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Exploring the Digital Skills Gap Among Bachelor Students: Challenges and Opportunities for Improvement

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Abstract: Digital skills have become an essnstial element for future educators to effectively utilize technology in learning. This article explore the digital skills gap among pre-service teacher. Through a combination of literature reviews and surveys with students, this research identified level of digital skill: basic, intermediate and advance among pre-service teacher to explore challenges and opportunities for improvement across department. Research result obtained variation and that overall digital skills mastery still needs significant improvement. This research identified challenges in enhancing digital skill the pre service-teacher included eliminating the perception that technology is not a priority for pre service teachers, limited time and resource available for formal courses. There found several strategic opportunities in imporvemnet digital skill of pre-service teacher, including innovating the teacher education curriculum by integrating digital pedagogy and technology-enhanced learning modules, leveraging available technologies such as learning management systems, augmented reality, virtual reality and AI-based tools for instructional practice, and forming partnerships with schools, edtech providers, and government agencies to provide hands-on digital training and sustainable support systems.

Keywords: Advance digital skill; Basic digital skill; Digital skill gap; Intermediate digital skill

Introduction

In the digital era, ICT has brought major changes in work patterns, information access, social interactions, and creativity. It has also significantly impacted the education sector (Balaban et al., 2023; Mualla & Mualla, 2024; Saif et al., 2022). Technology now allows people to access education from anywhere through online learning, multimedia and platforms and become an integral component of the modern education system (Sato et al., 2023; Global Education Monitoring Report, 2023; Vishnu et al., 2024; Ghanbaripour et al., 2024; Onu et al., 2024). Technology is no longer merely a supplementary tool in education. Without technology, learning becomes more passive and less engaging, potentially lowering student motivation and overall learning outcomes. It shows that everyone must be able to adapt the ICT advancements by effectively using technology, as well as evaluating and communicating information efficiently. This capability is referred to as digital literacy skills (Schulz et al., 2022; Themes, 2013; Tinmaz et al., 2022; UNESCO, 2011).

Proficiency in digital skills will equip individuals to tackle future challenges, including shifts in job types (Li, 2022; Vasile, 2023), the rapid advancement of technological innovations (Mahmud & Wong, 2022) and the growing access to information (Theben et al., 2023). Therefore, developing digital skills comprehensively is essential to ensure individuals are prepared to thrive in today's increasingly digital landscape.

In the framework for developing Indonesia's digital literacy curriculum, digital skills are one of the key pillars of digital literacy, the others include digital ethics, digital safety, and digital culture (Ameliah et al., 2022). By contrast, Indonesia is a country with high internet users, at least 69.21% of Indonesia's population are

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internet users in 2023 (BPS, 2023). Likewise, digital skills in Indonesia remain highly varied and have yet to reach an even distribution (SMERU, 2022). It's research state that, there is a significant gap between basic, intermediate and advanced digital skills. In the research found addition, the low digital literacy rates in Indonesia correspond to its weak performance in fundamental literacy skills.

Most studies in the field of digital skill carried out the general digital skill in small survey (Damuri et al., 2022) or specific on digital trained worker (Gayatri et al., 2022), very few studies have explicitly measured the digital skills of education students at various levels (basic, intermediate, and advance). For pre-service teachers, possessing basic and intermediate digital skills is essential for all, as these competencies are directly applicable to everyday teaching activities and classroom technology requirements. However, advanced digital skills offer a valuable advantage for students aiming to build careers as innovators or developers in the field of technology-enhanced education (Youssef et al., 2022; Santos et al., 2023). Students' levels of digital skills often vary depending on several factors, such as their educational background (Tzafilkou et al., 2022), the program of study they are enrolled in (Zhao et al., 2023), and their access to technology include the availability of technology facilities and resources (Cabero-Almenara et al., 2023; Tulinayo et al., 2018). Further, students in specific academic programs may exhibit higher levels of digital proficiency compared to others. For example, science-related programs often benefit from superior resources, including laboratories for science and computing, as well as specialized software, resulting in a deeper integration of technology into their learning activities (Holm, 2024; Vieira et al., 2023). This gap presents a challenge for educational institutions in ensuring that every student possesses adequate digital skills, whether at the basic, intermediate, or advanced levels.

