Evaluating Digital Competence Among University Students in Vietnam's Northern Mountainous Region: Challenges and Strategies for Enhancement

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Abstract **- Digital competence is increasingly recognized as a vital skill for individuals in contemporary society, particularly in light of the rapid and widespread advancements in information and communication technology. In the current digital context, it is imperative for university students to possess digital competencies that enable them to engage effectively in an open and global educational environment. This study employs a mixed-methods approach, integrating both qualitative and quantitative research methodologies, with a sample size exceeding 2,000 students from the Northern mountainous region of Vietnam, enrolled in member institutions of Thai Nguyen University, alongside 50 lecturer members who provide direct instruction. The study aims to elucidate the current state of digital competence among these students. The findings indicate that, overall, students in the Northern mountainous region of Vietnam exhibit a degree of confidence in their digital competencies, with a substantial proportion rating their skills as good or very good. However, the research also reveals that a significant number of students assess their digital abilities as merely average or poor. Furthermore, the study identifies several barriers that hinder the development of digital competencies among students. Based on these insights, the paper proposes implications for the administration of member universities of Thai Nguyen University, as well as for educational policymakers in Vietnam, suggesting specific plans, strategies, and actions aimed at enhancing digital competence among students in the Northern mountainous region and Vietnamese students more broadly in the near future.**

Keywords **- Digital competence, digital competence of students, ethnic minority students, northern mountainous region of Vietnam.**

1. Introduction

Structure Digital competence has emerged as an indispensable aspect of student development in the 21st century. According to research conducted in [1], digital competence encompasses various elements, including information skills, content creation, communication, ethical skills, problem-solving, technical/usage skills, and strategic skills. The concept of digital competence extends beyond mere technological proficiency; it also involves the ability to analyze and utilize digital information effectively. Studies have indicated that students often do not possess the level of digital competence that is expected, highlighting the necessity for educational institutions to proactively support the development of these skills to meet the demands of the modern labor market.

Numerous studies have proposed and employed various assessment frameworks to measure students' digital competence. For instance, the study in [2] utilized the Tsifrogram test, which is based on the DigComp model (the Digital competence Framework for Citizens), to evaluate the level of digital competence development among students. The findings of this research indicate that despite significant efforts to enhance digital competence among students, particularly in economic disciplines, there remain substantial limitations that need to be addressed.

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Recommendations have been made to improve digital competence, especially within the context of lifelong learning. Similarly, the study in [3] applied the DigComp framework to analyze university students' perceptions of digital competence and the influence of personal factors, such as gender, academic level, and residential area. The results revealed significant differences among student groups, with those residing in rural areas and studying non-technology-related fields exhibiting lower levels of digital competence than their peers.

Numerous studies have highlighted several significant issues concerning the development of digital competence among students. For instance, research in [4] conducted in Romania demonstrated a relationship between students' self-perceived digital competence and their level of self-directed learning. Students exhibiting higher levels of self-directed learning tended to possess greater digital competence and a more positive attitude towards the use of technology. However, the study also indicated that the integration of technology into teaching practices in Romania remains limited, partly due to traditional perceptions held by educators regarding the learning process. The findings revealed that students' digital competencies do not meet the demands of the labor market, and the instruction aimed at developing these competencies has not been particularly effective. These findings underscore that, despite the increasing prevalence of digitalization, significant barriers remain in adequately preparing students for participation in the labor market.

Several studies have reached a consensus regarding the fundamental components of digital competence; however, variability remains in the approaches and measurements employed. It was noted in [5] that the majority of research and policy initiatives in Europe are grounded in the DigComp framework, indicating a degree of uniformity in the definition and assessment of digital competence. Nevertheless, the study also highlights that, despite the rapid advancement of digital tools, both students and educators continue to attain only a basic level of digital competence. Conversely, the study conducted by [6] emphasizes the role of digital competence in the development of soft skills and creativity within the context of higher education. The authors assert that digital competence encompasses not only the ability to utilize technology but also the cultivation of critical thinking and creative skills. These elements contribute significantly to enhancing students' competitiveness in the labor market.

However, there remains considerable debate regarding whether current teaching methodologies are sufficiently flexible to meet the comprehensive development needs related to digital competence.

Based on the abovementioned key studies, it is evident that significant gaps remain in the research on students' digital competence that warrant further exploration. First, while most studies focus on assessing digital competence through the DigComp framework, there is a lack of in-depth research regarding how students apply these digital skills in their academic and professional contexts. Second, despite the abundance of research conducted in Europe and Asia, comparative studies on digital competence across different regions, particularly in developing countries, are notably scarce. Furthermore, the application of assessment methods for digital competence is still fraught with limitations. Research by [7] in Türkiye indicates that students' digital competence is not uniformly distributed according to gender and academic status. However, this study also reveals that aspects such as digital content creation have yet to be thoroughly investigated, and personal factors such as interests and prior technology usage experience significantly influence students' digital competence.

Thus, research on students' digital competence has made significant advancements in understanding and measuring this concept. However, numerous issues remain that warrant further investigation, such as the development of more flexible assessment frameworks, exploration of the influence of cultural and social factors on digital competence, and analysis of differences in digital competence across various fields of study and geographical regions. These gaps present opportunities for future research, including studies focused on the digital competence of students at Thai Nguyen University in Vietnam. Such research aims to elucidate the current state and methods of developing digital competence among students, thereby contributing to the establishment of modern educational programs that align with the evolving demands of the labor market.

2. Digital Competence

Digital competence is defined from various perspectives, ranging from cognitive abilities to specific technical skill sets. It encompasses the knowledge, skills, and attitudes necessary for individuals to effectively use digital technology to solve problems and participate in today's knowledge society. Experts largely agree that the core of this competence involves retrieving and processing information, communicating, and creating digital content using ICT.

2.1. The Concept of Digital Competence

Experts have articulated the concept of digital competence from various perspectives. From a cognitive standpoint, digital competence is defined as the ability to understand and utilize information in multiple formats from diverse sources, as presented through computers [8]. Digital competence encompasses a set of knowledge, skills, and attitudes necessary for effectively employing digital technology to enhance the efficiency of daily life. It includes cognitive skills, attitudes, and technological proficiency that enable individuals to address numerous problems and challenges in today's knowledge society [9].

From an individual-centered cognitive perspective, studies [10] and [11] emphasize that digital competence comprises the skills required to access and manipulate fundamental functions, enabling individuals to become confident and adept at adapting technology for personal, educational, and professional purposes. It is argued in [12] that digital competence encompasses the values, beliefs, knowledge, abilities, and attitudes necessary for the appropriate use of technology, including computers, various software applications, and the Internet. This competence allows individuals to research, access, organize, and utilize information to construct knowledge. Furthermore, studies [13] and [14], building on this definition, describe digital competence as the awareness, attitudes, and capabilities of individuals to effectively utilize digital tools and technical infrastructure to identify, access, manage, integrate, evaluate, analyze, and synthesize digital resources. This process facilitates the construction of new knowledge, the creation of communicative representations, and interactions with others in specific life situations, ultimately aiming to engage in constructive social actions and reflect on this process.

Digital competence refers to the ability to understand and utilize information in various formats, with a primary focus on critical thinking rather than mere technological skills [15]. In this context, the study in [16] discusses the concept of key digital competence, emphasizing the "ability to access, critically evaluate, use, and create information through digital means in order to connect with others and the community." Furthermore, several researchers argue that digital competence encompasses a range of skills, including technical, cognitive, and socio-emotional skills, progressing from basic operations to more complex tasks such as the creation and consumption of digital content [17], [18].

Studies [9] and [19] collectively define digital competence as a set of knowledge, skills, and attitudes (which encompass abilities, strategies, values, and awareness) necessary for effectively utilizing information and communication technologies, as well as digital tools, to perform tasks, solve problems, communicate, manage information, collaborate, create and share content, and actively, flexibly, creatively, effectively, comprehensively, selectively, ethically, and appropriately build knowledge for work, learning, leisure, and participation in society [20]. This definition was subsequently adopted by the European Commission as the official definition for the development of the Digital competence Framework (DigComp) for European citizens.

