GAWI
Journal of Action Research
Vol. 6 No. 1 2026

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

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Received	Accepted	Published
16/06/2026	04/07/2026	31/07/2026

DOI
10.59329/gawi.v6i1/303

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: BPS, digital competence, digcomp, rasch model,

How to cite:
Nuri, N., Marwoto, P., Subali, B., Sulhadi, S., Wahyuadi, R.A., & Ismiati, A. (2017). Students' Digital Competency Profile: An Observational Study of Five Areas of Digital Competency. *Gawi: Journal of Action Research*, *6*(1), 145-158

INTRODUCTION

A survey by Indonesia's Ministry of Communication and Information Technology shows that the primary use of the internet is to access social media. The phenomenon of social media use among Indonesian teenagers is an especially interesting subject of study (Meilana, 2021). Indonesia also ranks as the fourth-largest internet user base in the world, following China, India, and the United States. This growth has given rise to a new profession, the "content creator," tasked with compiling and producing material for educational, marketing, or entertainment purposes.

Van Dijk's discussion of the digital skills gap (as cited in Ragnedda & Muschert, 2013) attributes this gap to technological, social, and economic factors, and argues that digital skills must be strengthened across all segments of society. He categorizes digital skills into three levels, operational, informational, and strategic, which together determine how individuals access and benefit from digital technology. Building on this foundation, the present study contributes new observational instruments, a profile of Indonesian students, comparisons across educational levels, and 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, as it lays the foundation for the transition to higher education and the workforce, both of which increasingly depend on advanced digital competence, including information and data literacy, communication and collaboration, digital content creation, security, and problem solving (European Commission, 2019).

International studies show that students' digital competence at the secondary level remains uneven and inconsistent across DigComp domains. For example, empirical research using Structural Equation Modelling (SEM) found that although several digital competence domains improved following STEM-based and digital-tool interventions, problem-solving skills remained a challenge, pointing to a gap between everyday digital tool use and higher-level digital problem-solving ability (Blanc et al., 2025). Other literature reviews show that digital competence contributes significantly to students' critical thinking and information-evaluation skills, yet its classroom implementation remains suboptimal, particularly in source evaluation and real-context problem solving.

Research by Vuorikari, Pokropek, and Castaño Muñoz (2025) was motivated by the growing need for an accurate, efficient, and practical way to measure citizens' digital competence in educational, training, and policy survey contexts, since existing instruments tend to be lengthy, complex, and impractical. The study used a quantitative approach involving instrument development and validation to simplify the DigCompSat instrument without reducing the richness of the digital competence constructs, which include knowledge, skills, and attitudes drawn from the DigComp framework.

Local and international research data confirm this imbalance in digital competence among secondary school students. Although many students are familiar with digital devices for daily activities such as internet access and social media use, 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 has not yet been integrated systematically or targeted toward developing all competence domains, particularly those most essential for students' future readiness, such as problem solving and security.

The national challenge of achieving Quality Education (SDG 4) aligns with UNESCO's international agenda emphasizing 21st-century skills, including digital literacy and critical thinking, to prepare young people for complex information risks and global challenges such as climate change and technological innovation. Closer synergy between national education policy and digital learning practice in secondary schools is increasingly important for bridging this competence gap. This study therefore aims to map the digital competence profile of secondary school students across the five DigComp domains through an observational study, to identify students' strengths and weaknesses in digital competence, and to provide recommendations for meaningful, future-relevant digital learning strategies.

The DigComp framework was originally introduced as a reference model for developing and understanding digital competence in Europe (Ferrari, 2013) and was later refined into successive versions that expand and update its structure (Carretero et al., 2017; Vuorikari et al., 2022). It defines digital competence across five major areas comprising 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 key references in digital competence mapping, curriculum development, educational research, and digital literacy policy studies (Carretero et al., 2017; European Commission, 2016; European Commission, 2019).

Concerns about digital competence are not limited to students. Domestic and international studies on teachers' digital competence point to persistent gaps between policy expectations and classroom practice, along with the need for validated instruments capable of measuring ICT competencies consistently across contexts (Blyznyuk, 2018; Cabero-Almenara et al., 2021; Instefjord & Munthe, 2017; Tondeur et al., 2018). These findings reinforce the importance of examining digital competence from the learner's side as well, which is the focus of the present study.

