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Students' Digital Competency Profile: An Observational Study of Five Areas of Digital Competency

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ABSTRACT

This study is a preliminary investigation aimed at mapping the profiles and dynamics of students' digital competencies based on the five domains of the Digital Competence Framework (DigComp): Information & Data Literacy, Communication & Collaboration, Digital Content Creation, Security & Safety, and Educational Problem Solving. This study employs a quantitative descriptive approach using an observational method involving 195 high school students selected through purposive sampling via the Google Forms platform, as well as 66 university students from 12 public and private universities. The research instrument consists of a Likert-scale-based observation sheet validated using the Rasch Model (Rating Scale Model) with the assistance of Winsteps software. Overall, students' digital competencies fall into the "fairly good" category. The Security & Safety and Communication & Collaboration dimensions showed the highest levels of achievement, while Digital Content Creation ranked the lowest. The pattern of digital competency development shows an upward trend in higher grade levels, although not in a linear fashion. These findings indicate that students are still predominantly technology users and have not yet reached their full potential as digital creators. Therefore, there is a need to strengthen project-based learning and pedagogical innovations closely linked to digital skills to develop digital competencies more comprehensively and sustainably as part of efforts to support the 21st-century Global SDGs program.

Keywords: Digital competence, DigComp, Rasch model, BPS

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INTRODUCTION

A survey by the Ministry of Communication and Information Technology in Indonesia shows that the primary use of the internet is to access social media. In Indonesia, the phenomenon of social media use among teenagers is quite interesting to study (Meilana, M. S. 2021). Meanwhile, Indonesia ranks as the fourth-largest internet user base in the world, following China, India, and the United States. This phenomenon has given rise to a new term: “content creator,” referring to a new profession tasked with compiling and creating material (content) for educational, marketing, or entertainment purposes.

In his book, Jan Van (2005) discusses the digital skills gap caused by technological, social, and economic issues. To address this gap, digital skills must be strengthened across all segments of society; he also categorizes digital skills into several levels—operational, informational, and strategic—which determine how individuals access and benefit from digital technology (Cai, x, 2008) and This study makes a new contribution, whether in the form of observational instruments, profiles of Indonesian students, comparisons across educational levels, or implications for learning

The development of digital technology has brought fundamental changes to the global education ecosystem, forcing learning systems to transform from merely transferring knowledge into developing complex 21st-century skills. At the secondary school level, this phase is considered crucial because it serves as the foundation for the transition to higher education and the workforce, which increasingly depend on advanced digital competence (DigComp 3.0), including information & data literacy, communication & collaboration, digital content creation, security, and problem solving (European Commission, 2025).

International studies show that students’ digital competence at the secondary level is still uneven and inconsistent across DigComp domains. For example, empirical research using Structural Equation Modelling (SEM) found that although several digital competence domains improved after STEM-based and digital tools interventions, problem-solving skills remained a challenge. This indicates a gap between everyday digital tool usage and higher-level digital problem-solving abilities (Blanc et al., 2025). In addition, literature studies reveal that digital competence significantly contributes to students’ critical thinking and information evaluation skills, yet its classroom implementation remains suboptimal, especially in source evaluation and real-context problem solving.

Research conducted by Vuorikari, Pokropek, and Castaño Muñoz (2025) was motivated by the increasing need for accurate, efficient, and practical measurement of citizens’ digital competence in educational, training, and policy survey contexts. Existing instruments tend to be lengthy, complex, and less practical. Therefore, the study used a quantitative approach with instrument development and validation design to simplify the DigCompSat instrument without reducing the richness of digital competence constructs, which include knowledge, skills, and attitudes based on the DigComp framework.

Local and international research data also confirm the imbalance of digital competence among secondary school students. Although many students are familiar with digital devices for daily activities such as internet access and social media, meta-cognitive skills including information filtering, digital security, and problem solving in complex technological situations remain low and vary across schools and regions. This gap indicates that digital education integration has not yet been systematic and targeted toward developing all competence domains, particularly those most essential for students’ future readiness, such as problem solving and security.

