

Digital Skills Profile of Grade 11 Mechanical Engineering Students Based on the DigComp 2.2 Framework

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ABSTRACT

Digital transformation requires students to develop digital skills to support learning and prepare for the demands of the workplace. This study aimed to describe the digital skills profile of Grade 11 students in the Mechanical Engineering Program at SMKN 4 Kota Serang based on the DigComp 2.2 framework. The study employed a mixed-methods approach with an embedded design. The respondents comprised 65 students selected through total sampling, while qualitative data were obtained through interviews with six students. Quantitative data were collected using a 10-item open-ended test covering the five DigComp 2.2 competence areas and were analyzed using descriptive statistics. The results showed that 55 students (84.62%) were classified at the Intermediate level, 9 students (13.85%) at the Basic level, and 1 student (1.54%) at the Advanced level. All five competence areas were classified at the Intermediate level, with the highest mean score observed in Safety (3.14) and the lowest in Information and Data Literacy (2.97). These findings indicate the need to strengthen students' digital skills through contextual and project-based learning.

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INTRODUCTION

Digital transformation has reshaped various aspects of life, including how individuals learn, work, communicate, and access information. The development of digital technologies, such as artificial intelligence, robotics, and information and communication technology, has increasingly influenced both educational environments and the workplace. The OECD (2021) indicates that advances in digital technology have driven changes in the provision of education, including the use of artificial intelligence, learning analytics, robotics, and various digital technologies to support the learning process. In line with these developments, UNESCO (2023) emphasizes that digital technologies have significant potential to improve the quality of education while fostering the digital skills needed in everyday life. These conditions indicate that the ability to use digital technologies appropriately is no longer an additional

skill but an essential component of competence that needs to be developed through education (OECD, 2021; UNESCO, 2023).

The need for digital skills has also become increasingly important as the characteristics of the workplace continue to change. The OECD identifies digital skills as one of the capabilities individuals need to adapt to technological changes, expand learning and employment opportunities, and participate effectively in a digital society and economy (Organisation for Economic Co-operation and Development, 2023). The World Economic Forum (2023) likewise reports that technology literacy is among the core skills experiencing the fastest growth in importance, while analytical thinking, creative thinking, and problem-solving skills are increasingly required in workplaces undergoing technological change. In Indonesia, these changes have direct implications for vocational education because the development of Industry 4.0 and digitalization is altering the skills required by industries and the labor market. The Indonesian Ministry of Education has emphasized that vocational schools need to produce graduates who are relevant and adaptive to current and future industry demands, including the acquisition of new skills required by the Industry 4.0 labor market. Recent national digital development indicators likewise identify digital skills as an important component of the labor market and highlight a gap between the demand for and supply of workers with relevant digital skills in Indonesia. Therefore, vocational education has a strategic role in preparing students not only with occupational-specific skills but also with transferable digital competencies required in increasingly digitalized workplaces.

In the context of education, the development of digital skills should not be limited to the ability to operate technological devices. UNESCO defines digital skills as the abilities required to use, evaluate, and create information effectively through digital technologies and emphasizes their development as an important component of civic participation, lifelong learning, and employment opportunities (UNESCO, 2023). Thus, digital skills encompass a broader range of abilities, including accessing and evaluating information, communicating and collaborating through digital technologies, creating digital content, maintaining safety when using technology, and solving problems related to the use of technology. This understanding is particularly relevant to vocational education because workplace activities increasingly require employees to combine technical knowledge with the ability to manage digital information, communicate through digital platforms, produce digital documents or content, protect digital information, and respond to technology-related problems. Consequently, technical proficiency in operating digital devices alone does not necessarily indicate an individual's ability to use technology critically, productively, safely, and responsibly.

One framework that can systematically capture these multidimensional aspects of digital competence is the Digital Competence Framework for Citizens (DigComp) 2.2, developed by the European Commission. DigComp 2.2 provides a common reference framework comprising five competence areas: Information and Data Literacy, Communication and Collaboration, Digital Content Creation, Safety, and Problem Solving. The framework also provides knowledge, skills, and attitude

descriptors that illustrate how individuals can interact with digital technologies confidently, critically, and safely, including when dealing with emerging technologies such as artificial intelligence-based systems (Vuorikari et al., 2022). The selection of DigComp 2.2 in the present study is justified by its multidimensional structure, which extends beyond basic technical operation and enables digital competence to be examined through information management, digital communication and collaboration, content creation, safety, and problem solving. These areas are also relevant to the competencies expected of students preparing to enter technology-intensive workplaces. Thus, DigComp 2.2 provides an appropriate analytical framework for mapping students' digital skills not merely in terms of whether they can use digital devices, but also in terms of how effectively, critically, safely, and productively they use digital technologies.