Similar patterns have been reported within Indonesian contexts. Studies of digital and information literacy among Indonesian school students point to comparable strengths in basic device use alongside persistent weaknesses in critical evaluation and content-creation skills (Arima Devi & Winangun, 2024; Chandra et al., 2025; Nurlia et al., 2025; Putri et al., 2024; Putri et al., 2025).

The research problem addressed in this study stems from the rapid development of digital technology, which requires secondary school and university students to possess adequate digital competence. However, students' digital competence profiles across different domains have not been fully mapped empirically. An observational study is therefore 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 across several digital competence domains, determine the validity and reliability of the observation instrument, identify digital competence levels across educational stages, and determine the domains with the highest and lowest levels of mastery. The research questions 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?

Field data from the Central Statistics Agency (BPS) for 2015-2019, as cited in Anjarwati and Juliprijanto (2021), are presented in Figure 1.

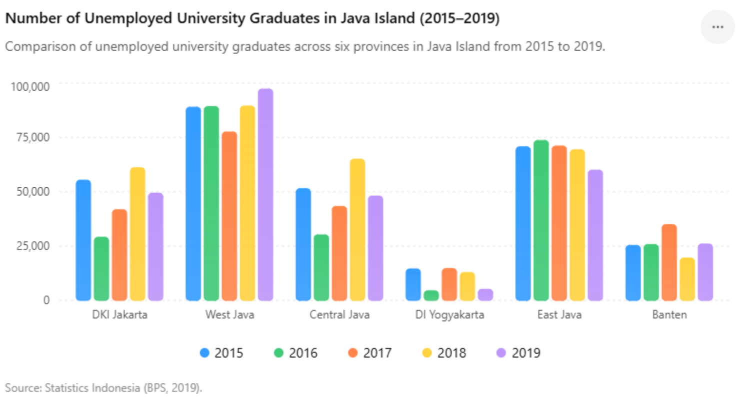

Figure 1. Unemployment Data of Higher Education Graduates from BPS Indonesia

Based on the official BPS reports for 2015-2019, shown in Figure 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, while the lowest was found in the Special Region of Yogyakarta (DIY), at 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. In response, many companies have implemented upskilling and reskilling programs for their employees, a logical consequence of keeping pace with rapid digital technological development, 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 fields of work. It is therefore essential to equip prospective workers and educators with these competencies so they can navigate future workplace challenges. Table 1 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’	A gap exists between academic competencies	This indicates the presence of a skills mismatch and highlights the need

Education Level	Open Unemployment Rate (OUR) 2025 (%)	Employability Interpretation	Indication of Digital Skills Gap	Implications for Educational Outcomes
		competencies, industry demands, and work experience.	and the digital skills required by the labor market.	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 rate suggests a mismatch between graduates' competencies and industry requirements.	The digital skills gap is a significant issue, as technological advancements in industry often outpace curriculum updates.	Vocational education outcomes have not yet fully achieved labor market readiness in accordance with industry expectations.

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

METHODS

Research Design

This preliminary study employs a quantitative observational design using a cross-sectional survey approach to map the digital competency profiles of high school and college students. It was conducted as a needs assessment to obtain an empirical picture of students' digital competency levels prior to developing a digital skills-based learning model (DigPro). Unlike experimental research, this study provided no treatments or interventions; instead, it measured the digital competency levels participants already possessed at a single point in time. This design allowed the researchers to obtain comprehensive information on the characteristics of digital competence across educational levels and domains. Participants were high school and university students from several educational institutions, selected via random sampling to represent variation in participant characteristics across diverse educational backgrounds.

Data Collection Methods

Data were collected using a Google Forms-based observation instrument, enabling quick, efficient, and standardized data collection. The instrument was developed based on the Digital Competence Framework for Citizens (DigComp), covering five domains: (1) Information and Data Literacy, (2) Communication and Collaboration, (3) Digital Content Creation, (4) Safety, and (5) Problem Solving. Indicator development also considered Professional Digital Competence, TPACK (Technological Pedagogical Content Knowledge; Koehler & Mishra, 2009), and DigCompEdu, given that some respondents were prospective teacher-education students. Each domain consisted of 2-3 indicators describing observable digital behaviors, skills, and experiences in learning activities. Before use, the instrument was validated by a panel of six experts in educational technology, science education, educational evaluation, and digital literacy, to ensure its content aligned with the constructs being measured.