Anyhow, basic research on the digital skills gap among bachelor students is essential for designing targeted strategic interventions, in this research focus on pre-service teacher. Without a deep understanding of the actual situation, interventions are likely to be generalized and less effective. In the future, they require digital skills to effectively integrate technology into the learning process, including the use of platforms (Zervas & Stiakakis, 2024), management of online classes (Hongsuchon et al., 2022), and the development of digital-based instructional materials (Dogan et al., 2021).

To achieve these goals, we outlined objectives according to the following research questions: how are digital skill levels distributed among pre-service teachers, what challenges and opportunities can be leveraged to improve the digital skills at the basic, intermediate, and advanced levels?

Digital Skill Framework

Digital skills are categorized into three levels: basic, intermediate, and advanced (Helsper et al., 2021). The basic skills refer to fundamental competencies in using digital devices, such as handling hardware, simple software, and basic online operations. Intermediate skills encompass more advanced abilities in using software or digital platforms, along with a deeper understanding of specific technologies, such as simple data analysis using basic programming, digital content management, or the use of graphic design software. Advanced skills involve a more specialized and comprehensive understanding of technology, including the ability to develop and manage complex technological systems, such as advanced coding, application development, machine learning, and cybersecurity.

Table 1. Scope of digital skills for each level

Level	Skills
Basic	Ability to use hardware (computer, smartphone, or tablet); Ability to use basic word processing and spreadsheet software (Microsoft Word and Microsoft Excel); Basic online operations (email, searching for information online).
Intermediet	Ability to use digital platforms; Basic programming skills; Digital content management; Use of graphic design software and digital marketing tools.
Advance	Programming and network management; Data science and Big Data; Artificial intelligence and machine learning; Internet of Things (IoT); Development of AR/VR and Mixed Reality; Mobile app development; Blockchain technology.

Method

Context of Study

This research was conducted by a survey at Faculty of Teacher Training Universitas Samudra in August 2024. The survey aimed to assess and categorize students' digital skills across the basic, intermediate, and advanced levels.

Participant

According to faculty data, Faculty of Teacher Training has a population of around 2385 active students. There are 10 departments, i.e., biology education, chemistry education, physics education, mathematics education, geography education, history education, Indonesian education, english education, elementary teacher education, and sports physical education. The research permit was submitted to the dean of the Faculty of Teacher Training and coordinators of department.

The participants who complete the questionare were 540 students which distributed to all undergraduate departments in Faculty of Teacher Training. The sample size for each study program varies as it is contingent upon the number of actively enrolled students within the respective program. It is ensured, however, that the samples represent at least 10% of the active student population in each program.

Table 2. Participants education profile (N = 540)

Department	N%
Biology education	12
Chemistry education	3
Physics education	7
Mathematics education	4
Geography education	17
History education	3
Indonesian education	13
English education	9
Elementary teacher education	14
Sports physical education	18

Procedure

A questionnaire distributed in an online version was provided to undergraduate students of Faculty of Teacher Training Universitas Samudra using SurveyHeart App. The questionnaire asked for information on basic digital skill, intermediated digital skill and advance digital skill, also student's academic profile. The questionnaire items measured on Likert scale.

Research Instrument

A 30-items instrument was designed based on basic digital skill, intermediated digital skill and advance digital skill. The instrument was extended from digital skill indicator provide by decent jobs for youth, and breakdown to digital skills for faculty of teacher training' students. Table 4 show the scope of digital skills for faculty of teacher training' students.