The relevance of the DigComp 2.2 framework is particularly evident in the Indonesian vocational education context. Current policies for vocational education emphasize stronger alignment between vocational school curricula and workplace requirements, including the development of competencies that respond to technological changes and Industry 4.0. These workplace requirements have substantive correspondence with the five DigComp 2.2 competence areas. The ability to search for and evaluate technical information corresponds to Information and Data Literacy; communicating and coordinating work through digital platforms corresponds to Communication and Collaboration; producing reports, documentation, and other digital outputs corresponds to Digital Content Creation; protecting data, devices, and digital identities corresponds to Safety; and identifying and resolving technology-related problems corresponds to Problem Solving. Therefore, although DigComp 2.2 was developed as a European reference framework, its competence areas provide a relevant conceptual lens for examining digital skills that are increasingly required in Indonesian vocational education and workplaces.

The importance of developing digital skills is particularly relevant in vocational education because of its direct connection to workplace demands. Students in vocational education are not only expected to possess technical competencies in their respective fields but also need to adapt to the use of technologies that are increasingly integrated into work processes. In the Mechanical Engineering Program, advances in manufacturing technology have encouraged the use of various digital technologies, such as Computer-Aided Design (CAD), Computer-Aided Manufacturing (CAM), Computer Numerical Control (CNC) machines, simulation software, and digital systems for production documentation and information management. These developments require students to integrate technical knowledge with digital information management, communication, content creation, safety practices, and technology-based problem solving. Therefore, digital skills constitute an important supporting competence that enables students to integrate technical knowledge with digital technologies during learning and when entering the workplace. This is consistent with the increasing importance of

technology literacy and digital skills as workforce competencies (Organisation for Economic Co-operation and Development, 2023; World Economic Forum, 2023).

Several previous studies have shown that digital competence is associated with various aspects of education and student development. Barboutidis and Stiakakis (2023), for example, examined students' digital competence in vocational education institutions and found that student characteristics and technology-use experience were associated with the development of digital competence. Chaw and Tang (2024) used the DigComp 2.2 framework to examine the relationship between digital competence and learning performance and found that several dimensions of digital competence were associated with students' learning performance. Meanwhile, Pagaldai et al. (2025) examined students' digital competence in vocational education and showed that digital competence was associated with technology-use experience, institutional digital capacity, and the learning environment. These findings indicate that digital competence is a multidimensional construct that is important to examine in educational contexts, particularly in vocational education, which is closely connected to technological developments in the workplace.

Although research on digital competence continues to develop, studies specifically mapping the digital skills profiles of vocational high school students based on the five DigComp 2.2 competence areas remain relatively limited. Previous studies have primarily focused on the relationship between digital competence and learning outcomes, factors influencing digital competence, instrument development, or digital competence among university students and vocational learners in general. In addition, relatively few studies have specifically described the achievement levels of each digital competence area among students in Mechanical Engineering Programs. This condition indicates the need for empirical evidence regarding the digital skills that have been developed and those that still require further strengthening among Mechanical Engineering students. Such mapping is important because students' levels of achievement may vary across the different DigComp 2.2 competence areas; therefore, an overall score alone may not adequately capture the characteristics of students' digital skills.

Based on the foregoing discussion, this study aimed to describe the digital skills profile of Grade 11 Mechanical Engineering students based on the DigComp 2.2 framework. The digital skills profile was analyzed across five competence areas: Information and Data Literacy, Communication and Collaboration, Digital Content Creation, Safety, and Problem Solving. This study is expected to provide empirical evidence regarding students' overall digital skills levels while also illustrating their achievement in each competence area. The findings may provide useful information for teachers and schools in identifying aspects of digital skills that should be maintained or further strengthened through the learning process. Thus, the findings may contribute to the development of vocational education that is more responsive to technological developments and the evolving demands of the Indonesian and global workplace.

