pelajar. *Jurnal Penyelidikan Sains Sosial (JOSSR)*, 7 (22), 115 - 128.
- Mohd Rokeman, N. R., Che Kob, C. G., Othman, F. W., Che Sobry, H., Mohd Raffi, M. L., Mohd Nong, S.

- A., Untong, M. F., & Mohd Yaacob, M. N. (2024). Navigating Digital Competence in TVET Education: Overcoming Challenges and Harnessing Opportunities for Industry 4.0. *Jurnal Pendidikan Bitara UPSI*, 17, 200–215. <https://doi.org/10.37134/bitara.vol17.sp2.20.2024>
- Nelson, M. (2017). The Role of a Mentor Teacher's TPACK in Prospective Preservice Teachers' Intentions to Integrate Technology. *Journal of Technology and Teacher Education*, 25(4), 449–473. <https://www.learntechlib.org/primary/p/178211/>
- Ningsih, T. (2019). Smart Teachers in Developing Students' Character in 4.0 Industrial Revolution Era. *Proceeding of 3rd International Conference on Empowering Moslem Society in the 4.0 Industry Era*, 3, 58–68.
- Prasetyo, H., & Sutopo, W. (2018). Industri 4.0: Telaah Klasifikasi Aspek dan Arah Perkembangan Riset. *Jurnal Teknik Industri*, 13(1), 17-26.
- Ramdhani, M. R., & Adawiyah, R. (2023). Strategi Peningkatan Kompetensi Guru Sekolah Kejuruan (SMK) Islam Swasta pada Era 4.0. *Progressive of Cognitive and Ability*, 2(3), 180-191.
- Rofiq, Z., Surono, S., Bruri Triyono, M., & Setiyo Hari Purwoko, B. (2019). Developing the Standard Competencies for Vocational Teacher Candidates of Mechanical Engineering. *Journal of Physics: Conference Series*, 1273(1), 1–10.
- Rozdi, Z. M., Ahmad, C. N. C., & Mohamed, Z. (2016). Competency Model of Science Teacher in 21st Century. *International Journal of Academic Research in Business and Social Sciences*, 6(12), 2012–2017.
- Schlechtendahl, J., Kretschmer, F. M., Lechler, A., & Verl, A. (2015). Making Existing Production Systems Industry 4.0-Ready. *Production Engineering*, 9(1), 143-148.
- Smolyaninova, O. G., & Bezyzvestnykh, E. A. (2019). Professional Training of Teacher 4.0: Developing Digital Competency by Means of EPortfolio. *Journal of Siberian Federal University - Humanities and Social Sciences*, 12(9), 1714–1732.
- Symanyuk, E. E., & Pecherkina, A. A. (2016). A Study on The Components of Teachers' Professional Competence. *New Educational Review*, 44(2), 198–210.
- Thongkam, K., Suwanjan, P., & Papat, P. (2019). Thai Vocational College Instructor Teaching Competency: A Second Order Confirmatory Factor Analysis. *Asia-Pacific Social Science Review*, 19(1), 224–232.
- Trilling, B. & Fadel, C. (2009). *21st Century Skills: Learning for Life in Our Times*. San Francisco: CA John Wiley & Sons.
- Vansteelandt, I., Mol, S.E., Caelen, D., Landuyt, I., and Mommaerts, M. (2017). Attitude Profiles Explain Differences in Pre-Service Teachers' Reading Behavior and Competence Beliefs, *Learning and Individual Differences*, 54, 109-115.
- Wafi, A. Y. (2019). Mengenal Lebih Dalam Apa Itu Revolusi Industri 4.0 dalam <https://www.kompasiana.com/wafiahmad/5dce6752d541df3e090b6772/mengenal-lebih-dalam-apa-itu-revolusi-industri-4-0>Diakses 30 November 2019.
- Wagiran, Pardjono, Suyanto, W., Sofyan, H., Soenarto, S., & Yudiantoko, A. (2019). Competencies of Future Vocational Teachers: Perspective of In-Service Teachers and Educational Experts. *Cakrawala Pendidikan*, 38(2), 388–400.
- Wurianto, A. B. (2018). Pengembangan Pendidikan Vokasi Bidang Sosio-Humaniora Menghadapi Revolusi Industri Era 4.0. *Prosiding Seminar Nasional Vokasi Indonesia, Volume 1*, e-ISSN 2654-6493.
- Zanella, P., Antonelli, R. A., & Bortoluzzi, S. C. (2017). Assessment of Teacher Competencies: Analysis in the Accountancy Program at UTFPR. *Revista de Educação e Pesquisa em Contabilidade*, 11(2).
- Zarifian, P. (2002). *The Competence Model*. Liasons Editions.
- Zopiatis, A. (2010). Is it Art or Science? Chef's Competencies for Success. *International Journal of Hospitality Management*, 29(3), 459-467.
- Zulkifli, Z. (2020). Analisis Kompetensi Guru Menghadapi Era Revolusi Industri 4.0. *JISIP Jurnal Ilmu Sosial Dan Pendidikan*, 4(3).