Furthermore, the national education challenge to achieve Quality Education (SDG 4) aligns with UNESCO’s international agenda emphasizing the development of 21st-century skills, including digital literacy and critical thinking, to prepare young generations for complex information risks and global challenges such as climate change and technological innovation. Synergy between national education policies and digital learning practices in secondary schools is increasingly important to bridge this competence gap. Therefore, this study aims to map the digital competence profile of secondary school students based on the five DigComp domains through an observational study, to identify students’ strengths and weaknesses in digital competence and provide recommendations for meaningful and future-relevant digital learning strategies.

The DigComp framework was developed in response to the need for comprehensive digital competence standards for citizens in the era of digital transformation. This framework defines digital competence into five major areas with 21 core competencies and progressive proficiency levels, making it an important conceptual foundation for education, training, and public policy. As an operational implementation of the framework, the DigCompSat instrument was developed to measure digital competence through a survey-based self-assessment approach. DigComp and DigCompSat have been widely used as major references in digital competence mapping, curriculum development, educational research, and digital literacy policy studies (Carretero et al., 2017; European Commission, 2016; European Commission, 2019).

The research problem of this study lies in the rapid development of digital technology, which requires secondary school students and university students to possess adequate digital competence. However, students' digital competence profiles across different domains have not been fully mapped empirically. Therefore, an observational study is needed to describe the level and variation of digital competence among secondary school students and volunteer university students from various higher education institutions. This study aims to describe students' digital competence profiles based on several digital competence domains, determine the validity and reliability of the observation instrument construct, identify digital competence levels across educational stages, and determine the domains with the highest and lowest levels of mastery. The research questions in this study are: (1) What is the profile of secondary school students' digital competence in each digital competence domain? and (2) Which digital competence domains show the highest and lowest levels of mastery?

On the other hand, field study data from the Central Statistics Agency (BPS) for the period 2015–2019, as cited in Anjarwati, L., & Juliprijanto, W. (2021), are presented in Figure 1.

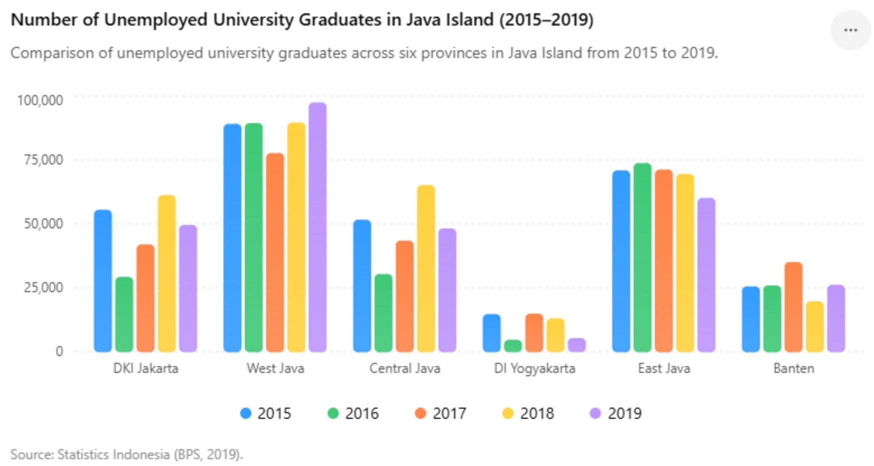

Figure 1. Unemployment Data of Higher Education Graduates from BPS Indonesia

Based on the official BPS reports from 2015–2019, as shown in Figure 1.1, the number of unemployed higher education graduates at the national level was relatively high and predominantly concentrated on the island of Java. The highest number of unemployed university graduates was recorded in West Java Province in 2019, reaching 97,304 people. Meanwhile, the lowest number of unemployed higher education graduates was found in the Special Region of Yogyakarta (DIY), amounting to 4,419 people in 2016. The high unemployment rate in West Java was mainly caused by the large number of graduates who had completed their education but had not yet been absorbed into the labor market. Various companies have implemented upskilling and reskilling programs for many of their employees as a logical consequence of keeping pace with the rapid development of digital technology, in order to meet market demands and provide efficient services.

Digital competencies play a crucial role in today's era, given the widespread use of digital technology across various fields of work. Therefore, it is essential to equip prospective workers and educators with these competencies to help them navigate future workplace challenges. The following table analyzes the relationship between Open Unemployment Rate (OUR) data by education level from the Central Statistics Agency (BPS) for 2025 and the concepts of employability, the digital skills gap, and educational outcomes—concepts widely used in labor market and higher education research.