METHOD

This study employed a mixed-methods approach with an embedded design, in which quantitative data served as the primary source of data and qualitative data were used to support and clarify the quantitative findings. The study was conducted at SMKN 4 Kota Serang during the second semester of the 2025/2026 academic year. The respondents comprised 65 Grade 11 students in the Mechanical Engineering Program, selected using total sampling. Qualitative data were obtained through semi-structured interviews with six students who were purposively selected based on variations in their digital skills levels as determined from the quantitative assessment.

The research instrument was a 10-item open-ended test developed based on the five competence areas of the Digital Competence Framework for Citizens (DigComp) 2.2: Information and Data Literacy, Communication and Collaboration, Digital Content Creation, Safety, and Problem Solving (Vuorikari et al., 2022). Each competence area was represented by two items. The use of DigComp to assess digital competence in vocational education has also been demonstrated by Barboutidis and Stiakakis (2023). The responses were scored using an analytical rubric, with scores ranging from 2 to 10 for each item, resulting in a total score range of 20–100.

Table 1. Mapping of the Test Instrument Based on the Five DigComp 2.2 Competence Areas

Digcomp 2.2 Competence Area	Item Number	Number of Items
Information and Data Literacy	1-2	2
Communication and Collaboration	3-4	2
Digital Content Creation	5-6	2
Safety	7-8	2
Problem Solving	9-10	2

Before being administered, the instrument was evaluated for content validity, empirical validity, and reliability. Content validity was assessed by three experts using Aiken's V coefficient, which yielded a value of 0.78. Empirical validity was examined using the Pearson Product-Moment correlation based on responses from 65 participants, with the calculated correlation coefficients ranging from 0.439 to 0.766. These values exceeded the critical value of 0.244, indicating that all items were valid. Instrument reliability was assessed using Cronbach's alpha, which yielded a value of 0.808, indicating good internal consistency. Similar validity and reliability procedures for digital competence instruments have also been applied in research involving vocational high school students by Tan et al. (2024).

The quantitative data were analyzed using descriptive statistics, including minimum and maximum scores, mean, standard deviation, frequency, and percentage. The total scores were classified into three categories: Basic (20–52), Intermediate (>52–84), and Advanced (>84–100).

Table 2. Overall Digital Skills Level Classification

Total Score	Category
20-52	Basic
>52-84	Intermediate
>84-100	Advanced

The profile of each competence area was determined based on the mean score of the two corresponding items. Because the raw scores ranged from 2 to 10, the mean score for each competence area was converted to a 1–5 scale by dividing it by 2. The converted scores were then classified into three categories: Basic (1.00–2.33), Intermediate (>2.33–3.67), and Advanced (>3.67–5.00).

Table 3. Digital Skills Profile Classification for Each DigComp 2.2 Competence Area

Mean Score	Category
1,00-2,33	Basic
>2,33-3,67	Intermediate
>3,67-5,00	Advanced

Qualitative data were analyzed using the model proposed by Miles et al. (2014), which consists of data condensation, data display, and conclusion drawing and verification. The interview data were analyzed based on the five DigComp 2.2 competence areas and were used to provide context for the quantitative findings. Subsequently, the quantitative and qualitative findings were integrated through joint interpretation to obtain a more comprehensive description of the students' digital skills profile.

RESULTS AND DISCUSSION

Respondent Characteristics

This study involved 65 Grade 11 students from the Mechanical Engineering Program at SMKN 4 Kota Serang as respondents, selected using total sampling. All respondents came from two classes, namely XI TP 1 and XI TP 2, meaning that the data represented the entire population of Grade 11 Mechanical Engineering students in the 2025/2026 academic year. The distribution of respondents by class is presented in Table 4.

Table 4. Respondent Characteristics

Class	Number of Students	Percentage (%)
XI TP 1	32	49,23
XI TP 2	33	50,77
Total	65	100,00

As shown in Table 4, the respondents consisted of 32 students (49.23%) from class XI TP 1 and 33 students (50.77%) from class XI TP 2. The proportions of respondents from the two classes were relatively balanced, providing a representative description of the digital skills of Grade 11 students in the Mechanical Engineering Program at SMKN 4 Kota Serang. All respondents subsequently participated in the digital skills assessment using an open-ended test developed based on the Digital Competence Framework for Citizens (DigComp) 2.2, which served as the basis for developing the digital skills profile in this study.

