CHAPTER I
INTRODUCTION

1.1.Research Background

Globally, digitalization in education has emerged as a key transformational change in the 21st-century learning landscape (Mulyanti et al., 2024). This shift changes how teaching materials are delivered and affects the roles of teachers, learning strategies, and students' education experiences. Organizations such as UNESCO (2021) and Organisation for Economic Co-operation and Development (OECD) in 2020 highlight the critical importance of integrating digital technology to foster an inclusive, flexible, and responsive education system that can address global challenges, including technological disruptions and crises like the COVID-19 pandemic (Reimers et al., 2020; UNESCO, 2018, 2022).

In response, various countries have formulated national policies and digital competency frameworks to ensure educators possess the necessary skills to effectively utilize technology (Law et al., 2018). These skills range from employing Learning Management Systems (LMS), engaging in simulation-based learning, to harnessing Artificial Intelligence (AI) and data analytics for learning assessments. As technologies such as big data, the Internet of Things (IoT), and machine learning continue to advance, the education sector must not only keep pace with these developments but also embed ethical values, digital security, and information literacy into the learning process (Rahmawati, Oduro-Okyireh, et al., 2022). Consequently, the digitalization of education is intrinsically linked to enhancing the digital competence of teachers, who play a pivotal role in ensuring the success of this digital transformation.

In the contemporary digital transformation era, digital competence is a key attribute that educators, including teachers across various levels and disciplines, must possess (Seufert & Scheffler, 2016). For educators, digital competence encompasses not only the technical skills required to utilize technological devices

but also the pedagogical expertise needed to integrate technology effectively, safely, and ethically into the learning experience (Ana et al., 2019; Caena & Redecker, 2019; Redecker, 2017; Saripudin et al., 2021a, 2019, 2020). In 21st-century education, teachers are expected to facilitate innovative, collaborative, and adaptive learning in response to ongoing technological advancements. This capability is particularly essential in vocational education, where technology plays a critical role in equipping students to navigate the dynamic and digital landscape of the modern workforce (Cattaneo et al., 2022a).

Teachers' digital competence skills are aligned with the principles of the Technological, Pedagogical, Content, Knowledge (TPACK), a framework that describes how teachers can effectively integrate technology into their teaching, and Technology, Andragogy, Work and Knowledge (TAWOCK), models, which integrate several essential components, including pedagogy, content, technology, and working knowledge. The TAWOCK model is a new concept of TPACK that integrates the principles of vocational education by adding several different components into TAWOCK to improve the professionalism of vocational educators (Arifin et al., 2020). However, numerous studies and reports indicate that the level of digital competence among vocational teachers remains relatively low to moderate (Batz et al., 2021; Cattaneo et al., 2022a; Saripudin et al., 2021a, 2019, 2020).

This deficiency is evident in their ability to utilize learning technology and their understanding of industrial technology. Vocational education is designed to emphasize not only theoretical knowledge but also practical skills through laboratory activities, industrial simulations, and work skills training (Billett, 2011). The disparity between teachers' technological proficiency and the advancements in industry technology results in students receiving an education that is not aligned with the realities of the workforce. In the working field reality, workers are required to sustain their competence following the changes (Ana et al., 2018; Choy & Le, 2023).

A series of research by Saripudin related to digital competence and literacy combined several results and conclusions. Research conducted by Saripudin identifies a consistent set of challenges encountered by vocational high school teachers regarding the mastery and application of digital technology within the educational process. Saripudin et al. (2019) conducted initial research employing a qualitative methodology to investigate the utilization of digital media by productive teachers across various vocational high schools in West Java (Saripudin et al., 2019). The findings from in-depth interviews indicated that teachers typically selected digital media based on factors such as ease of use and affordability. However, many educators faced challenges in mastering software and identified a disconnect between available resources and the requirements of the industrial sector. Additionally, Saripudin et al. (2020) explored vocational high school teachers' perceptions of e-learning implementation during the COVID-19 pandemic. Their results revealed that, while most teachers reported not experiencing significant difficulties in preparing and delivering e-learning, they encountered substantial challenges in evaluating digital learning and ensuring its effectiveness—particularly due to constraints such as limited internet connectivity and inadequate supporting devices (Saripudin et al., 2020).

Finally, Saripudin et al. (2021) conducted a quantitative study of 371 vocational high school teachers in Cimahi City and found that the level of digital literacy of teachers was at an intermediate level, with significant differences influenced by age, length of service, and access to technology. Younger teachers tend to have higher digital literacy and are more adaptive to the use of digital learning media. Overall, these three studies emphasize the importance of developing a digital competency framework for vocational teachers that considers contextual factors such as age, access to technology, industry dynamics, and differences in needs between vocational teachers and general teachers (Saripudin et al., 2021a).