To complement the DigCompSat instrument developed by Vuorikari et al. (2025), this study adapts a more concise and contextual approach to measuring digital competence, using a Google Forms-based observation sheet aligned with project-based learning activities. The instrument selected 2-3 representative indicators from each DigComp domain, allowing it to capture 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, 5 = Very High, see Table 2) to enhance measurement sensitivity and provide a broader range of response options. Using Google Forms enabled real-time data recording, simplified documentation, and supported more efficient quantitative analysis. The instrument was used to observe students' digital competencies during a Blynk IoT- and Microsoft Excel-based photovoltaic experiment project, so that the assessment captured not only self-assessment but also actual performance 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.

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

Participants

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

The sample was selected using purposive sampling based on three 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 ensured that participants had sufficient exposure to digital learning practices, so that the data obtained would be relevant for mapping digital competence within 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 around the five main DigComp domains: Information and Data Literacy, Communication and Collaboration, Digital Content Creation, Security and Safety, and Educational Problem Solving. Each domain was elaborated into several observable behavioral indicators during the learning process (see Table 3).

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, 4 = Highly observed (Wright & Masters, 1982). Before implementation, the instrument was tested in Winsteps using the Rasch Rating Scale Model (RSM) 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 indicators aligned with the DigComp construct and the characteristics of secondary school students.

Data Analysis Technique

Digital competence research on instrument development and validation 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 encompassing empirical evidence, score interpretation, and the consequences of instrument use. Building on these foundations, the Mini-21 and Nano-6 instruments were developed as efficient versions of DigCompSat that preserve validity and reliability: Mini-21 is recommended for relatively comprehensive digital competence mapping, while Nano-6 suits large-scale rapid surveys, offering flexibility for digital competence research and evaluation (Hambleton et al., 1991; Kline, 2016; McDonald, 1999; Messick, 1995; Samejima, 1969; Vuorikari et al., 2025).

Observation data in this study were coded and analyzed in two main stages using the Rasch Model in Winsteps, following established procedures for Rasch measurement in the human sciences (Bond & Fox, 2015; Boone et al., 2014). The analysis converted ordinal data into logit (interval scale) values, identified item difficulty levels, measured students' ability in each domain, and tested unidimensionality and category consistency. The Rasch analysis results were used to confirm that the instrument had good measurement quality and was free from observer bias.

Once the data were confirmed to fit the model, descriptive statistical analysis was conducted to calculate the mean score for each domain, identify standard deviations and achievement variation, generate digital competence profile graphs, and analyze fluctuation patterns across grade levels. Results were presented as five-domain DigComp radar charts, bar charts for each sub-competency, and interpretative narrative descriptions. This approach allowed the study to describe digital competence profiles comprehensively, empirically, and contextually, while providing a strong basis for recommendations to strengthen digital learning in secondary schools.

Students' digital competence data were analyzed using the Rasch Rating Scale Model (RSM) with Winsteps software. The Rasch Model transforms ordinal Likert-scale data into interval-scale (logit) data, enabling more objective measurement of ability 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, where θn is the respondent's ability, βi is the item difficulty level, and τk is the threshold of the rating scale category.

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

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.

Instrument quality was evaluated through construct validity testing using item fit statistics, namely Infit MNSQ and Outfit MNSQ, with acceptable values ranging from 0.5 to 1.5 (Linacre, 2002). Person and item reliability were also calculated to assess measurement consistency, expressed mathematically as follows:

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

The separation index was used to indicate the instrument's ability to distinguish respondents' ability levels and item difficulty levels, formulated as follows:

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

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 strong discriminative power in mapping variation in students' digital competence.

After the data were confirmed to meet the Rasch model assumptions and the instrument demonstrated good measurement quality, the analysis continued with descriptive statistics to calculate mean scores, ability distributions, and fluctuation patterns across each digital competence domain. Results were presented as competence profile graphs and interpretative descriptions, comprehensively illustrating 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.