Overall Distribution of Digital Skills Categories

The distribution of students' digital skills levels was determined based on their total test scores, which were subsequently classified into three categories: Basic, Intermediate, and Advanced. This classification was used to provide an overall description of students' digital skills levels before further analysis was conducted for each DigComp 2.2 competence area. The distribution of students' digital skills categories is presented in Table 5.

Table 5. Distribution of Students' Digital Skills Categories

Category	Frequency	Percentage (%)
Basic	9	13,85
Intermediate	55	84,62
Advance	1	1,54
Total	65	100,00

As shown in Table 5, the majority of students were classified at the Intermediate level, comprising 55 students (84.62%). Meanwhile, 9 students (13.85%) were classified at the Basic level, and only 1 student (1.54%) was classified at the Advanced level. Thus, the overall digital skills of Grade 11 students in the Mechanical Engineering Program were predominantly at the Intermediate level. This finding indicates that, based on the total scores obtained from the test instrument, most students had attained a moderate level of digital skills, whereas only a very small proportion had reached the Advanced level.

The predominance of the Intermediate category indicates that students' digital skills have not yet fully developed to a high level of proficiency. Within the DigComp 2.2 framework, digital competence is not limited to the ability to operate technological devices but encompasses the knowledge, skills, and attitudes required to use digital technologies effectively, critically, safely, and responsibly (Vuorikari et al., 2022). Therefore, the Intermediate level should be understood as an indication that most students have acquired a sufficient level of proficiency to use digital technologies, while there remains room for further development toward more complex levels of competence. This condition is consistent with the multidimensional nature of digital competence, in which an individual's level of proficiency may vary across different competence areas (Vuorikari et al., 2022).

The findings are consistent with Chaw and Tang (2024), who showed that students possessed a level of digital competence that enabled them to use technology to support learning activities, although achievement levels varied across competence areas. This finding demonstrates that an overall score alone is insufficient to explain the characteristics of digital competence in greater detail. In the context of vocational education, Barboutidis and Stiakakis (2023) likewise demonstrated that students' digital competence needs to be examined across different competence areas because the factors associated with competence development may vary across areas. Therefore, the predominance of the Intermediate

category in the present study needs to be followed by an analysis of the five DigComp 2.2 competence areas to identify those with relatively higher and lower levels of achievement.

The predominance of the Intermediate category also indicates that the development of digital skills among vocational high school students should be directed toward more complex abilities rather than merely the use of technology for basic activities. This need is particularly important in vocational education because learning processes and workplace practices are increasingly integrated with digital technologies. Mechanical Engineering students, for example, need to develop the ability to use technical software, manage digital information, communicate through digital platforms, produce digital content or documents, maintain data security, and solve problems encountered when using technology. These requirements are consistent with the five DigComp 2.2 competence areas: Information and Data Literacy, Communication and Collaboration, Digital Content Creation, Safety, and Problem Solving (Vuorikari et al., 2022). Therefore, the findings presented in Table 5 provide a basis for examining students' digital skills achievement in greater detail across each DigComp 2.2 competence area.

Digital Skills Profile Based on the DigComp 2.2 Framework

Following the overall assessment of students' digital skills, the subsequent analysis focused on their digital skills profile across the five competence areas of the Digital Competence Framework for Citizens (DigComp) 2.2: Information and Data Literacy, Communication and Collaboration, Digital Content Creation, Safety, and Problem Solving. This analysis aimed to identify students' level of proficiency in each digital competence area and to determine which aspects had developed relatively well and which still required further strengthening. The mean score for each competence area was then classified into the Basic, Intermediate, and Advanced categories based on the score intervals established in the research method.

Table 6. Digital Skills Profile of Students Across the Five DigComp 2.2 Competence Areas

Digcomp 2.2 Competence Area	Mean	Percentage (%)	Category
Information and Data Literacy	2.97	59.38	Intermediate
Communication and Collaboration	2.99	59.85	Intermediate
Digital Content Creation	3.01	60.15	Intermediate
Safety	3.14	62.77	Intermediate
Problem Solving	3.02	60.31	Intermediate

As shown in Table 6, all five digital skills competence areas were classified at the Intermediate level, with mean scores ranging from 2.97 to 3.14. Safety obtained the highest mean score (3.14), followed by Problem Solving (3.02), Digital Content Creation (3.01), Communication and Collaboration (2.99), and Information and Data Literacy (2.97). Although all competence areas were classified at the same level, the differences in mean scores indicate variations in students' levels of proficiency across the DigComp 2.2 competence areas.