Table. 1. Analysis of Unemployment Rates by Education Level and Their Relationship to Employability and the Digital Skills Gap

Education Level	Open Unemployment Rate (OUR) 2025 (%)	Employability Interpretation	Indication of Digital Skills Gap	Implications for Educational Outcomes
No Schooling/Incomplete Primary School and Primary School Graduates	2.30	Employability is relatively high in informal sectors and low-wage occupations that do not require higher educational qualifications.	The low demand for digital skills makes the digital divide less apparent within this group.	Educational outcomes are relatively low, but labor market expectations are also low, resulting in a comparatively low unemployment rate.
Junior High School (SMP)	3.80	Graduates have employment opportunities in informal sectors, small-scale trade, and basic service occupations.	They begin to encounter limitations in digital literacy when entering formal employment sectors.	Educational outcomes are not yet sufficient to meet the requirements of technology-based occupations.
Diploma I/II/III	4.31	Employability is relatively strong due to the acquisition of more specialized technical and vocational skills.	The digital skills gap is comparatively smaller because diploma programs are generally practice-oriented.	Educational outcomes are more closely aligned with industry and labor market needs.
University	5.39	Employability depends largely on the alignment between graduates' competencies, industry demands, and work experience.	A gap exists between academic competencies and the digital skills required by the labor market.	This indicates the presence of a skills mismatch and highlights the need to strengthen 21st-century competencies.
General Senior High School (SMA)	6.88	Employability is lower because graduates often lack clearly defined occupational specializations.	Basic digital skills are often insufficient to meet the demands of modern industries.	Educational outcomes remain more academically oriented rather than focused on workforce readiness.
Vocational Senior High School (SMK)	8.63	Although designed to prepare students for employment, the highest unemployment	The digital skills gap is a significant issue, as technological	Vocational education outcomes have not yet fully achieved labor

Education Level	Open Unemployment Rate (OUR) 2025 (%)	Employability Interpretation	Indication of Digital Skills Gap	Implications for Educational Outcomes
		rate suggests a mismatch between graduates' competencies and industry requirements.	advancements in industry often outpace curriculum updates.	market readiness in accordance with industry expectations.

Source: Statistics Indonesia (BPS), *Open Unemployment Rate by Educational Attainment, 2025*.

METHOD

Research Design

This preliminary study employs a quantitative observational research design using a cross-sectional survey approach to map the digital competency profiles of high school students and college students. This study was conducted to perform a needs assessment to obtain an empirical picture of students' digital competency levels prior to the development of a digital skills-based learning model (DigPro). Unlike experimental research, this study does not provide specific treatments or interventions to participants; rather, it focuses on measuring the digital competency levels participants already possess at a single point in time. This design was chosen to enable the researcher to obtain comprehensive information regarding the characteristics of digital competence across various educational levels and digital competence domains. The study participants consisted of high school students and university students from several educational institutions selected via random sampling, thereby aiming to represent the variation in participant characteristics from diverse educational backgrounds.

Data Collection Methods

In this study, data collection was conducted using a Google Forms-based observation instrument, which enabled quick, efficient, and standardized data collection. The research instrument was developed based on the Digital Competence Framework for Citizens (DigComp), which covers five domains of digital competence, namely: (1) Information and Data Literacy, (2) Communication and Collaboration, (3) Digital Content Creation, (4) Safety, and (5) Problem Solving. The development of indicators considered aspects of Professional Digital Competence, TPACK (Technological Pedagogical Content Knowledge), and DigCompEdu, given that some respondents were prospective teacher students. Each domain consists of 2–3 indicators that describe observable digital behaviors, skills, and experiences in learning activities. Before use, the instrument was first validated by a panel of 6 experts comprising faculty members in the fields of educational technology, science education, educational evaluation, and digital literacy to ensure the instrument's content aligns with the constructs being measured.