The United Nations Educational, Scientific, and Cultural Organization defines digital competence as the ability to access, manage, understand, integrate, communicate, evaluate, and create information safely and appropriately through digital means to serve the needs of the general labor market, advanced occupations, and entrepreneurial ventures [21]. This definition highlights several essential competencies, including access, management, communication, evaluation, and creation of information, which are aligned with digital technologies. The primary objective of digital competence is to facilitate effective engagement in work and productive labor. These competencies encompass what is broadly referred to as computer literacy, information and communication technology (ICT) literacy, information literacy, and media literacy.

A comprehensive review of the concepts of digital competence as articulated by various international authors reveals that, despite differing perspectives, the notion of digital competence exhibits considerable diversity. Nevertheless, there is a significant degree of convergence in the core understanding of digital competence, which centers around the retrieval and processing of information through new technologies, as well as the communication and creation of digital content utilizing ICT.

In Vietnam, the study of digital competence has garnered significant attention from various experts. For instance, the study in [22], drawing on the European Commission's definition of digital competence, describes it as the ability to effectively and consciously utilize the tools of the information society in work, leisure, and communication. A prerequisite for this capability is mastery of ICT tools, which includes the ability to use computers to locate, evaluate, store, create, present, and exchange information, as well as to communicate and engage in collaborative networks via the Internet.

Meanwhile, the study in [23] adopts the definition of digital competence provided by UNESCO, characterizing it as the ability to access, manage, understand, integrate, communicate, evaluate, and create information safely and appropriately through digital technology to serve the needs of the general labor market, advanced occupations, and entrepreneurial initiatives. It is asserted in [23] that an individual's digital competence is developed based on foundational competencies such as empathy, critical thinking, problem-solving, creativity, and innovation. In this context, the attitudinal component is regarded as an indispensable aspect of digital competence, significantly influencing the proposal of a digital competence framework for Vietnam.

As indicated in [24], digital competence can be understood as the ability to focus and apply technology in practice through attitudes, empathy, critical thinking, problem-solving, and innovative creativity. Perspectives on digital competence among students have also been explored [25], which defines digital competence as the requirements and qualities related to the competencies and skills necessary to access, operate, and interact with digital devices and systems within a social environment. Furthermore, a study by [26] has concentrated on digital competence in teaching, specifically addressing its application in higher education institutions both globally and in Vietnam, with the aim of enhancing the quality of education to meet the demands of digital transformation in the current era.

Despite the diverse articulations of approaches and concepts related to DLS, there exists a notable commonality among these perspectives: they all emphasize the importance of understanding information technology and the capacity to apply technological elements to enhance both the learning experience and the everyday lives of learners.

2.2. Components of Digital Competence

The diversity of concepts surrounding digital competence (DC) has resulted in a corresponding variety of NLS structures, as highlighted in the research conducted by [1].

The synthesis in [1] of 126 studies focused on DC for students in higher education identified several fundamental components of DC, including the following: (1) Information literacy, which pertains to the ability to search for, evaluate, store, and comprehend information [27], [28]; (2) Online communication literacy, which involves engaging with others through digital tools on online platforms and encompasses collaboration and connectivity [29]; (3) Digital content creation, which refers to the ability to produce content in various digital formats [30]; (4) Technology literacy, which addresses access to digital tools and the technical knowledge required for their effective use [31]; (5) Problem-solving literacy, which involves the capacity to resolve issues effectively [30]; (6) Ethical issues related to technology use in daily life, which students must navigate [27], [32]; and (7) Collaborative strategies, which refer to the application of various NLS to achieve personal and professional success [1], [33], [34].

The components identified in these studies closely align with those described in the European DigComp framework for DLS. The DigComp framework, particularly the updated version 2.1, is recognized as one of the most comprehensive frameworks for NLS in Europe. It represents an improved iteration of the earlier DigComp 2.0 framework [35] and the original DigComp framework [9]. The structure of DC as outlined by the DigComp framework comprises five key components: (1) Information and data literacy; (2) Communication and collaboration; (3) Digital content creation; (4) Safety; and (5) Problem solving. Each of these components is represented by indicators that highlight the essential learning areas necessary for citizens to adapt to the demands of the 21st century [36]. A commonality in identifying the components of DC across these frameworks is the consistent emphasis on information literacy, communication literacy, content creation literacy, safety literacy, and problem-solving literacy.

In Vietnam, research [22] introduced an initial digital competency model comprising three main factors: information positioning, information acquisition, and information utilization. This model further delineates eight specific components: (1) Identifying information needs when faced with a problem requiring resolution; (2) Determining the scope and relevance of information sources; (3) Selecting appropriate methods and tools for information retrieval; (4) Evaluating and filtering the retrieved information; (5) Organizing and managing collected information systematically; (6) Effectively utilizing the found information, including its organization and storage; (7) Employing computer tools for collaborative work; and (8) Drafting documents and presenting ideas in both spoken and written forms. These components describe and assess Vietnamese students new literacy skills (NLS).

Additionally, a study [25] proposed a digital competency framework specifically tailored for Vietnamese students, which consists of seven digital competency components: (1) Operating devices and software; (2) Information and data literacy; (3) Communication and collaboration in digital environments; (4) Digital content creation; (5) Cybersecurity and safety; (6) Learning and developing digital skills; and (7) Digital competencies related to professional contexts.

Each of these components is characterized by specific manifestations of competency.

In general, authors discussing the components of digital competency tend to converge on several common elements, namely, information literacy, content creation skills, communication proficiency, and problem-solving abilities. Although there is currently no universally accepted framework applicable across all fields and nations, these shared components may serve as a foundational reference for researchers and policymakers engaged in the study of digital competencies.

2.3. The Digital Competence Framework (DCF)

The International Computer Literacy and Information Study (ICILS) defines digital competence as "an individual's ability to use computers to investigate, create, and communicate effectively in participation at home, at school, in the workplace, and in the community" [37]. The digital competence framework developed by ICILS in 2013 comprises seven aspects organized into two strands: "collecting and managing information" and "creating and exchanging information." In 2018, ICILS conducted further research and revised the 2013 framework, expanding it to eight aspects organized into four strands, with two aspects in each strand. The four strands are Understanding Computer Use (which includes the aspects of the fundamentals of computer use and conventions of computer usage), Gathering Information (which encompasses accessing, evaluating, and managing information), Producing Information (which involves transforming and creating information), and Digital Communication (which includes sharing information and using information responsibly and safely). In 2017, with the support of the European Commission, the Joint Research Centre (JRC) initiated a strategic research project aimed at promoting digital competence initiatives for the European community. The outcomes of this project led to the proposal of a digital competence framework for citizens, referred to as "DigComp 2.0." This framework is regarded as a "tool" for enhancing citizens' digital competence. The DigComp 2.1 framework is divided into five competence areas, each encompassing specific digital competencies.

In 2018, UNESCO conducted empirical research to evaluate 47 digital competence frameworks from economically diverse countries across various continents, comparing these frameworks with the European DigComp framework. The findings concluded that all competencies described in the 47 digital competence frameworks could be mapped to the DigComp framework [38].

Subsequently, UNESCO agreed to integrate several competencies into the DigComp framework to establish a global reference framework known as the Digital competence Global Framework (DLGF). This foundational knowledge will inform and guide the research, allowing us to build upon the contributions of previous scholars in the field.

3. Research Methodology

In this study, the research team employed a mixed-methods approach, integrating both qualitative and quantitative research methodologies to collect data for the article. The tools utilized for data collection included a questionnaire for the quantitative research method and an analysis of relevant research work and documents for the qualitative research method.