To facilitate the visualization of differences in achievement across the competence areas, the mean digital skills scores are presented in a bar chart, as shown in Figure 1.

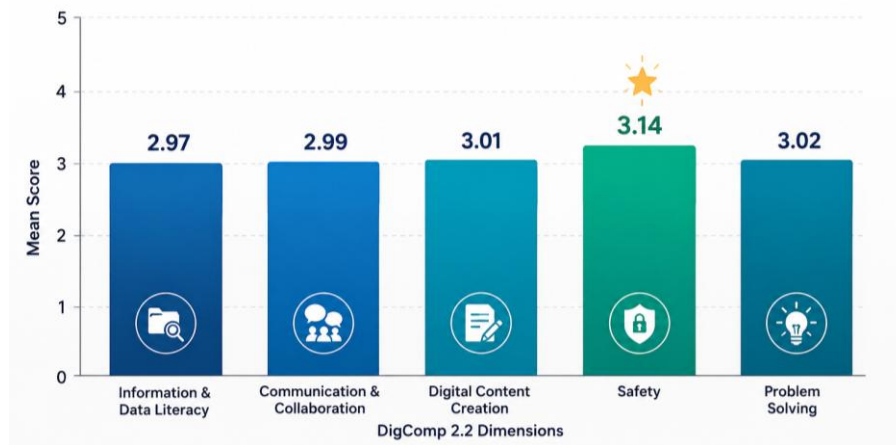


Figure 1. Mean Digital Skills Scores of Students Across the DigComp 2.2 Competence

Figure 1 shows that Safety had the highest level of achievement compared with the other competence areas, whereas Information and Data Literacy had the lowest mean score. Although the differences in mean scores across the competence areas were relatively small, this pattern indicates that students' digital skills have not developed uniformly across all competencies measured by the DigComp 2.2 framework (Vuorikari et al., 2022). These findings indicate that students have attained an intermediate level of digital skills but still require further strengthening in several competence areas to achieve higher levels of proficiency.

The variation in achievement across the competence areas suggests that students' digital skills are influenced not only by the intensity of technology use but also by the characteristics of learning activities undertaken at school. Therefore, the following discussion integrates the quantitative assessment results with interview findings, interpretations based on the DigComp 2.2 framework, and comparisons with previous studies to provide a more comprehensive understanding of students' digital skills profiles across the respective competence areas.

Information and Data Literacy. Based on the assessment results, Information and Data Literacy obtained a mean score of 2.97 and was classified at the Intermediate level, making it the lowest-performing competence area among the five areas. The interview findings showed that students used the internet as an additional source of information when they encountered difficulties understanding technical drawings, job sheets, or practical learning materials. Students also reported that they were accustomed to paying attention to technical information such as dimensions, shapes, projections, symbols, and scales before carrying out machining activities. However, the interview findings did not indicate consistent practices of source verification. Thus, students' use of digital information was still more oriented toward finding and understanding information than toward evaluating the quality and credibility of sources.

According to DigComp 2.2, Information and Data Literacy encompasses the ability to search for, evaluate, manage, and appropriately use digital information and data (Vuorikari et al., 2022). This finding is consistent with Setiyawan et al. (2023), who found that vocational high school students still faced limitations in digital information literacy and vocational information literacy. The finding is also relevant to Kim (2023), who identified Information and Data Literacy as an important area of students' digital competence and showed that competence levels were associated with computer-use experience and skills. Thus, the Intermediate achievement level in the present study indicates that students' basic ability to access information has developed, but their ability to critically evaluate and manage information still requires further strengthening. Strengthening this competence area can be achieved through learning activities that encourage students to compare multiple information sources, assess source credibility, and integrate information from technical drawings, job sheets, and digital sources when completing practical assignments. Project-based learning activities can be used to train students to independently search for and verify information, thereby fostering more comprehensive development of their information and data literacy.

Communication and Collaboration, The Communication and Collaboration competence area obtained a mean score of 2.99 and was classified at the Intermediate level. The interview findings showed that all respondents used digital media, particularly WhatsApp, to communicate and coordinate with teachers and peers, while several students used Google Meet for online learning. These platforms were used to convey information, submit assignments, engage in discussions, and coordinate learning activities. However, the use of technology for more complex forms of collaboration, such as jointly developing documents or completing projects, was not yet predominant.