Table 3. Reliability and validity of instrument for digital skill

Type/Level	Cronbach's Alpha
Basic	0.791
Intermediate	0.754
Advance	0.713

The instrument composed of 10 items for each level digital skill. This instrument validated by experts before distribution. Then instrument evaluated in reliability, validity and consistency. The evaluation was applied through a confirmatory factor analysis approach using. All the Cronbach's alpha value in Table 3 showed the internal consistency (> 0.7).

Table 4. Scope of digital skills for faculty of teacher training' students

Level	Skill
Basic	Using hardware (computer, smartphone, or tablet); Using basic software (word processing in Word, spreadsheets in Excel, and presentations in PowerPoint); Basic online operations (email, searching for information online); Communicating and collaborating online via platforms like Google Meet, Zoom, and learning platforms.
Intermediet	Managing a Learning Management System (LMS); Integrating multimedia (videos, audio, and images) into teaching materials; Using collaborative applications like Google Docs, Padlet, and Trello; Using digital learning applications like virtual labs; Utilizing applications for learning evaluation such as Quizizz; Designing and managing digital learning content using applications like Canva or others; Analyzing simple data through statistical applications to monitor student progress and learning performance.
Advance	Basic programming (coding) or creating simple applications; Developing digital learning experiences for immersive learning, such as AR and VR; Managing large-scale data to analyze student performance or create data-driven learning systems; Conducting research in the field of educational technology.

Data Analysis

Each departmen and skill level is associated with a score, maximum value, minimum value, and standard deviation. The mean score is derived from the values obtained from students or participants, while the standard deviation quantifies the extent of variation or dispersion from the mean. This metric offers insight into the variability in digital competencies across different skill levels. Subsequently, the data for each level (basic, intermediate, and advanced) are classified into categories of low, moderate, and high proficiency. Due to variations in sample sizes across the departments, the range of values for these categories differs, corresponding to the upper and lower threshold values.

Result and Discussion

As shown in Table 5, every department in teacher training faculty expressed different category of digital skills in level basic, intermediate dan advance. Then Table 6 show the desciptive statistic regarding Digital Skill of pre-service teacher in techer training faculty.

Table 5. Descriptive statistic regarding digital skill on each department in faculty of teacher training

Departmen	Level	Max	Min	Score	Std. Deviation	Inf
Biology education	Basic	2040	680	1560	0.74	Moderate
	Intermediate	2040	680	1329	0.77	Moderate
	Advance	2040	680	816	0.41	Low
Chemistry education	Basic	510	170	376	0.83	Moderate
	Intermediate	510	170	329	0.81	Moderate
	Advance	510	170	213	0.51	Low
Physics education	Basic	1080	360	955	0.55	High
	Intermediate	1080	360	792	0.76	Moderate
	Advance	1080	360	490	0.57	Low
Mathematics education	Basic	600	200	481	0.72	High
	Intermediate	600	200	404	0.83	Moderate
	Advance	600	200	258	0.54	Low
Geography education	Basic	2700	900	1888	0.76	Moderate
	Intermediate	2700	900	1621	0.73	Moderate
	Advance	2700	900	1086	0.50	Low
History education	Basic	510	170	376	0.72	Moderate
	Intermediate	510	170	313	0.71	Moderate
	Advance	510	170	186	0.30	Low
Indonesian education	Basic	2070	690	1480	0.72	Moderate
	Intermediate	2070	690	1307	0.74	Moderate
	Advance	2070	690	806	0.38	Low
English education	Basic	1470	490	1160	0.76	High
	Intermediate	1470	490	948	0.80	Moderate
	Advance	1470	490	446	0.31	Low
Elementary teacher education	Basic	2280	760	1632	0.76	Moderate
	Intermediate	2280	760	1368	0.75	Moderate
	Advance	2280	760	891	0.40	Low
Sports physical education	Basic	2940	980	2235	0.73	Moderate
	Intermediate	2940	980	1643	0.62	Moderate
	Advance	2940	980	1277	0.56	Low