To complement the DigCompSat instrument developed by Vuorikari et al. (2025), this study adapts an approach to measuring digital competence using a Google Forms-based observation sheet designed to be more concise and contextual, in line with project-based learning activities. The instrument was developed by selecting 2–3 representative indicators from each DigComp digital competency domain, ensuring the instrument remains capable of capturing students' digital competency profiles without overburdening the observation process. Unlike DigCompSat, which uses a four-point Likert scale, this study employs a five-point Likert scale (1 = Very Low, 2 = Low, 3 = Moderate, 4 = High, and 5 = Very High) to enhance measurement sensitivity and provide a broader range of response options. The use of Google Forms enables real-time data recording, simplifies the observation documentation process, and supports more efficient quantitative analysis. This instrument was used to observe students' digital competencies during the implementation of a Blynk IoT- and Microsoft Excel-based photovoltaic experiment project, so that the assessment focused not only on self-assessment but also on the actual performance demonstrated by participants during the learning process.

Table 2. Developed Observation Indicators for Digital Competence Assessment

Digital Competence Domain (DigComp)	Observation Indicators	Likert Scale (1–5)
1. Information and Data Literacy	Able to search for relevant scientific information sources and journal literature through the internet.	1–5
	Able to select valid data to support the project.	1–5
	Able to organize and store experimental data and graphical results systematically.	1–5
2. Communication and Collaboration	Able to communicate effectively through relevant digital platforms.	1–5
	Actively collaborates and shares information within the group during project activities.	1–5
	Demonstrates appropriate digital etiquette when discussing and sharing data.	1–5
3. Digital Content Creation	Able to create digital tables and graphs using Microsoft Excel and AI-assisted tools.	1–5
	Able to process experimental data into digital reports efficiently.	1–5
	Able to modify or develop digital content according to project requirements using free-access platforms.	1–5
4. Safety	Maintains the security of digital accounts and data used in the project.	1–5
	Uses digital devices and applications responsibly and from reliable sources.	1–5
	Understands the importance of data privacy when using relevant digital platforms.	1–5
5. Problem Solving	Able to overcome technical issues related to Blynk IoT or Microsoft Excel through discussion and collaboration.	1–5
	Able to select appropriate digital solutions to complete project-based tasks.	1–5
	Able to evaluate group work outcomes to improve the quality of digital-based projects.	1–5

Likert Scale**:** 1 = Very Low, 2 = Low, 3 = Moderate, 4 = High, 5 = Very High.

Thus, the observation instrument developed remains aligned with the internationally validated DigComp framework, but has been simplified to suit the context of IoT-based photovoltaic experiments. This approach allows for a more authentic assessment of digital competencies, as it is based on students' actual behavior and performance during the learning process—making it more accessible and relevant to their daily lives. The platform used was Google Forms, and the survey was distributed via the MGMP and Para Kolaga WhatsApp group (WAG), as well as to MGMP members, faculty colleagues, and students. The observation questionnaire was developed based on digital competency indicators, accompanied by a scoring rubric as a learning tool, and validated by six expert validators. The indicators used align with the dimensions of digital skills to be measured, and the results were evaluated using Aiken's V table.

Participants

This study involved 195 secondary school students from several schools with different characteristics in terms of location (urban and semi-urban), school status (public and private), and students' socio-economic backgrounds. In addition, 66 university students from 12 public and private higher education institutions participated in the study. These variations were considered to obtain a more representative overview of students' digital competence profiles within diverse learning contexts. The participants consisted of Grade IX, X, XI, and XII students with relatively balanced proportions to identify possible dynamics of digital competence across grade levels.

The sample was selected using purposive sampling based on the following criteria: (1) schools had implemented digital-based learning or used a Learning Management System (LMS), (2) students actively used digital devices in learning activities, and (3) schools were willing to provide observation access during the learning process. This approach aimed to ensure that participants had sufficient exposure to digital learning practices so that the data obtained would be relevant for mapping digital competence based on the DigComp framework.

Research Design

This study used a quantitative descriptive approach with a non-participatory observational method. This design was chosen to empirically map the profile and dynamics of students' digital competence based on actual behaviors observed during the learning process. The study did not provide any treatment but instead observed naturally occurring classroom phenomena. This observational design enabled researchers to identify achievement tendencies across the five DigComp domains without manipulating variables. The focus of the study was on score distribution, competency fluctuation patterns, and tendencies of the most dominant and weakest domains. Therefore, this study functioned as a profiling study that provides a diagnostic basis for future educational interventions.