A series of international research by Cattaneo in vocational education reveals that teachers' digital competence has unique characteristics, distinguishing them from general educators, particularly since vocational learning occurs in diverse settings like schools, workplaces, and training institutions (Cattaneo et al., 2022a). A study of over two thousand teachers in Switzerland found that vocational teachers' digital competence was moderate and influenced more by personal factors, like attitudes towards technology and usage frequency, than by institutional infrastructure. Additionally, the type of teaching role—vocational, general, or baccalaureate—affected digital competence levels.

Another study indicated that teachers' confidence in their digital skills significantly enhances technology acceptance; higher confidence leads to a greater perception of technology's ease and usefulness in learning (Antonietti et al., 2022). Digital competency frameworks like DigCompEdu should be expanded to address complex vocational learning contexts and emphasize teachers' ability to connect theory and practice in technology-based environments.

The demands for vocational students equally apply to educators, who serve a critical role in facilitating knowledge acquisition among students. Consequently, graduates of vocational education may encounter significant challenges when entering the job market due to a lack of practical skills and digital readiness (Cavanagh et al., 2015; Setuju et al., 2024). A low level of digital competence among educators can pose a substantial barrier to achieving quality learning outcomes. Therefore, it is crucial to develop a contextual, comprehensive framework for digital competence that addresses real needs to support both general and vocational teachers in their strategic role of shaping the next generation of learners (Rahmawati, Abdullah, et al., 2022).

Vocational teachers must possess digital competencies that encompass two key dimensions. The first dimension is digital competency in learning integration, which refers to effectively utilizing technology to design, manage, and evaluate

meaningful and contextually relevant learning experiences (Instefjord & Munthe, 2017a). The second dimension involves digital competency in industrial science integration, highlighting the teachers' capacity to understand and incorporate advancements in industrial technology into the vocational learning process. The synergy of these two competencies is crucial to ensure that vocational education produces graduates who are not only academically proficient but also digitally and professionally prepared to thrive in the ever-evolving workforce.

Typically, "digital competence" encompasses a broad range of skills, integrating technical, operational, intellectual, and psychosocial dimensions. Mastery requires both procedural and cognitive abilities, such as effectively utilizing computer software, for example (Region, 2020). One essential cognitive skill is the innate ability to intuitively decode or "read" visual signals embedded within graphical user interface (GUI). Additionally, procedural skills include tasks such as file processing and image modification.

Searching for information on the internet is also considered a combination of cognitive and procedural skills, as it involves working with search engines, estimating data, sorting through misleading or biased information, and distinguishing between relevant and non-essential data (Ferrari et al., 2013). It is widely recognized that engaging in meaningful conversations with others requires a specific set of social and emotional skills. In the context of an increasing reliance on digital work and learning environments, digital competence has emerged as a vital "survival skill." This crucial ability allows users to perform complex digital tasks effectively, reinforcing the idea that digital competence is essential for thriving in today’s world (Liu et al., 2020).

It is essential for vocational education teachers, as the key providers of new knowledge to their students, to master digital competencies, particularly in the context of the teaching-learning process within vocational education. Given the significant demand for a balance between behaviorist and constructivist

pedagogies, vocational high school teachers must enhance their capacity for digital competence (Sudira, 2019).

Throughout the duration of the pandemic, spanning from 2019 to the present, the vocational educator gained valuable insights into the crucial importance of digital competence in their teaching and learning process. This period highlighted the vital role that digital skills play in effective teaching and learning, or laboratory practices in a digital landscape (Cattaneo et al., 2022b). The findings of the preceding study indicate that digital competence is an ongoing skill that necessitates continual mastery (Mehrvarz et al., 2021). Furthermore, the previous research indicated that the digital competence of vocational school teachers in Indonesia is only situated at a low to intermediate level (Saripudin et al., 2021b).

Besides, the framework of lifelong learning published by the European Commission urges every human to elevate their life skills that one of which is digital competence. Furthermore, along with the program of reimagining the future of education, teachers must be capable of reaching sustainable development goal 4, quality education. The goals of quality education are now focused on strengthening digital education (Asongu et al., 2019). The working skill demands are developing year by year. There are lots of skills that should be possessed by workers to survive in digital working, such as social skills, technical skills, and emotional skills. The working world is closely related to technical skill, which is usually trained in vocational education. The new skill demands in the industry create new skill demands for students and graduates. It is why vocational education must improve its learning quality through the teachers to prepare the graduates as future workers to possess many skills especially needed in the working world (Amornvuthivorn, 2016; Gunadi et al., 2020; Toner, 2011).