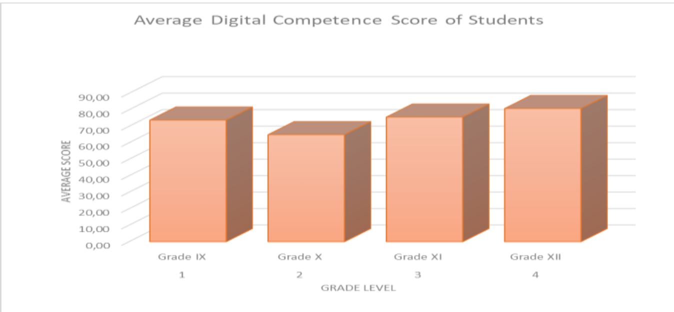

Figure 2: Digital Competencies of High School Students

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.

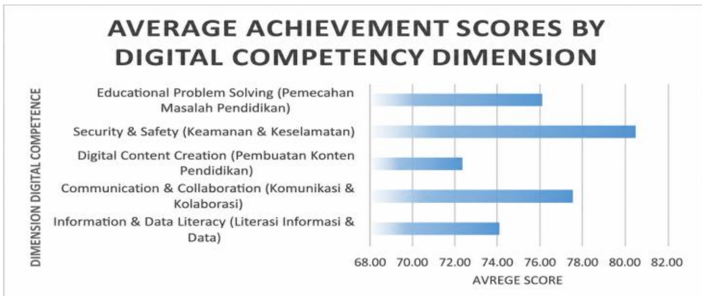

Figure 3 Average Scores of Digital Competence among Grade IX, X, XI, and XII Students

The observation results for 195 secondary school students, shown in Figure 3, indicate that average achievement across the five main dimensions of digital competence varies significantly. Combined with the findings by grade level (IX-XII), the results show that the development of digital competence is influenced not only by grade level but also by the characteristics of each competence dimension. The Security and Safety dimension showed the highest average score (approximately 80-81), indicating that students generally have good awareness of digital security, such as protecting personal data and maintaining ethical technology use. This finding is consistent with 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, indicating that most students still function more as technology consumers than as digital content creators. Skills within this dimension include creating and editing digital content (text, images, videos), understanding copyright and licensing, and basic programming. This low achievement may reflect limited project-based learning experiences that encourage digital creativity, along with insufficient integration of digital production tasks into the curriculum. Although Grade XI (75.64) and Grade XII (80.83) students demonstrated improved overall digital competence, this improvement did not fully extend to digital content creation skills, suggesting that students' learning experiences remain more focused on using technology for information consumption and communication than for producing digital works.

These findings are consistent with earlier studies indicating that digital content creation represents a higher level of competence, requiring the integration of creativity, digital literacy, and problem-solving skills (Hatlevik & Christophersen, 2013; Hatlevik et al., 2015). Within the DigComp framework, digital content creation also encompasses innovation and digital solution development, which generally require more exploratory and practice-based learning approaches (European Commission, 2018). Stronger learning strategies are therefore 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 and Collaboration dimension ranked second, with an average score of around 77-78, indicating 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 et al., 2017). 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 and Data Literacy dimension, the average score was around 74, indicating 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, shaped by learning experiences, cognitive maturity, and the intensity of technology integration in learning activities. They underscore the importance of more targeted pedagogical interventions, particularly to strengthen higher-order digital skills such as 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

Based on Figure 4, the observation results for 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.

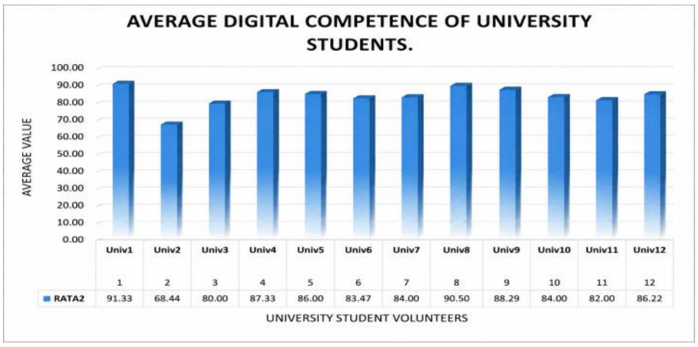

Figure 4 Average Scores of Digital Competence among University Students

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 their academic environments 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 point to a gap in digital competence development among higher education institutions. Factors that may influence this gap include the availability of technological infrastructure, the integration of digital-based learning into the curriculum, institutional support and digital training, and the prevailing academic culture around technology use.