DigComp 2.2 identifies the ability to interact, share information, and collaborate through digital technologies as components of Communication and Collaboration (Vuorikari et al., 2022). This finding is consistent with Putra et al. (2020), who showed that communication and collaboration skills are associated with the work readiness of vocational high school students. A study by Mohamad et al. (2025) involving vocational university students also showed that digital competence, including communication and collaboration, is associated with factors such as technology-use experience, access to ICT resources, and ICT training. These findings support the interpretation that the use of technology for communication needs to progress toward more structured digital collaboration experiences so that students' competence does not remain limited to information exchange and task coordination. This competence can be developed through project-based learning that requires students to use digital platforms to develop documents, engage in discussions, divide tasks, and complete projects collaboratively. Thus, technology can serve not only as a means of communication but also as a collaborative workspace that supports learning and preparation for the workplace.

Digital Content Creation, The Digital Content Creation competence area obtained a mean score of 3.01 and was classified at the Intermediate level. The interview findings showed that students had

used digital devices to prepare practical reports and learning assignments, although some students still experienced difficulties operating computers and word-processing applications optimally. Some students more frequently used mobile phones to complete assignments, whereas others felt more comfortable using computers or laptops because typing, editing, and searching for references were easier. This condition indicates variation in students' experiences in producing digital content.

Within the DigComp 2.2 framework, Digital Content Creation encompasses the ability to create, develop, modify, and integrate digital content, as well as an understanding of copyright and licensing issues (Vuorikari et al., 2022). This finding is consistent with Tan et al. (2024), who developed and validated a digital learning competence scale for vocational high school students, viewing digital competence as an important ability for effective learning in digital environments. León Lizárraga et al. (2022) also showed that students' digital competence should be examined through communication and content-creation practices in virtual environments, rather than solely through their operational ability to use digital devices. Thus, the Intermediate achievement level in the present study indicates that students have acquired basic abilities to produce digital content, but their experience in developing more diverse and productive forms of content still needs to be expanded.

Strengthening this competence can be achieved through project-based learning activities that provide students with opportunities to produce various forms of digital content, such as reports, presentations, practical documentation, and digital products related to mechanical engineering. The integrated use of productivity software and technical applications can also help students develop the ability to create and manage digital content relevant to learning requirements and workplace demands.

Safety, The Safety competence area obtained a mean score of 3.14 and was classified at the Intermediate level, making it the highest-performing competence area in relative terms. The interview findings showed that most respondents had implemented digital security practices, such as using personal passwords, storing documents on Google Drive, performing backups, keeping copies on flash drives, and organizing files into designated folders. These practices indicate an awareness of the importance of maintaining data security and availability. However, the protective measures reported by the respondents were still largely focused on file security and backup practices, whereas privacy protection, digital identity management, and awareness of cyber threats were less evident in their responses.

According to DigComp 2.2, Safety encompasses the ability to protect devices, personal data, privacy, health, well-being, and the environment when using digital technologies (Vuorikari et al., 2022). This finding is consistent with Rioseco Pais et al. (2023), who specifically examined the Safety area based on DigComp and showed that safety is one of the areas of digital competence that needs to be examined separately among students. Pichitpreecha et al. (2024) likewise identified data protection, privacy, and digital security as important components of students' digital safety skills. Thus, although Safety was the highest-performing competence area in the present study, its Intermediate classification

indicates that this competence can still be developed beyond basic file-protection practices toward a more comprehensive understanding of digital security. Strengthening this competence can be achieved by integrating topics such as personal data protection, account security, digital identity management, ethical use of digital media, and awareness of cyber threats into learning activities. Through this approach, students can develop not only the ability to secure documents but also the capacity to protect their data and digital identities when using technology for learning and in the workplace.

Problem Solving, The Problem Solving competence area obtained a mean score of 3.02 and was classified at the Intermediate level. The interview findings showed that some students attempted to resolve technology-related problems independently, such as checking internet connections, identifying possible causes of technical problems, and trying alternative solutions when devices or software encountered difficulties. However, other students preferred to seek assistance from teachers or peers because they were concerned that their actions might worsen the condition of the device. These differences indicate that students' digital problem-solving abilities remain varied, particularly in terms of independence and confidence when dealing with technical problems.