The target population for the questionnaire consisted of students from the member universities of Thai Nguyen University located in the mountainous northern region of Vietnam, all of whom had completed at least one academic year at their respective institutions.

For sampling, the research team implemented a random sampling technique while considering the students' place of residence. A total of over 2,250 students and 50 lecturers currently teaching at member universities of Thai Nguyen University were included in the sample.

The questionnaire was designed to encompass two main areas: general information about the survey participants and the current state of digital competence among students at Thai Nguyen University in the northern mountainous region of Vietnam. This assessment was based on the European DigComp framework version 2.1 and the global reference framework DLGF, which includes seven groups of digital competence competencies and specific criteria: (1) Operating devices and software four criteria); (2) Information and data literacy six criteria); (3) Communication and collaboration in digital environments (10 criteria); (4) Digital content creation four criteria); (5) Cyber security and safety (10 criteria); (6) Learning and developing digital skills (14 criteria); and (7) Digital competence related to employment two criteria). To measure the manifestation of digital competence among students across these seven groups, a five-point Likert scale was employed, consisting of the following options: (1) Very poor, (2) Poor, (3) Average, (4) Good, and (5) Very good.

The questionnaire was distributed using two methods: (1) Direct distribution, in which the research team personally administered the questionnaires to students, provided guidance on how to complete them, and subsequently collected the completed forms; and (2) Indirect distribution, in which the research team designed the criteria corresponding to the seven groups of digital competence competencies using Google Forms and shared the link with the relevant survey participants.

To analyze the survey results, the research team utilized the data obtained from the assessment of the current state of digital competence among students in the northern mountainous region of Vietnam (as presented in Table 1).

The analysis was conducted according to the seven groups of digital competence competencies.

Table 1. Comparison of student self-assessment results of their digital competencies by criterion

Criterion	Self-assessed as "Average" Competency Level	Self-assessed as "Below Average" Competency Level	Self-assessed as "Poor" Competency Level
Analyzing, Interpreting, and Evaluating Data, Information, and Digital Content.	1177 students (51.7%)	115 students (5.1%)	33 students (1.4%)
Systematic Organization and Processing of Data, Information, and Digital Content.	1178 students (51.8%)	124 students (5.3%)	34 students (1.5%)
Organizing, Storing, and Accessing Data, Information, and Digital Content in a Digital Environment.	1154 students (50.7%)	122 students (5.4%)	34 students (1.5%)
Correctly Identifying the Need for Information, Data, and Digital Content; Innovating Personal Search Strategies.	1059 students (46.5%)	78 students (3.4%)	34 students (1.5%)
Accessing Sought Information, Data, and Digital Content, Understanding Interrelations, and Creating New Digital Content; Evaluating Data, Information, and Digital Content Reliability.	1101 students (48.4%)	98 students (4.3%)	31 students (1.4%)

To quantify the results, weights were assigned corresponding to the response levels: Very poor (0), Poor (1), Average (2), Good (3), and Very good (4). For each group of competencies, the criteria were analyzed across three dimensions: quantity, percentage, and overall performance. Overall mean value:

$$\overline{X} = \frac{\sum_{i=1}^{n} x_i n_i}{\sum_{i=1}^{n} n_i} \quad (1)$$

where n_i represents the number of respondents selecting the corresponding answer x_i.

4. Results and Discussion

The research findings indicate that students in the northern mountainous region generally hold a positive perception of their digital skills, although their proficiency tends to decrease as tasks become more complex. Although many students are confident in areas such as cybersecurity, there are notable deficiencies in advanced competencies such as content creation and strategic problem-solving.

4.1. Self-Assessment Results of Non-Language Skills among Students from the Northern Mountainous Region of Vietnam

The analysis of competencies related to the operation of equipment and software shows clear variations in student proficiency across different criteria (Figure 1).

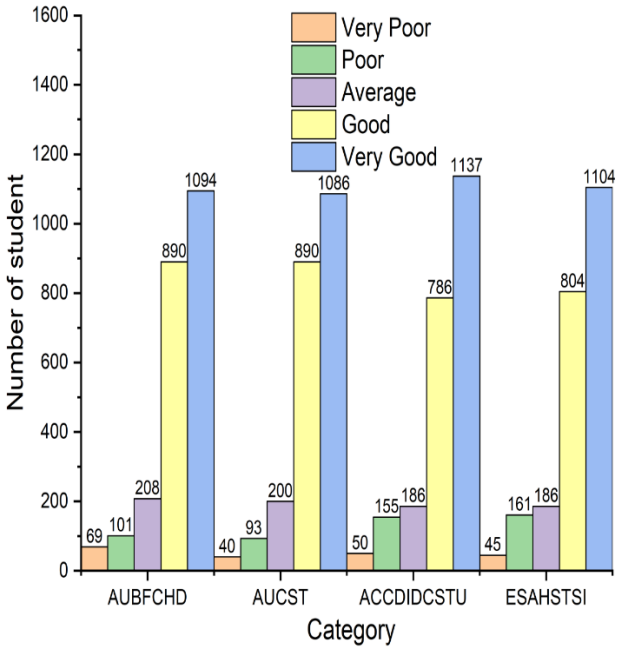


Figure 1. Self-assessment of students' competencies in operating equipment and software in northern mountainous areas of Vietnam

The overall average score for this competency group reveals that the criterion of "recognizing and using common software tools" has the highest average score: $\overline{X} = 2.432$, while the criterion of "understanding key concepts of data, information, and digital content necessary for software and technology use" has the lowest $\overline{X} = 2.390$.

A more detailed examination of each criterion provides insight into the specific areas in which students exhibit varying levels of confidence and ability.

First, regarding the operation of hardware devices, survey results indicate that less than 45% of students feel confident in their abilities at a level they would consider good or better. Meanwhile, 48.1% of respondents (1,094 students) rated their competency as average, and a notable portion of students rated themselves lower. Specifically, 4.4% (101 students) assessed their skills as poor, and 3.0% (69 students) considered their proficiency very poor. These findings suggest that a significant number of students lack confidence in their ability to handle basic hardware operations, highlighting a gap in hands-on experience with physical devices.

For the criterion of recognizing and using common software tools, the data similarly reflect a considerable proportion of students who rate themselves at an average level, with 47.1% (1,086 students) falling into this category. Additionally, 4.1% (93 students) consider their proficiency poor, while 1.9% (43 students) rate themselves as very poor. Although more students appear confident in their ability to navigate common software compared to hardware, there remains a substantial percentage of students with limited proficiency. This indicates that, despite frequent exposure to software during their academic journey, many students still struggle to master essential tools.

The understanding of key concepts such as data, information, and digital content appears to be the most challenging area for students, as nearly half of them (49.9%, or 1,137 students) rated themselves at an average level. More concerning, over 10% of students rated their understanding as poor or very poor, with 6.8% (155 students) considering their abilities poor and 4.1% (55 students) evaluating them as very poor. This is the weakest area for students, suggesting that conceptual knowledge of data and digital content, a fundamental skill in today's technology-driven world, remains underdeveloped.