Research Instrument

The research instrument was an observation sheet of students' digital competence developed based on the five main DigComp domains: Information & Data Literacy, Communication & Collaboration, Digital Content Creation, Security & Safety, and Educational Problem Solving. Each domain was elaborated into several observable behavioral indicators during the learning process.

Tabel 3. Instrument

Domain	Examples of Behavioral Indicators
Information & Data Literacy	Students are able to search for relevant information sources and compare the accuracy of digital information.
Communication & Collaboration	Students actively collaborate using digital platforms (Google Docs/LMS/discussion forums).
Digital Content Creation	Students are able to create digital presentations, videos, or simulations according to the assigned tasks.
Security & Safety	Students use sources by providing references and maintaining digital ethics.
Educational Problem Solving	Students utilize digital applications or simulations to solve science-related problems.

The instrument used a Rating Scale Model (1–4): 1 = Not observed, 2 = Less observed, 3 = Fairly observed, and 4 = Highly observed. Before implementation, the instrument was tested using Winsteps with the Rasch Rating Scale Model (RSM) approach to examine construct validity (item fit: Outfit MNSQ 0.5–1.5), item and person reliability, separation index, and scale category functioning. Content validation was conducted by science education and digital literacy experts to ensure the suitability of the indicators with the DigComp construct and the characteristics of secondary school students.

Data Analysis Technique

In the context of instrument development and validation, digital competence research is supported by strong psychometric foundations, particularly Item Response Theory (IRT), Structural Equation Modeling (SEM), and the concept of integrated validity. IRT enables precise analysis of item quality and latent ability estimation, including through the Graded Response Model for

Likert-scale data, while SEM is used to empirically test construct validity. Validity is understood as a unified inference that includes empirical evidence, score interpretation, and the consequences of instrument use. Based on these theoretical foundations, the Mini-21 and Nano-6 instruments were developed as efficient versions of DigCompSat while maintaining validity and reliability. Mini-21 is recommended for relatively comprehensive digital competence mapping, whereas Nano-6 is suitable for large-scale rapid surveys, thus providing high flexibility for digital competence research and evaluation (Hambleton et al., 1991; Kline, 2016; Messick, 1995; Samejima, 1969; Vuorikari et al., 2025).

Observation data in this study were coded and analyzed through two main stages using the Rasch Model analysis with Winsteps software. The analysis converted ordinal data into logit (interval scale), identified item difficulty levels, measured students' ability in each domain, and tested unidimensionality and category consistency. The Rasch analysis results were used to ensure that the instrument had good measurement quality and was free from observer bias.

After the data were declared fit, descriptive statistical analysis was conducted to calculate the mean score for each domain, identify standard deviations and achievement variations, create digital competence profile graphs, and analyze fluctuation patterns across grade levels. The analysis results were presented in the form of five-domain DigComp radar charts, bar charts for each sub-competency, and interpretative narrative descriptions. This approach enables the study to describe digital competence profiles comprehensively, empirically, and contextually, while also providing a strong basis for recommendations to strengthen digital learning in secondary schools.

The observation data on students' digital competence were analyzed using the Rasch Rating Scale Model (RSM) with the assistance of Winsteps software. The Rasch Model was used to transform ordinal Likert-scale data into interval scale data (logit), enabling more objective measurement of abilities independent of sample characteristics. Mathematically, the probability of respondent *n* giving a response in category *k* for item *i* is expressed by the following log-odds equation

$$\text{In}\left(\frac{P_{nik}}{P_{ni(k-1)}}\right) = B_n - \left(\frac{P_{nik}}{P_{ni(k-1)}}\right) = B_n - D_i - D_i - F_k F_k$$

where (\theta_n) is the respondent's ability, (\beta_i) is the item difficulty level, and (\tau_k) is the threshold of the rating scale category. Through this model, construct validity was tested based on infit and outfit mean square (MNSQ) values, person and item reliability, separation index, and scale category functioning to ensure measurement consistency and accuracy.