According to DigComp 2.2, Problem Solving encompasses the ability to identify technological needs, resolve technical problems, select appropriate solutions, and use digital technologies to address specific needs (Vuorikari et al., 2022). This finding is consistent with (Sari et al., 2023), who identified variations in students' digital competence in the area of problem solving based on test results, observations, and interviews. Røe et al. (2024) also showed that problem solving was one of the relatively prominent areas of students' digital competence, although the overall competence level of the participants was classified as Intermediate. These findings reinforce the results of the present study, indicating that digital problem-solving abilities can develop through direct experience in dealing with technology-related problems, although the level of independence may vary among students. The development of these abilities can be supported through problem-based and project-based learning activities that provide students with opportunities to address digital problems directly. Teachers can design situations that require students to identify the causes of problems, determine alternative solutions, test those solutions, and evaluate the outcomes. Through such activities, students can develop not only the ability to use digital technologies but also analytical, adaptive, and independent thinking when dealing with technology-related problems.

Synthesis of Findings

Overall, the findings indicate that the digital skills of Grade 11 students in the Mechanical Engineering Program were classified at the Intermediate level across all five DigComp 2.2 competence areas, with mean scores ranging from 2.97 to 3.14. The relatively small differences in achievement across the competence areas indicate that the five competencies developed at broadly similar levels, although differences in relative achievement were observed. Safety obtained the highest mean score, whereas Information and Data Literacy obtained the lowest. This pattern indicates that students have

attained an intermediate level of digital skills, but their competence has not yet fully developed toward higher levels, particularly in abilities that require critical evaluation and more complex use of digital technologies. This finding is consistent with Tan et al. (2024), who conceptualized digital competence among vocational students as a multidimensional construct encompassing cognitive abilities, technology use, thinking skills, activity management, and self-regulation. Deschênes et al. (2024) also showed that the development of digital competence in vocational education requires learning support that enables students to develop digital competence in a more structured and targeted manner.

From the perspective of vocational education, the findings indicate that students have used digital technologies to obtain information, communicate, produce content, maintain data security, and solve basic technical problems. However, all five competence areas remained at the Intermediate level, indicating that the development of digital skills needs to move beyond basic technology use toward more critical, creative, collaborative, secure, and problem-oriented applications. This is consistent with Roselidyawaty et al. (2024), who identified digital competence as an important requirement in TVET education in response to the development of Industry 4.0. In the Indonesian context, Astuti et al. (2021) also showed that mastery of digital technologies is an important component of vocational education competence in supporting workplace demands. Therefore, digital skills development in vocational high schools needs to be integrated into learning through authentic experiences that require students to search for and evaluate information, collaborate using digital technologies, produce digital content, apply digital security practices, and solve technology-based problems.

CONCLUSION

This study shows that the digital skills profile of Grade 11 students in the Mechanical Engineering Program at SMKN 4 Kota Serang, based on the Digital Competence Framework for Citizens (DigComp) 2.2, was generally classified at the Intermediate level. All five digital competence areas—Information and Data Literacy, Communication and Collaboration, Digital Content Creation, Safety, and Problem Solving—were classified at the same level, although their levels of achievement varied. Safety had the highest level of achievement, whereas Information and Data Literacy had the lowest. These findings indicate that students have sufficient ability to use digital technologies to support the learning process; however, more complex digital competencies, particularly critical evaluation of information, digital collaboration, and digital content development, still require further strengthening.

The integration of the quantitative assessment results with the interview data indicates that achievement across the competence areas was influenced by students' experiences in using digital technologies during learning activities. Students were accustomed to using digital technologies to communicate, prepare assignments, maintain data security, and solve basic technical problems. However, their use of digital technologies was still predominantly oriented toward supporting the completion of learning tasks and had not yet been fully directed toward developing more reflective, creative, and collaborative digital competence as emphasized in the DigComp 2.2 framework.

The findings imply that digital skills development in vocational high schools should be implemented in an integrated manner across all digital competence areas through contextual and project-based learning. Teachers should not only facilitate the use of digital technologies in the learning process but also design activities that encourage students to critically evaluate information, collaborate through digital platforms, produce more creative digital content, apply comprehensive digital security practices, and independently solve technology-based problems. In this way, digital skills development in vocational high schools can contribute to graduates' readiness to meet the demands of an increasingly digitalized workplace.

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