Table 6. Descriptive statistic regarding digital skill on teacher training faculty

Level	Max	Min	Score	Std. Deviation	Inf
Basic	16200	5400	12146	0.75	Moderate
Intermediate	16200	5400	10054	0.75	Moderate
Advance	16200	5400	6573	0.47	Low

Digital Skill Among Pre-Service Teacher Across Different Department

Biology education students have the potential to achieve all three levels of digital skills -basic, intermediate, advanced- in “high” category. or both the basic and intermediated levels, the skills that need to be mastered are general in scope, as mentioned earlier. Meanwhile, for advanced levels, special skills are needed related to specific software such as MEGA (Molecular Evolutionary Genetics Analysis) software which is used for analyzing genetic data and DNA sequences (Kumar et al., 2018), PyMOL for visualization of protein and molecular structures (Rosignoli & Paiardini, 2022), PyRx for studying binding mechanisms between ligands and receptors (Houshmand & Houshmand, 2023), and Swiss Model for constructing protein structures (Krebs & Zoete, 2023) and Python for analysis of experimental or research data (Badenhorst et al., 2019), where analyzing experimental data using Python requires an understanding of the programming language (coding). Other digital skills for advanced level include the use of digital microscopy for image and video analysis of cells and tissues of organisms (Zhao et al., 2023), development of AR/VR content for learning biology (Chauhan et al., 2024), use of Biology databases such as NCBI (Wang et al., 2023), AI to analyze patterns in biological data such as species classification, genetic patterns or prediction of ecosystem outcomes (Han & Liu, 2019), and development of geographic information systems (GIS) for ecological studies (Ramesh et al., 2024). But according to the results (Table 5), almost all students have never developed skills at the advanced level. Instead, digital skills at the basic and intermediate levels only reached the “moderate”. This study explored and identified several reasons for the inadequate digital skills within the biology education department. Key factors include a curriculum that does not facilitate the development of advanced digital skills, limited availability of technological facilities and resources, and a lack of formal training in advanced skills. Moreover, the program is primarily oriented towards basic and intermediate skills to aid in mastering course content. Furthermore, students seldom perform simple data analyses using Excel or manage paper references using Mendeley.

Intermediate digital skills for chemistry education students can include the ability to use ChemSketch or ChemDraw simulation software to draw molecular structures or chemical reactions (Marpaung et al., 2021), the ability to use specialized chemical databases such as PubChem or the American Chemical Society (ACS) to search for data on chemical compounds or reactions (Kim et al., 2023), the ability to use Avogadro platform to model 3D molecular structures and predict molecular properties (Pushpalatha et al., 2023). While advanced digital skills include the ability to use advanced simulation software such as GROMACS, LMMPS or AMBER which can be used to model interactions between molecules at the atomic level (Thielemann et al., 2019; Deshchenya & Kondratyuk, 2023), the ability to use Gaussian quantum chemistry software (Mohapatra et al., 2021), ORCA or GAMESS which can be used for simulation and calculation of molecular electronic structures (Fedorov, 2021), and the ability to use Monte Carlo simulation software to model complex chemical systems (Liu et al., 2021). Furthermore, the ability to master programming languages to analyze complex chemical data, the ability to use AI and machine learning algorithms to predict the results of chemical reactions (Kapustina et al., 2024), the ability to use GIS for spatial analysis of chemical environments such as pollutant distribution, water and soil quality, the ability to analyze big data for chemical research (Bari et al., 2023), the ability to use digital spectroscopy tools such as Nuclear Magnetic Resonance (MR), UV-Vis, FTIR, and Mass Spectrometry, the ability to create and manage chemical databases (Guo et al., 2020), and the ability to develop AR/VR content for chemistry learning (Abdinejad et al., 2021). The curriculum within the chemistry education program includes courses in computational chemistry, which are designed to facilitate the acquisition of advanced digital skills. However, as evidenced by the data in Table 5, these advanced digital skills are rated as 'low,' while basic and intermediate digital skills are assessed at a 'moderate' level. Upon further examination of the curriculum in the chemistry education program, it becomes apparent that it does not emphasize advanced skills extensively. Instead, the courses primarily concentrate on chemical theory and pedagogy. Additionally, the implementation of software for molecular dynamic modeling and big data analysis is hindered by the unavailability of the necessary hardware on campus. The heightened difficulty and complexity associated with these advanced skills deter students, who favor simpler skills that are readily applicable to their routine tasks. Students in the chemistry education study program predominantly view their future roles as educators, often overlooking other relevant career profiles that graduates could pursue.