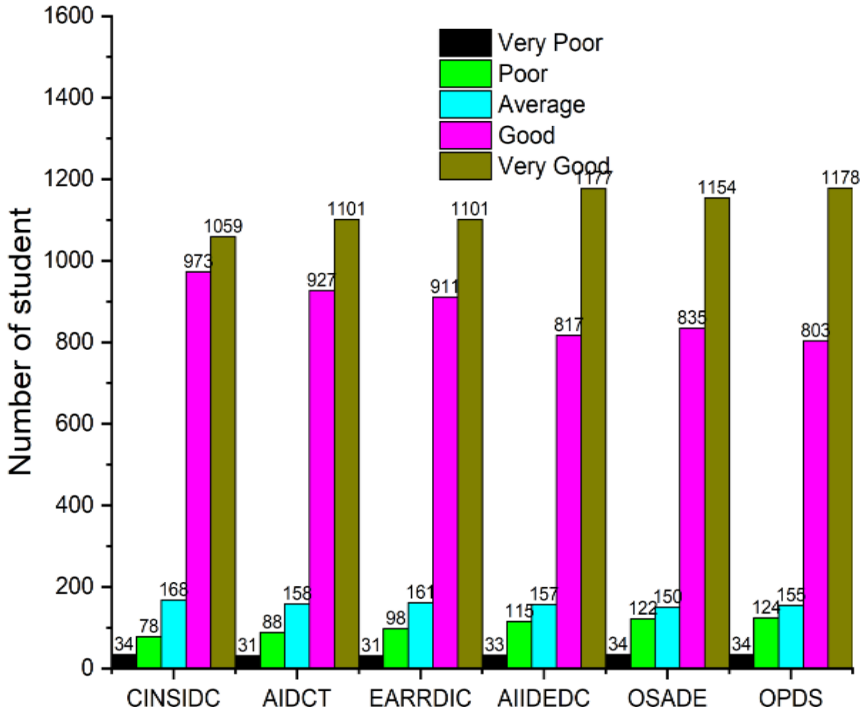
This could have long-term implications, as these concepts are crucial for a range of tasks, from software operation to data management in various digital environments.

Finally, in the criterion of evaluating and selecting appropriate hardware and software tools for problem-solving, 48.4% (1,101 students) rated themselves as average. A smaller but significant group rated their skills as poor (7.1%, or 161 students), while 1.9% (45 students) rated themselves as very poor. This competency involves higher-level decision-making skills and an understanding of the appropriateness of technology for specific tasks.

The lower confidence among students in this area reflects their limited exposure to complex problem-solving scenarios that require the integration of various technologies.

Overall, fewer than 50% of students across all competencies rated themselves as good or very good, while the proportion of students rating their skills as poor or very poor ranged from 6.0% to 10.9%. Interviews with students suggest that these gaps in competency may stem from limited hands-on experience with peripheral devices during their education, as most students used computers primarily in school labs. Additionally, owing to the diversity of software required for different courses, students struggled to find sufficient time to fully explore and master the tools. This lack of comprehensive exposure to both hardware and software tools not only affects students' immediate academic performance but could also hinder their ability to adapt to the rapidly evolving technological landscape in their future careers.

The information and data exploitation competency groups were detailed through six specific criteria. Students from the northern mountainous region of Vietnam rated their own competencies in information and data exploitation at an average level, with a relatively high proportion, over 50% across all six surveyed criteria. The percentage of students who rated their competency as poor ranged from 3.4% to 5.4%, while those who rated their competency as very poor accounted for 1.3% to 1.4% (Figure 2).



Note: CINSIDC refers to the correct identification of the need for information, data, and digital content searches; AIDCT denotes the timely access to information, data, and digital content; EARRDIC pertains to the evaluation of the accuracy, reliability, and relevance of data, information, and digital content; AIIDEDC involves the analysis and interpretation of information and data, as well as the evaluation of digital content; OSADE signifies the organization, storage, and access of data in a digital environment; and OPDS represents the systematic organization and processing of data.

Figure 2. Self-assessment results of information and data retrieval competencies among students in the northern mountainous region of Vietnam

This self-assessment indicates that while most students perceive themselves to possess moderate skills in handling information and data, a non-negligible proportion of students still experience challenges in mastering these competencies. This could imply a need for targeted interventions to improve proficiency in information and data exploitation, particularly for students who rate themselves at lower levels of competency.

The average competency score of the group was $\overline{X} = 2.445$, with the criterion "Correctly identifying the need for information, data, and digital content searches, along with the ability to innovate personal search strategies" displaying the highest average value among the six criteria. In contrast, the criterion "Systematically organizing and processing data, information, and digital content" exhibited the lowest average value within the group: $\overline{X} = 2.503$. An analysis of the survey results (Table 2) revealed these findings.

Table 2. Comparison of average scores between student self-assessments and lecturer evaluations for the seven competency groups of digital competence

No	Digital competency group	Student Self-Assessment	Lecturer's Evaluation	Deviation
1	Operating digital devices and software	2.432	2.528	0.096
2	Extracting information and data	2.445	2.412	0.033
3	Digital communication and collaboration	2.508	2.095	0.413
4	Creating digital content	2.338	2.020	0.318
5	Online security and safety	2.585	2.294	0.291
6	Learning and developing digital skills	2.503	2.308	0.195
7	Using digital skills for professional development	2.461	2.392	0.069
	Overall average for the seven competency groups	2.467	2.293	0.175

The analysis of the data presented in Table 1 reveals significant insights into the digital competencies of students in the northern mountainous region of Vietnam.

The findings indicate that a substantial proportion of students rate their abilities in various competencies as only average, with notable differences across specific skills.

For example, the competencies related to analyzing, interpreting, and evaluating data, information, and digital content were assessed at an average level by 51.7% of the students. However, a significant portion (6.5%) of students rated themselves as below average or poor, highlighting the need for targeted interventions. Similarly, 51.8% of students rated their competency in systematically organizing and processing data as average; however, 6.8% expressed challenges in this area. This suggests that while many students have moderate confidence in handling data systematically, a considerable number still require further support.

The ability to organize, store, and access data in a digital environment was rated as average by 50.7% of the students, with 6.9% identifying a lack of proficiency. This demonstrates that, although some students feel comfortable with digital data management, a sizable number still face difficulties, potentially limiting their ability to effectively engage in data-driven environments. Of particular concern is the competency related to correctly identifying the need for information and innovating personal search strategies, which had the lowest average rating among the six criteria, with only 46.5% of the students assessing their skills on average. This result suggests that many students find it challenging to develop effective search strategies and adapt to the dynamic nature of digital content. This could be attributed to insufficient exposure to information literacy training, which affects their ability to meet their information needs in a more innovative manner.

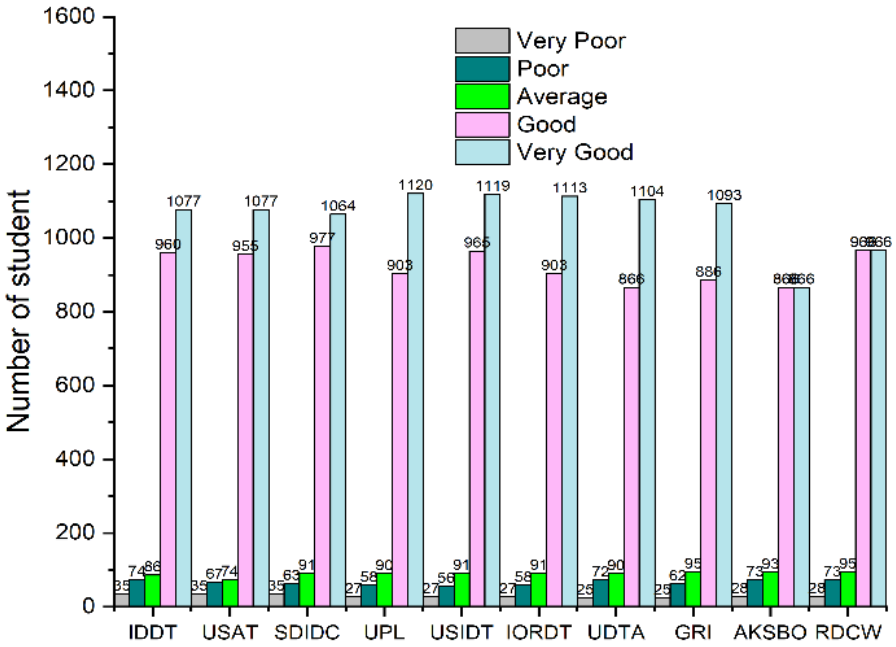
Moreover, assessing and evaluating information reliability was rated as average by 48.4% of students, while 5.7% indicated below-average or poor competency in this area.