Furthermore, the COVID-19 pandemic necessitated an immediate transition to online classes as a mode of instruction; more specifically, experimental courses needed to be rethought in order to achieve the highest possible academic performance while adhering to the constraints that were in place (Chans et al.,

2022). Moreover, vocational education teachers pushed themselves to shift the approach digitally, which is mainly needed to conduct a practice (Raman et al., 2021). It raises the topic of how teachers could integrate the teaching and learning process digitally, both in practicum and academics.

Not only does COVID-19 influence the utilization of digital equipment in teaching, but also the rocketing developments and innovations of technology in education (Et al., 2021; Hunter et al., 2020; Yildiz, 2020). The teachers' professional competence should be aligned with this rapid development to ensure that the teacher has the necessary skills to carry out the teaching process. Those matured skills include attitude, understanding, and competence as an educator.

Previous studies have indicated that digital competence for educators is a significant concern, leading to the publication of numerous frameworks aimed at establishing a standard for digital competency. Research has highlighted the different needs in digital competence between general and vocational educators (Chakroun, 2019; Khademi-Vidra & Bakos, 2024; Lahn & Berntsen, 2023; Roll & Ifenthaler, 2021). However, prior frameworks that have been used as standards in this research have not effectively addressed the distinct needs of vocational and general educators, which are indeed different.

Until now, there has been a lack of a comprehensive and up-to-date digital competency framework that distinctly addresses the differing needs of general and vocational educators while adapting to the evolving technology landscape and the demands of 21st-century learning. Although frameworks like DigCompEdu (2017) have emerged as global references, they still present limitations regarding local contextualization, flexibility across various educational levels, and responsiveness to shifts in the technological landscape, including AI, data literacy, and the integration of industry within vocational education. This dissertation aims to bridge this gap by proposing a new digital competence framework that is more adaptive, measurable, and relevant for general and vocational educators in Indonesia and comparable regions globally. The framework will focus on expanding the previous

framework to meet the needs of vocational educators. As explained through the background of this study, vocational educators have a more complex integration of digital competence by combining the industrial content and knowledge.

Employing a mixed-methods approach, this research incorporates FGD with vocational high school teachers, pairwise surveys to identify competency priorities, a national survey of vocational educators, and FGD with experts from three continents, including Asia, Australia, and Europe. This study aims to contribute to the development of a new framework of digital competence for educators coping general and vocational educators, that can be applied and adopted not only in Indonesia. This framework is called Digital Competence for General and Vocational Educators (DICGEVE). Therefore, a comprehensive data collection and method will be applied to achieve a reliable result. Moreover, the pairwise survey will be analyzed using three methods of Multi-Criteria Decision Making (MCDM), including Analytical Hierarchy Process (AHP), Simple Additive Weighting (SAW), and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). A sensitivity analysis process then analyzes those three MCDM methods to test its changes.

The findings from this comprehensive qualitative and quantitative analysis will be synthesized to create a new digital competency framework for educators that is not only theoretical but also practical, contextual, and forward-looking. As a result, this research makes significant academic and practical contributions to advancing teacher professionalism in the digital age.

1.2. Research Problems

This study is underpinned by a series of research questions designed to achieve the objectives of the study.

a. How does the existing literature define digital competence in vocational education and for educators?

b. What are vocational educators' perceptions, needs, and challenges regarding digital competence in classroom practice?
c. How reliable are digital competence indicator prioritization results using Fuzzy AHP, SAW, and TOPSIS under various weighting scenarios?
d. Which components of digital competence should be prioritized by vocational educators based on the educational experts' judgment?
e. How can digital competence's validated components and criteria be synthesized into a new framework for vocational education development?

1.3. Research Objectives

The research objectives delineated in this study are intrinsically linked to the formulated research questions, as outlined:

a. To examine and synthesize how existing literature defines digital competence in general and vocational education contexts, particularly in relation to educators' professional roles.
b. To explore vocational teachers' perceptions, practical needs, and challenges related to the implementation of digital competence in classroom instruction.
c. To evaluate the reliability and consistency of digital competence indicator prioritization outcomes by applying Fuzzy AHP, SAW, and TOPSIS under different weighting conditions.
d. To identify and determine which components and subcomponents of digital competence are considered most important by the experts.
e. To integrate the validated components and priority criteria of digital competence into the development of a renewed and context-sensitive digital competence framework for vocational and general educators namely DICGEVE.