The quality of the instrument was evaluated through construct validity testing using item fit statistics, namely Infit Mean Square (MNSQ) and Outfit Mean Square (MNSQ), with acceptable criteria ranging from 0.5 to 1.5. Furthermore, person and item reliability were calculated to assess measurement consistency, which can be mathematically expressed as follows:

$$\text{Reliability} = \left(\frac{Sparation^2}{1+ Sparation^2}\right) = \left(\frac{Sparation^2}{1+ Sparation^2}\right)$$

Meanwhile, the separation index was used to indicate the instrument's ability to distinguish respondents' ability levels as well as item difficulty levels, which is formulated as follows:

$$\text{Separation} = \left(\frac{SD}{RSME}\right) = \left(\frac{SD}{RSME}\right)$$

Where SD is the standard deviation of the estimated ability or difficulty, and RMSE is the root mean square error of measurement. A high separation value indicates that the instrument has strong discriminative power in mapping variations in students' digital competence.

After the data were confirmed to meet the Rasch model assumptions and the instrument demonstrated good measurement quality, the analysis was continued using descriptive statistics to calculate mean scores, ability distributions, and fluctuation patterns across each digital competence domain. The results were presented in the form of competence profile graphs and interpretative descriptions to comprehensively illustrate the profile and dynamics of secondary school students' digital competence.

RESULT AND DISCUSSION

Digital competency data were analyzed descriptively to describe the participants' digital competency profiles in each DigComp domain. The analysis includes the number of participants (n) at each educational level, the mean, standard deviation, median, minimum and maximum values, score range, and 95% confidence interval to provide a more comprehensive picture of the data distribution and the level of variation in participants' digital competencies. The presentation of these descriptive statistics allows for a more accurate interpretation of score trends in each digital competence domain without assuming any longitudinal changes or developments.

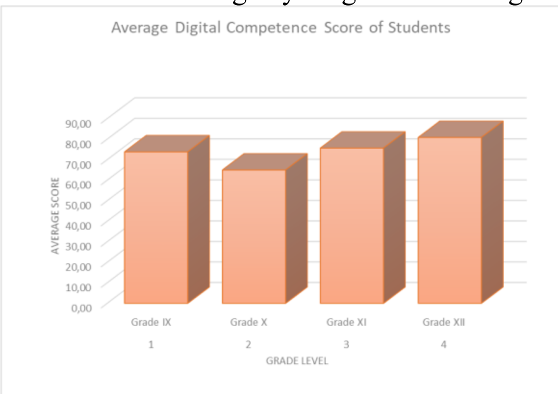

Figure 2: Digital Competencies of High School Students

The results of random field observations conducted on students from several secondary schools showed that students' digital competence levels varied. Most students were able to use digital devices for basic learning activities, such as searching for information on the internet, using simple office applications, and accessing online learning platforms. However, more advanced skills, such as critically evaluating digital information, using technology for problem solving, and creatively utilizing digital applications, were still unevenly developed. These findings indicate differences in digital competence levels among students and schools, highlighting the need for structured and continuous learning improvements to enhance students' digital competence comprehensively.

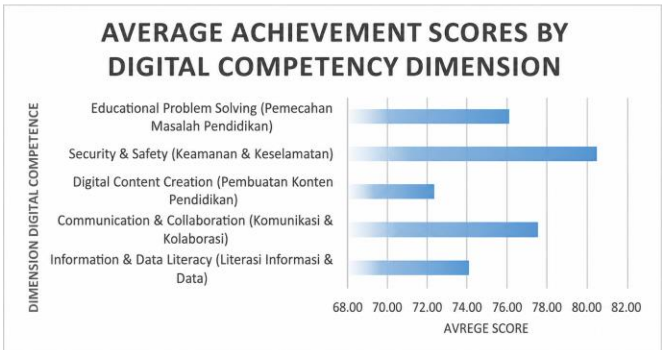

Figure 3. Average Scores of Digital Competence among Grade IX, X, XI, and XII Students

Based on Figure 3 the observation results of 195 secondary school students show that the average achievement across the five main dimensions of digital competence varies significantly. When combined with previous findings based on grade levels (IX–XII), the results indicate that the development of digital competence is influenced not only by grade level but also by the characteristics of each competence dimension. The *Security & Safety* dimension showed the highest average score (approximately 80–81). This indicates that students generally have good awareness of digital security, such as protecting personal data and maintaining ethical technology use. This finding is consistent with the increasing exposure to cybersecurity issues in education and daily life (European Commission, 2018).