Given the increasing prevalence of misinformation in the digital space, this gap highlights the critical need for educational institutions to prioritize the enhancement of students' ability to critically evaluate information.

Overall, while many students seem to possess a moderate level of digital competency, significant gaps remain, particularly in areas that involve critical analysis, systematic data processing, and strategic information searching. Addressing these areas through targeted training programs and practice-based learning can help bridge these gaps and empower students with stronger digital competencies that are essential for academic success and informed decision-making.

The competency group related to communication and collaboration in digital environments comprises 10 distinct criteria. The average competency value for this group was found to be, with the criterion "Identifying opportunities for self-improvement in digital competence and practicing the role of a digital citizen through appropriate technologies" exhibiting the highest average value: $\overline{X} = 2.508$. In contrast, the criterion "Applying flexible and effective communication strategies with various public groups according to specific objectives" recorded the lowest average value among the ten criteria: $\overline{X} = 2.451$.

Based on the obtained results (Figure 3), it is evident that some criteria within this competency group received relatively high self-assessment scores from the students. Specifically, the criterion concerning recognizing cultural and generational diversity in digital environments showed that 966 students (42.1%) rated their ability as very good, while 173 students (7.5%) rated their competency as excellent. These findings suggest that a significant proportion of the student population perceives certain competencies within the realm of digital communication and collaboration as strengths.

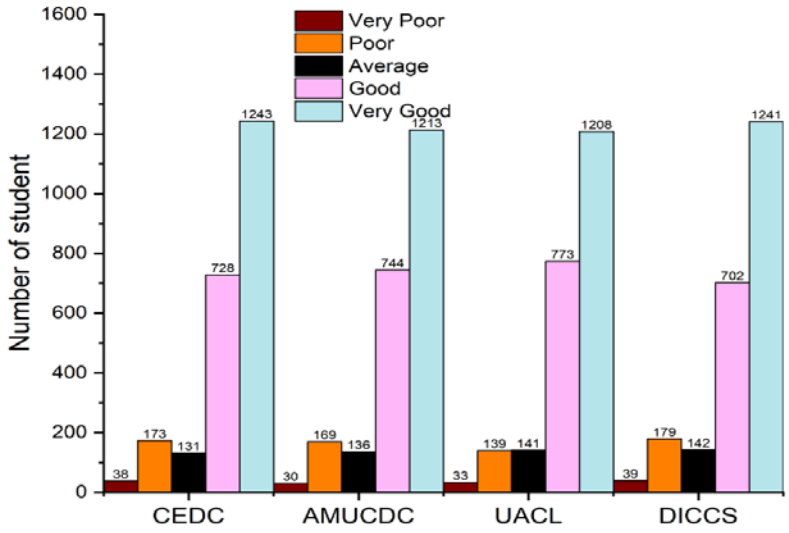


Note: IDDT - Interacting digitally with other digital tools; USAT - Understanding and selecting appropriate tools; SDIDC - Sharing data, information, and digital content; UPL - Understanding principles and laws; USIDT - Understanding societal implications of using digital tools; IORDT - Identifying opportunities and resources for digital tools; UDTA - Using digital tools appropriately; GRI - Gathering relevant information; AKSBO - Applying knowledge and skills for business objectives; RDCW - Recognizing digital culture in the workplace.

Figure 3. Self-assessment results of digital communication and collaboration competencies among students in the northern mountainous region of Vietnam

For the remaining criteria, approximately 46% to 50% of the students rated their abilities as average, while approximately 7% assessed their competencies as poor or very poor. This indicates that the criteria requiring practical application and real-world implementation had relatively low rates of positive self-assessment (good or very good) and a higher proportion of negative evaluations (poor or very poor). These findings suggest the need for more emphasis on hands-on learning opportunities to enhance students' confidence and competence in applying theoretical knowledge to practical situations.

The self-assessment results from 2,276 students in the Northern Mountainous Region of Vietnam regarding their digital content creation competencies are summarized across five levels (Figure 4), with an average score: $\overline{X} = 2.338$. Among the criteria, "Understanding and correctly applying copyright regulations for data, information, and digital content" had the highest average score: $\overline{X} = 2.371$. In contrast, the criterion "Designing, developing, and formulating commands for computer systems to address specific problems or tasks" recorded the lowest average score: $\overline{X} = 2.317$.



Note: CEDC - Creating and Editing Digital Content; AMUCDC - Ability to Modify, Upgrade, and Combine Digital Content; UACL - Understanding and Applying Copyright Laws; DICCS - Designing and Issuing Commands for Computer Systems.

Figure 4. Self-assessment results of digital content creation competencies among students in the northern mountainous region of Vietnam

Based on the collected data, it is evident that a considerable proportion of students rated their digital content creation competencies as average, ranging from 53.1% to 54.6%. However, it is concerning that this competency group also shows a relatively high number of students self-rating their skills as below average, compared to other competency groups. Specifically, between 6.1% and 7.7% of students rated themselves as having poor abilities, and 1.3% to 1.7% rated their skills as very poor.

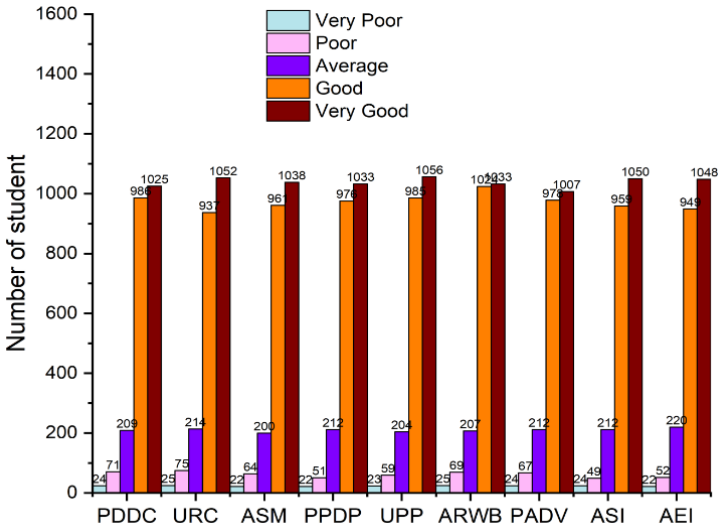
These findings indicate significant limitations in students' digital content creation skills. The main reasons for this lack of proficiency seem to be a shortage of motivation and an insufficient supportive environment for creativity. The creation of digital content often requires a combination of technical knowledge, creativity, and practical experience, all of which require nurturing through an engaging and supportive learning atmosphere. The relatively low levels of confidence reported by students suggest that they may not receive the encouragement or resources necessary to explore creative endeavors in a digital setting, such as access to tools for content creation or structured opportunities to engage in creative projects.

Moreover, the disparity in scores, particularly in applying copyright regulations versus designing and developing computer commands, reflects a potential imbalance in the curriculum. While students may be gaining an understanding of theoretical or regulatory aspects, they may lack hands-on practice or exposure to practical skills that directly contribute to creative problem-solving with technology.

This suggests that educational institutions should focus more on experiential learning opportunities, allowing students to experiment with digital tools in problem-solving scenarios and encouraging collaboration on creative digital projects. Such measures could significantly improve students' competencies in creating meaningful and original digital content.

To address these gaps, educational interventions could include providing more project-based learning modules that emphasize practical skill development and real-world applications. In addition, fostering a community that encourages digital experimentation, creativity, and collaboration could help students find the motivation and inspiration needed to strengthen their digital content creation skills. Building an environment in which students feel comfortable exploring and making mistakes can also promote a culture of innovation, which is essential for developing these critical 21st-century skills.

The self-assessment results for cybersecurity and safety competencies (Figure 5) indicate an average score of $\overline{X} = 2.585$. Among the criteria, the highest average score was found in "Fully understanding the impact of digital technologies and their usage on the environment" at $\overline{X} = 2.608$, while the lowest average score in this competency group was for "Ability to avoid risks and maintain one's health, emotional well-being, and mental resilience when using digital technology" at $\overline{X} = 2.565$.