1.4. Significance of the Research

This research holds significant theoretical and practical implications for the development of digital competencies among educators in the context of the ongoing digital transformation in education.

a) Theoretical point

Theoretically, it contributes to current knowledge by updating existing digital competency frameworks, such as DigCompEdu 2017, into a more comprehensive, contextual, and relevant model tailored to the needs of today's educators. The primary innovation of this study is the introduction of a new competency area that addresses contemporary challenges in educational technology, as well as the differentiation between digital competencies for general and vocational teachers, an aspect that has not been sufficiently addressed in existing frameworks. Consequently, this research enriches the academic literature surrounding professional development for educators and competencies for the 21st century.

b) Practical point

From a practical standpoint, the findings are intended to serve as a strategic reference for education stakeholders, including the Ministry of Education, teacher training institutions, and vocational education providers, as they design training curricula that align with technological challenges and the evolving demands of the workforce. The new framework developed through this study can also guide the creation of data-driven policies aimed at enhancing the quality of digital learning and the integration of technology within classrooms. Moreover, by engaging experts from three continents—Asia, Australia, and Europe—this research expands the global perspective on developing digital competencies, ensuring that the resultant framework possesses cross-cultural relevance and the potential for implementation in an international educational context. The distinctions between this framework and the preceding framework pertain primarily to the sub-component that differentiates general educators

from vocational educators. Additionally, this framework consolidates several elements from the previous framework into a unified structure. This study is particularly pertinent to initiatives aimed at strengthening the alignment between educational institutions and industry, especially within vocational education.

1.5. Limitation of the research

This study presents several limitations that should be acknowledged to fully understand the scope and generalizability of its findings. The FGD involved only teachers from a single city, representing vocational educators in Indonesia. Although these teachers are actively linked to vocational teacher networks across various regions, the interpretation of their needs remains contextual and cannot be universally applied at a national level. This study focuses exclusively on vocational educators, aiming to integrate the existing components of the digital competence framework for educators with the vocational-specific components outlined in our developed framework.

The study employs a mixed-methods approach, incorporating advanced quantitative techniques such as Fuzzy AHP, SAW, and TOPSIS; however, the prioritization and modeling of digital competency indicators are largely influenced by the subjective perceptions and assessments of the participants and experts. The ranking of these indicators is significantly affected by the weights assigned by the respondents, making them specific to their time and backgrounds. Third, while the involvement of international experts from Asia, Australia, and Europe offers valuable cross-perspective validation, their representation is not proportional across all regions. Consequently, the framework produced is more suitable as a foundation for further development rather than as a definitive universal model.

Lastly, this study did not directly assess teachers' digital skills through performance tests or observations; it primarily relied on perceptions gathered via surveys and focus groups. This approach limits the extent to which the findings truly

reflect the teachers' actual capabilities in implementing digital learning practices in the classroom.

1.6. Dissertation Organization Structures

The structure of this dissertation is comprised of six main chapters, each of which is outlined as follows: Chapter I provides an introduction to the research problem, including its background, the formulation of the research question, the objectives of the study, the potential benefits of the research, and an overview of the dissertation's organizational structure. Chapter II explores relevant theories pertinent to the research, such as the theory of lifelong learning in educational contexts, digital competence for educators, the TPACK and TAWOCK models within the teaching framework, the Technology Acceptance Model (TAM), as well as AI literacy and critical thinking for educators in the realm of vocational education. This chapter also includes a concise overview of model formation and related research findings. Chapter III outlines the research methodology, detailing elements such as: (1) the conceptual framework; (2) the research paradigm that supports the formulation of the research approach; (3) the research procedures that clarify the research stages; (4) the research design, which incorporates Design-Based Research (DBR) as the foundation for model development, alongside systematic literature reviews, surveys, and focus group discussions; (5) participants, providing a detailed account of those involved in the research, such as teachers and experts; (6) research instruments developed from the literature, structured in a user-friendly format (*Jotform*) to streamline online data collection; and (7) data analysis methods that facilitate effective processing and interpretation of the data. Chapter IV presents significant findings concerning developing a digital competence model framework for educators, particularly within vocational education, utilizing an F-AHP-based MCDM approach. Chapter V discusses the research outcomes about relevant theories and previous studies. Finally, Chapter VI offers conclusions,

implications, and recommendations derived from the findings and discussions of the conducted research.