The Digital Content Creation dimension showed the lowest average score, around 72. This finding indicates that most students still function more as technology consumers rather than digital content creators. Skills within this dimension include creating and editing digital content (text, images, videos), understanding copyright and licensing, and basic programming. The low achievement may be caused by limited project-based learning experiences that encourage digital creativity, as well as insufficient integration of digital production tasks in the curriculum. Although Grade XI (75.64) and Grade XII (80.83) students demonstrated improved overall digital competence, this improvement has not fully strengthened digital content creation skills. This suggests that students' learning experiences are still more focused on using technology for information consumption and communication rather than for producing digital works.

These findings are consistent with previous studies stating that digital content creation represents a higher level of competence because it requires the integration of creativity, digital literacy, and problem-solving skills (Hatlevik et al., 2015). In the DigComp framework, digital content creation also includes innovation and digital solution development, which generally require more exploratory and practice-based learning approaches (European Commission, 2018). Therefore, stronger learning strategies are needed, such as project-based learning, digital storytelling, and digital media production assignments, so that students can become productive and innovative digital creators rather than merely technology users.

The Communication & Collaboration dimension ranked second, with an average score of around 77–78. This high score indicates that students are relatively active and skilled in interacting and collaborating through digital platforms. This finding is also supported by the growing use of social media and collaborative learning applications (Redecker, 2017). Meanwhile, the Educational Problem Solving dimension showed an average score of approximately 76.12, indicating that students are fairly capable of using digital technology to solve learning problems, although they still require improvement in critical thinking and technology-based problem solving.

In the Information & Data Literacy dimension, the average score was around 74. This indicates that students' ability to search, evaluate, and manage digital information is fairly good but still not optimal. Information literacy is considered a fundamental component of digital competence (Fraillon et al., 2019). Overall, these findings suggest that students' digital competence development is multidimensional and influenced by learning experiences, cognitive maturity, and the intensity of technology integration in learning activities. The results emphasize the importance of more targeted pedagogical interventions, especially in strengthening higher-order digital skills such as digital content creation and problem solving, so that students' digital competence can develop more evenly across all dimensions.

The Observation Results of University Students' Digital Competence

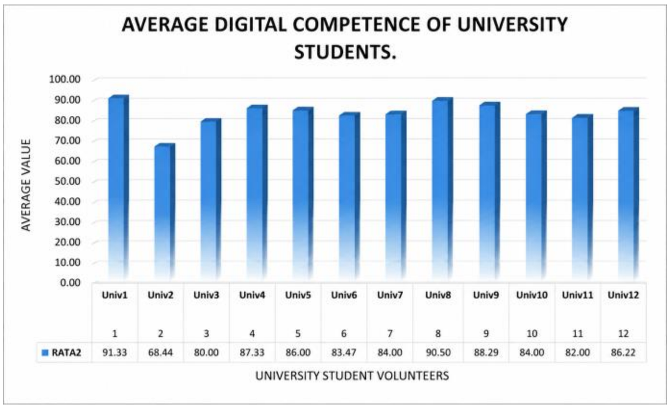

Figure 4. Average Scores of Digital Competence among University Students

Based on Figure 4, the observation results of 66 volunteer university students from 12 higher education institutions show that students' digital competence is generally in the high category, with an average score of 86.22. These findings indicate that university students are generally well prepared to meet the demands of learning in the digital era.

When viewed across institutions, there are significant variations in digital competence achievement. Several universities demonstrated very high average scores (above 90), such as STIE Anindyaguna Semarang and UIN Walisongo Semarang, indicating that the academic environments in these institutions have effectively supported the mastery of digital technology. In contrast, some institutions showed relatively lower scores, such as IAINU Kebumen (around 70), indicating limitations in students' digital competence development.

These differences indicate a gap in digital competence development among higher education institutions. Factors that may influence this gap include: Availability of technological infrastructure, Integration of digital-based learning into the curriculum, Institutional support and digital training, Academic culture in the use of technology

Although the overall average is categorized as high, the findings also reveal that university students' digital competence is not yet evenly distributed or systematically integrated into the learning process. This finding is consistent with earlier observations showing that technology mastery is often still partial and not strongly connected with pedagogical aspects and the professional development of prospective teachers.

Therefore, this preliminary study confirms that the overall trend of digital competence is positive and improving, but clear gaps among universities still exist. This indicates the need for more systematic integration through the development of digital competence-based learning models. These findings provide an important foundation for further research aimed at designing structured, contextual, and sustainable learning model innovations to ensure that university students' digital competence is not only high in scores but also meaningful and applicable in real educational practice.