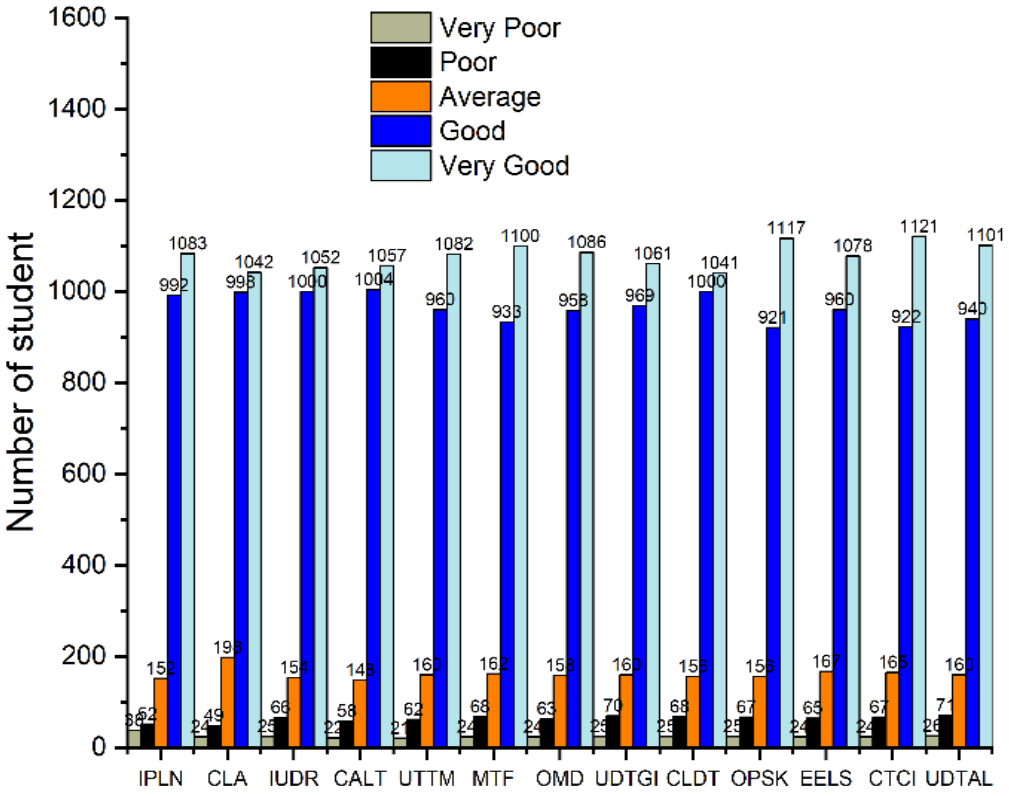
Note: PDDC - Protecting Digital Devices and Content; URC - Understanding Risks and Challenges; ASM - Awareness of Security Measures; PPDP - Protecting Personal Data and Privacy; UPP - Understanding Privacy Policies; ARWB - Avoiding Risks for Well-being; PADV - Protecting Against Digital Violence; ASI - Awareness of Social Impacts; AEI - Awareness of Environmental Impacts.

Figure 5. Self-assessment results of cybersecurity and safety competencies among students in the northern mountainous region of Vietnam

Interestingly, approximately 45% of students (ranging from 1, 007 to 1, 056 students per criterion) in this competency group confidently rated their abilities as good, and approximately 9% rated their competencies as very good, which is the highest proportion observed among the other competency groups. The remaining students predominantly rated their skills at an average level, ranging from 40.7% to 42.8%. The percentage of students rating themselves as having poor abilities varied between 2.1% and 3.3%, while those who rated themselves as very poor ranged from 0.9% to 1.2%. The high proportion of positive self-assessments in this competency group can largely be attributed to early exposure to cybersecurity concepts. Specifically, cybersecurity and safety were introduced as part of computer science curricula at the high school level, equipping students with foundational knowledge on safe practices when participating in social media and digital environments. Furthermore, educational institutions have actively emphasized these skills as part of their soft skills training, thereby fostering greater awareness and competency in cybersecurity and online safety.

Despite these encouraging figures, the relatively lower average scores related to emotional and mental health awareness highlight an area for improvement. Educational programs should thus not only focus on equipping students with technical knowledge regarding online security but also emphasize the importance of maintaining digital well-being. Initiatives such as workshops, seminars, and courses that specifically address managing screen time, dealing with online stressors, and promoting healthy digital habits could be instrumental in enhancing students' abilities to protect their mental and emotional health in a digital context. Building resilience and risk management skills is crucial, as students face an increasingly complex online environment.

The self-assessment results for learning and digital skill development competencies, encompassing 14 different criteria, are illustrated in Figure 6. The average score for this competency group was found to be $\overline{X} = 2.503$, with the highest average score observed for the criterion "Recognizing the importance of lifelong learning for personal development" at $\overline{X} = 2.585$. In contrast, the lowest average score within this group was for "Identifying and effectively using digital resources for learning purposes" at $\overline{X} = 2.585$.



Note: IPLN - Identifying Personal Learning Needs; CLA - Continuous Learning Awareness; IUDR - Identifying and Using Digital Resources; CALT - Choosing Appropriate Learning Tools; UTTM - Using Tools for Time/Task Management; MTF - Managing Time and Finances; OMD - Organizing and Managing Digital Information; UDTGI - Using Digital Tools for Gathering Information; CLDT - Collaborative Learning with Digital Tools; OPSK - Organizing, Planning, and Storing Knowledge; EELS - Establishing and Evaluating Learning Strategies; CTCI - Critical Thinking for Continuous Improvement; UDTAL - Using Digital Tools to Assess Learning.

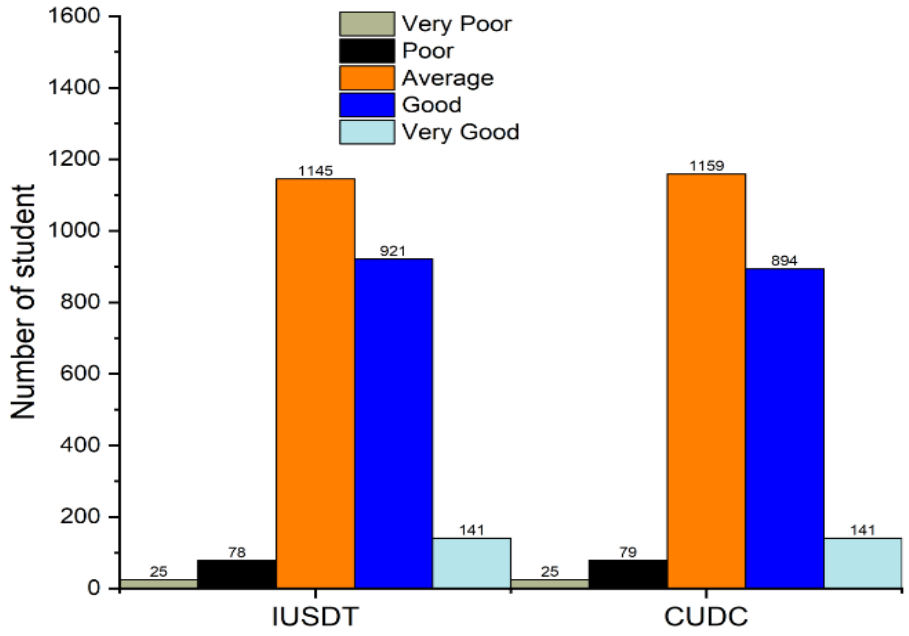
Figure 6. Self-assessment results of learning and digital skill development competencies

The survey results indicated that the majority of students rated their abilities on average, ranging from 43.5% to 48.8%. Additionally, the proportion of students who rated their competencies as poor ranged from 2.1% to 2.8%, whereas those who rated themselves as very poor ranged from 0.9% to 1.3%. Overall, these findings suggest that students perceive themselves as having moderate competencies in learning and digital skill development, with a small but noteworthy percentage acknowledging the significant challenges in this area.