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 is consistent with earlier observations showing that technology mastery is often still partial and not strongly connected to pedagogical aspects or the professional development of prospective teachers.

This preliminary study therefore confirms that the overall trend of digital competence is positive and improving, but clear gaps among universities still exist, indicating 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, so that university students' digital competence is not only high in scores but also meaningful and applicable in real educational practice.

The results in Figure 5, drawn from observations of 66 volunteer university students across 12 higher education institutions, confirm that students' digital competence is categorized as high, with an average score of 86.22.

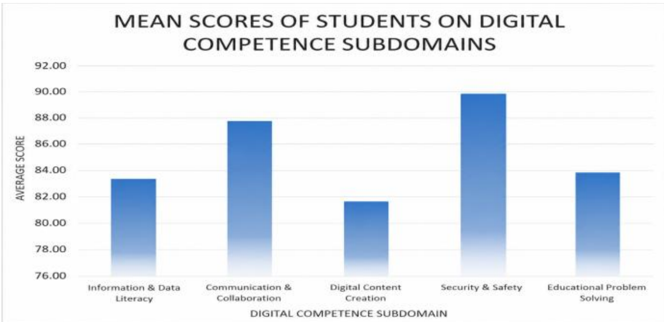

Figure 5 Integration of University Students’ Digital Competence

A deeper analysis reveals that these achievements are not evenly distributed across institutions or across digital competence indicators. Integrating this with the DigComp-based analysis reveals a more specific pattern: the highest achievement was in the Security and Safety dimension, with a score of 89.90, followed by Communication and Collaboration at 87.78. These results indicate that university students are relatively accustomed to maintaining digital security and to interacting and collaborating through technology.

Information and 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 require greater attention: 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 transitioned from technology users to producers of digital learning content, suggesting that their digital competence remains largely operational rather than creative and innovative. Relating this to the variation among institutions shown earlier, it can be concluded that universities with higher achievement 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.

From both analyses, several important conclusions can be highlighted: the overall trend of university students' digital competence is already high; gaps remain visible, both among institutions and across competence indicators; and the most significant imbalance occurs in digital content creation and problem-solving skills. These findings strengthen the case for developing digital competence-based learning models that focus not only on technology use but also on creativity, problem solving, and digital critical thinking. Future research should therefore focus on the contextual integration of TPACK, strengthening project-based digital learning, developing innovative learning models such as DigPro, and applying sustainable, adaptive approaches to meet the demands of the Society 5.0 era.

CONCLUSION

Based on the research findings, university students' digital competencies can be categorized as high, with an average score of 86.22; however, significant differences remain across the various DigComp domains. The highest performance was observed in Security and Safety and Communication and Collaboration, indicating that students are generally proficient in using digital technology safely and effectively to interact and collaborate. 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 for the demands of the digital workforce and future job opportunities. For high school students, the average digital competency score was 73.81; the Security and Safety and Communication and Collaboration dimensions again had the highest scores, indicating relative strength in digital use and interaction, while Digital Content Creation was the lowest-scoring dimension, indicating that students remain predominantly technology users rather than creators of digital content. The digital competencies of high school students therefore still require strengthening, particularly in higher-order digital skills such as digital creation and technology-based problem solving.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

ACKNOWLEDGMENTS

The authors thank the twelve participating higher education institutions across Indonesia, including STIE Anindyaguna Semarang, IAINU Kebumen, Universitas Stella Maris Sumba, Politeknik Negeri Semarang (Polines), Sekolah Tinggi Ilmu Statistik (Polstat STIS), STKIP/ISBI

Singkawang, STT Pati, UIN Walisongo Semarang, Universitas Brawijaya, Universitas Islam Negeri Salatiga, Universitas Negeri Semarang, and Universitas Pancasakti Tegal, which together represent diverse geographical, institutional, and academic backgrounds. The authors also thank the promoters who supported this research during the preliminary study phase, the technical assistance and discussion teams, and all the high school and university student volunteers whose openness and active participation made this study possible. Their contributions, we hope, will support ongoing efforts to improve education and digital competence in Indonesia.

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