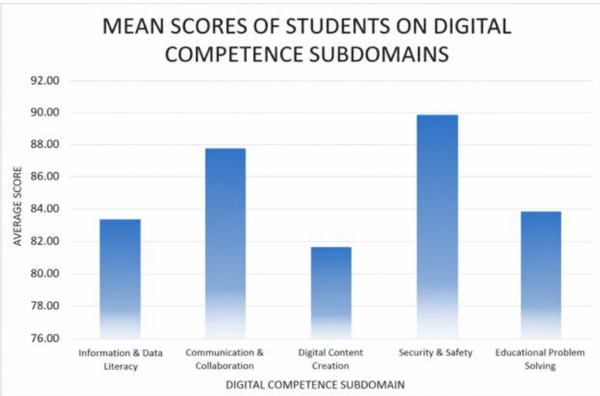

Figure 5. Integration of University Students' Digital Competence

The study results presented in Figure 5 show that observations of 66 volunteer university students from 12 higher education institutions indicate that students' digital competence is categorized as high, with an average score of 86.22. However, a deeper analysis reveals that these achievements are not evenly distributed across institutions or across digital competence indicators. When integrated with the analysis based on DigComp indicators, a more specific pattern emerges. The highest achievement was found in the Security & Safety dimension, with a score of 89.90, followed by Communication & Collaboration at 87.78. These results indicate that university students are relatively accustomed to maintaining digital security and interacting and collaborating through technology.

Meanwhile, Information & Data Literacy obtained a score of 83.54, indicating that students' ability to access, understand, and evaluate digital information is fairly good, although critical information literacy skills still need improvement. Two dimensions that require greater attention are Educational Problem Solving (83.89) and Digital Content Creation (81.72), which showed the lowest achievement. The low achievement in digital content creation indicates that students have not fully transformed from being technology users into producers of digital learning content. This strongly suggests that students' digital competence is still mostly at the operational level rather than at the creative and innovative level. When related to the variation among higher education institutions shown in the previous graph, it can be concluded that universities with higher achievements have likely succeeded in integrating collaborative practices and basic digital literacy into learning activities. However, almost all institutions still face challenges in developing digital content production and technology-based problem-solving skills.

Synthesis of Findings

From both analyses, several important conclusions can be highlighted: The overall trend of university students' digital competence is already high. Gaps are still visible, both among institutions and across competence indicators. The most significant imbalance occurs in digital content creation and problem-solving skills.

Implications for Further Research

These findings strengthen the urgency of developing digital competence-based learning models that focus not only on technology use but also on creativity, problem solving, and digital critical thinking. Therefore, future research should focus on: Contextual integration of TPACK, Strengthening project-based digital learning, Developing innovative learning models (such as DigPro), Applying sustainable and adaptive approaches to meet the demands of the Society 5.0 era.

CONCLUSION

Based on the research findings, students' digital competencies can be categorized as high, with an average score of 86.22; however, there are still significant differences across the various DigComp domains. The highest performance was observed in the areas of Security & Safety and Communication & Collaboration, indicating that students are generally proficient in using digital technology safely and effectively to interact and collaborate. However, the dimensions of Digital Content Creation and Educational Problem Solving showed the lowest scores, indicating that students still function primarily as technology users rather than as creators and innovators. This pattern aligns with findings from previous studies at the secondary education level, which highlight that high-level digital competencies remain a common challenge across all stages of education. Although basic and operational digital skills are well-established, higher education institutions must place greater emphasis on developing students' abilities in digital content creation, critical problem-solving, and the use of innovative technologies to better prepare graduates to meet the demands of the digital workforce and future job opportunities. Meanwhile, the average digital competency score for high school students was 73.81. For high school students, the "Security & Safety" and "Communication & Collaboration" dimensions had the highest scores, indicating that students are relatively strong in the areas of digital use and interaction. Conversely, Digital Content Creation was the lowest-scoring dimension, indicating that students are still predominantly technology users rather than creators of digital content. Thus, the digital competencies of high school students still require strengthening, particularly in higher-order digital skills, such as digital creation and technology-based problem-solving.

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