The relatively high average score for recognizing the value of lifelong learning is encouraging, as it indicates that students understand the importance of continuous learning for personal and professional growth. This awareness is a critical foundation, as lifelong learning is essential in today's rapidly changing digital landscape, where technological advancements require individuals to constantly adapt and acquire new skills. However, it is concerning that the ability to identify and use digital learning resources effectively received the lowest average rating. This indicates that while students value learning, they may lack the practical skills or confidence to harness available digital tools and resources for effective learning.

The dominance of average ratings suggests that many students may be limited by traditional learning methods, which could restrict their ability to fully leverage digital tools for self-improvement and skill acquisition. The relatively low proportion of students who rated themselves as good or very good in this competency group further underscores the need for more structured support in fostering self-directed learning using digital resources. To bridge these gaps, educational institutions must prioritize fostering digital competence and independent learning skills, enabling students to confidently utilize digital resources for learning. Moreover, educational systems should provide more guidance and structured opportunities for students to explore and practice the effective use of digital learning platforms. Incorporating project-based learning, peer-to-peer teaching, and technology-integrated assignments could empower students to engage with digital resources more effectively. Institutions should also consider integrating explicit modules on digital resource management and strategies for self-directed learning, focusing on how to find, evaluate, and use digital tools to foster a growth mindset.

The self-assessment results for competencies in using digital skills for professional careers in Figure 7 reveal an average group score of $\overline{X} = 2.461$.



Note: IUSDT - Identifying and Using Specific Digital Tools; CUDC - Combining and Using Digital Content.

Figure 7. Self-assessment results of digital skills utilization competencies for professional careers

For the criterion "Identifying and using specific digital tools and technologies relevant to one's professional field," 1,145 students (50.3%) rated themselves at an average level, 921 students (40.4%) rated their abilities as good, and 141 students (6.2%) rated themselves as very good. Only 4.5% of students rated themselves as poor or very poor. The average score for this criterion was $\overline{X} = 2.465$.

For the criterion "Combining and using data, information, and digital content specific to one's professional field," 1,159 students (50.9%) rated themselves as average, 894 students (39.3%) rated themselves as good, and 141 students (6.2%) rated their abilities as very good. The percentage of students who rated themselves as poor or very poor was 4.6%. The average score for this criterion was $\overline{X} = 2.465$.

The results indicate that a significant proportion of students consider their digital skills for professional use, on average, with over half of the respondents placing themselves at this level for both criteria. This suggests that while there is a solid baseline understanding and use of digital tools and technologies relevant to their professional fields, there is still room for improvement to raise overall proficiency. The relatively lower percentage of students who rated themselves as "good" or "very good" implies that many are not yet fully confident in their ability to effectively integrate digital skills into their professional practice.

The finding that approximately 40% of students rated themselves as good and approximately 6% as very good shows that a considerable portion of the student population possesses above-average digital competencies, indicating potential for successful professional application.

However, the presence of approximately 4.5% to 4.6% of students rating themselves as poor or very poor in both criteria signals a gap that could hinder their readiness for professional settings.

These individuals may require targeted support, such as training sessions tailored to digital tools specific to their fields or mentoring programs focused on practical applications.

The results indicate that students in the northern mountainous region of Vietnam at Thai Nguyen University generally perceive their digital skills proficiency positively. The findings also reveal a decrease in self-assessed digital competence levels as the complexity of tasks and required skills increase. Specifically, students expressed a positive self-assessment regarding cybersecurity and safety competencies, suggesting that they are aware of and concerned about online security issues. This is a promising indication of awareness among these students' concerning cybersecurity in the digital age.

However, students from the northern mountainous region displayed lower confidence in more complex competency groups, such as digital content creation and problem-solving. This lack of confidence in more challenging competencies has a considerable impact on their ability to harness useful information from digital environments for learning purposes, as well as their ability to meet the demands of the current digital society. The ability of students to master information and communication technologies (ICT) is an essential prerequisite for developing digital competencies, which play an irreplaceable role in 21st-century higher education.

Therefore, the mastery of digital tools, coupled with conscious and in-depth usage, will be key to the success of students in general, and specifically for students from the northern mountainous region of Vietnam studying at Thai Nguyen University, as they prepare for the future. To meet the demands of their academic pursuits and future professional requirements in alignment with societal needs, each student, particularly those from the Northern Mountainous Region, needs to focus on continuously improving their digital skills.

Cultivating these competencies will empower them to effectively engage with the digital landscape, adapt to the evolving demands of the labor market, and thrive in an increasingly digitized world.

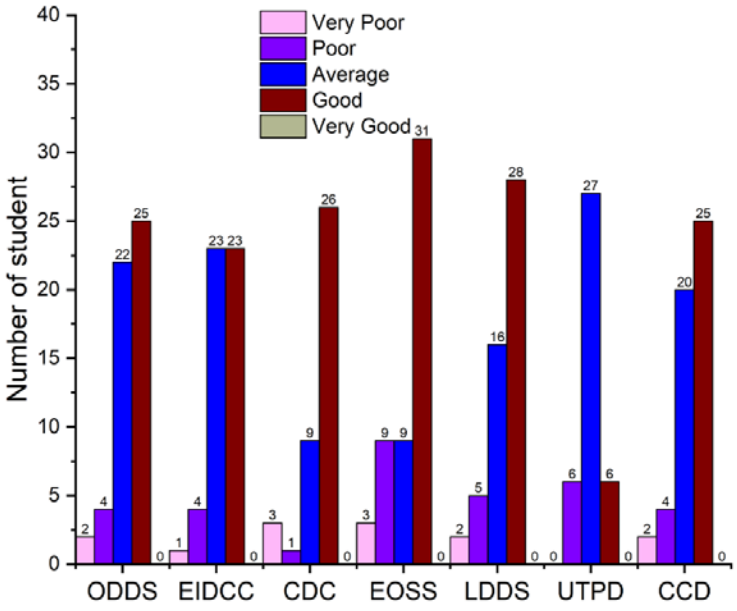
Institutions must also recognize the need for additional support and targeted interventions to strengthen students' proficiency in more advanced digital competencies. Providing structured opportunities for experiential learning, such as project-based learning that integrates digital technologies, can help bridge the gap between theoretical understanding and practical application.

Additionally, fostering a supportive learning environment that encourages students to explore, innovate, and take risks with digital content is vital for enhancing their overall digital competence.

By doing so, students will be better equipped to utilize the wealth of resources available in the digital environment, thereby enriching their learning experiences and expanding their professional capabilities.

4.2. Lecturer Evaluation of Digital Competencies among Students in the Northern Mountainous Region of Vietnam

To gain a more objective perspective on the current digital competencies of students from the northern mountainous region of Vietnam, the research team invited lecturer members who are directly involved in teaching at various member institutions of Thai Nguyen University to evaluate students' digital skills. The results obtained (Figure 8) provide an objective assessment of the current digital competencies of these students.



Note: ODDS - Operating Digital Devices and Software; EIDCC - Extracting Information and Data; Communicating and Collaborating; CDC - Creating Digital Content; EOSS - Ensuring Online Security and Safety; LDDS - Learning and Developing Digital Skills; UTPD - Using Digital Tools for Professional Development; CCD - Communicating and Collaborating Digitally.

Figure 8. Lecturer evaluation of digital competence among students from the Northern mountainous region of Vietnam

The survey results indicate that lecturer members generally rated the digital competence of students from the Northern Mountainous Region of Vietnam across all seven competency groups predominantly at an average level, with an overall score of $\overline{X} = 2.300$. A detailed breakdown of each digital competency group is as follows:

(1) Operating Digital Devices and Software: Lecturer evaluations indicated that 43.1% of students were rated at a good level and 7.8% at a very good level in operating digital devices and software. Meanwhile, 49.1% of lecturer members rated students' abilities as average, while 3.9% rated them as poor, suggesting a moderate level of competency in this area, with an overall average score of $\overline{X} = 2.528$.

(2) Extracting Information and Data: The evaluation of students' abilities to extract information and data showed that 45.1% of lecturers rated students at an average level, while an equal percentage rated them as good. This implies a relatively balanced distribution of skills in this area, with an overall average score of $\overline{X} = 2.412$.

(3) Creating digital content: Among lecturers, 51.0% rated students' skills as average, while 17.6% rated them as good. However, 19.6% of lecturers rated students as having poor or very poor abilities in creating digital content. This finding highlights significant gaps that need to be addressed to improve students' creative engagement with digital tools, with an overall average score of $\overline{X} = 2.095$.

(4) Ensuring Online Security and Safety: Lecturer evaluations of online security and safety competencies indicated that 19.6% of students were rated as having good skills, while 60.8% were rated as average. This suggests a general awareness of cybersecurity but a lack of advanced understanding and application, with an overall average score of $\overline{X} = 2.020$.

(5) Learning and Developing Digital Skills: Regarding students' ability to learn and develop digital skills, 54.9% of lecturers rated students at an average level, while 35.3% rated them as good or very good. However, 9.8% of lecturer members rated students' abilities as poor, indicating a need for greater emphasis on the continuous development of digital competencies, with an overall average score of $\overline{X} = 2.294$.

(6) Using Digital Skills for Professional Development: The evaluation of students' ability to utilize digital skills for professional purposes revealed that 52.9% of lecturers rated them as average, while 37.3% rated them as good or very good. Despite this, 11.8% of lecturer rated students' professional digital skills as poor, underscoring a gap between theoretical understanding and practical application in professional settings, with an overall average score of $\overline{X} = 2.308$.

(7) Communicating and Collaborating Digitally: Lecturer evaluations of students' ability to communicate and collaborate in digital environments indicated that 49.0% of the students were rated at an average level, while 43.1% were rated as good or very good. Only 7.8% of lecturer members rated these skills as poor, suggesting a relatively favorable level of competency in this area, with an overall average score of $\overline{X} = 2.392$.

Overall, evaluations of students' digital competence by lecturer members largely aligned with students' self-assessments, with the majority of students rating their competencies as average.

However, poor and very poor ratings were recorded across all competency areas, generally fluctuating around 9.0%. These findings underscore that while many students possess foundational digital competencies, a significant proportion still requires additional support to improve their skills, particularly in more advanced and applied areas such as digital content creation, cybersecurity, and professional digital skills utilization. Addressing these deficiencies is essential to ensure that all students are adequately prepared to meet the demands of a digital society.

To determine the current state of digital competencies among students from the Northern mountainous region at Thai Nguyen University, this study conducted a survey that collected data from 50 lecturers and over 2,220 students from this region who were currently enrolled at Thai Nguyen University.

The survey results indicate that approximately 50% of the students self-assessed their digital competencies at an average level across 50 criteria spanning 7 distinct competency groups of digital competence.

The average results of students' self-assessments and lecturer evaluations regarding students' digital competencies across the 7 competency groups.

Among the 50 criteria assessed, the criterion "Seeking opportunities for self-improvement in digital competence and practicing digital citizenship through appropriate technologies" received the highest self-assessment scores from students$\overline{X} = 2.821$. This result aligns with the characteristic motivation of students to grow and adapt within the digital landscape. Conversely, the criterion "Designing, developing, and issuing commands for computer systems to solve specific problems or tasks" received the lowest average self-assessment score $\overline{X} = 2.317$. This outcome is primarily due to students perceiving a significant gap between theoretical knowledge and its practical application.

The overall average scores for the seven digital competency groups, as assessed by both students and lecturer $\overline{X} = 2{,}294$, were below 2.5, indicating an intermediate level of competency. Notably, lecturer evaluations tended to be lower than students' self-assessments, reflecting a difference in perception regarding students' proficiency, particularly in areas requiring practical, hands-on experience.

When examining the seven digital competency groups, it was observed that competencies that are more straightforward to quantify, such as Group 1: Operating digital devices and software, Group 2: Extracting information and data, and Group 7: Using digital skills for professional development, showed minimal discrepancies between student self-assessments and lecturer (GV) evaluations. However, in the remaining groups, particularly Groups 3, 4, 5, and 6, the discrepancies were considerably larger.

The primary reason for this divergence is that these competencies require specific conditions or environments in which students can fully demonstrate their digital skills.

For example, students expressed relatively high confidence in their competencies in online security and safety: $\overline{X} = 2.585$, whereas lecturer evaluations were more conservative: $\overline{X} = 2.294$. Conversely, lecturer members tended to rate students higher ($\overline{X} = 2.528$) in operating digital devices and software, as their evaluations were primarily based on students' performance during practical sessions in a controlled academic setting $\overline{X} = 2.432$. In contrast, students who were also exposed to additional devices and software outside the university environment recognized that they still had much to learn and therefore rated themselves lower.

5. Conclusion

To evaluate the digital competencies (DC) of students from northern mountainous regions at Thai Nguyen University, the authors developed a specific assessment framework based on the European DigComp 2.1 framework and UNESCO's Global Reference Framework. This DC framework was structured to quantify the digital competencies of students at Thai Nguyen University in this region. Data from surveys conducted with 2,250 students and 50 lecturers revealed that, across all 50 criteria within the seven DC component groups, more than 50% of students self-assessed their digital competency as average or higher. The criterion "Seeking opportunities to enhance digital skills and engage in digital citizenship through appropriate digital technologies" received the highest self-assessment rating: $\overline{X} = 2{,}821$, reflecting student inclination. In contrast, the criterion "Designing, developing, and issuing commands for computer systems to solve specific tasks or problems" received the lowest self-assessment: $\overline{X} = 2{,}317$, indicating students''perception of a gap between theory and practice.

Several objective and subjective factors contribute to the current limitations in students' digital competency: (1) Most students are from mountainous regions where high school digital literacy training and access to digital tools are limited, resulting in lower initial digital competency levels upon entering university; (2) The current university curriculum offers limited support for developing students' digital literacy competencies, as foundational digital knowledge and skills are not comprehensively addressed; (3) The digital infrastructure, information technology equipment, network connectivity, and internet services at Thai Nguyen University member institutions remain limited;

(4) The digital literacy requirements for employment in northern mountainous localities are minimal, resulting in lower motivation among students to develop their digital skills further. These factors collectively hinder the development of digital competencies among northern mountainous students at Thai Nguyen University's member institutions.

Amidst Vietnam's national push for digital transformation, particularly in northern mountainous areas, graduates must acquire digital competencies that meet practical demands. Accordingly, it is essential to invest in enhancing digital literacy for these students. Based on an analysis of survey and interview results with students and lecturers, this paper proposes five solutions to improve the digital competencies of students in northern mountainous areas at Thai Nguyen University and across Vietnam more broadly during their academic studies: (1) raise awareness of the importance and role of digital literacy among university administrators, faculty, and students; (2) disseminate digital platform etiquette guidelines to students; (3) invest in facilities, equipment, and IT infrastructure to meet the digital competency requirements of university graduates; (4) integrate digital competency development content into the existing Thai Nguyen University curriculum and organize digital competency training for students and faculty; and (5) establish policies to encourage and support faculty and students in improving digital competencies.

Moreover, as a multidisciplinary university with over 250 undergraduate programs preparing graduates for a wide range of fields, Thai Nguyen University would benefit from additional research to specify digital competencies tied to specific employment roles. This approach would allow for targeted surveys and in-depth analyses of digital competencies across various academic disciplines at Thai Nguyen University.

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