Based on the data in the Table 5, physics education students' basic digital skills have reached a “high” category, while intermediate digital skills have reached a “moderate” category and advanced digital skills are still “low”. At the basic level, it indicates that students are very familiar with the use of office tools such as word, excel and powerpoint. They always use these tools for daily tasks, such as compiling scientific papers, making laboratory reports, making presentation slides by utilizing the animation feature in powerpoint, and processing data and making graphs using excel. Physics practicums frequently require the presentation of data through graphical formats, which indirectly cultivates proficient basic digital skills among students. At the intermediate level, students demonstrate a satisfactory proficiency in digital skills, falling within the “moderate” category. This proficiency includes skills such as utilizing PhET simulations (Banda & Nzabahimana, 2023) and trackers to analyze object motion via video (Sarkar, 2022). Additionally, students at this level are adept at using online collaboration tools like Padlet (Chen, 2022), creating 2D animations with Canva, developing quizzes for educational assessment via the Quizizz application, and effectively employing artificial intelligence to assemble instructional materials. This enhancement in intermediate digital skills is facilitated by media and ICT literacy courses integrated into physics education, which bolster skill development at this level. Conversely, at the advanced level, the digital skills of physics students remain deficient, primarily due to inadequate time allocation for advancing these skills. The program includes two courses aimed at enhancing advanced digital skills: computational physics and data science, along with independent study. In the computational physics course, students learn fundamental programming and the application of Matlab for addressing physics-related problems. The data science course introduces students to Python for the statistical processing and visualization of simple physics data. Nonetheless, there is a lack of enthusiasm among students to engage deeply in these areas, as the majority aspire solely to become educators, a role perceived to require less advanced skills.

The digital skills profile of students in the mathematics education study program mirrors that of their counterparts in the physics education program, with basic skills rated as "high," intermediate skills as "moderate," and advanced skills as "low" (refer to Table 5). Specific intermediate digital competencies acquired include using Geogebra for modeling and visualization (Ziatdinov & Valles, 2022), SPSS for statistical analysis, and Mendeley for reference management. However, only a minority of students have developed advanced digital skills, such as solving mathematical problems using MATLAB. To elevate advanced digital skills within student education programs, more rigorous efforts are required. These include enhancing problem-solving capabilities through machine learning tools like TensorFlow or PyTorch (Dai et al., 2022), analyzing big data with Apache Spark or Hadoop, visualizing big data through Tableau (Gabdullin et al., 2024), and simulating complex mathematical systems with NetLogo or AnyLogic (Paris et al., 2018).

Students enrolled in the geography education study program require intermediate and advanced digital skills to facilitate their learning and enable the analysis, visualization, and prediction of complex geographic phenomena. Suitable intermediate digital skills for these students to cultivate include the utilization of ArcGIS for visualizing simple spatial data (Vaart et al., 2024), remote sensing techniques for image analysis (Degerli & Çetin, 2022), Digital Elevation Models (DEM) for analyzing topographical slopes and rainfall patterns (AL-Areeq et al., 2023), GPS technology for collecting spatial data in the field (Ma et al., 2024), and Google Earth Pro for creating simple 3D maps. These competencies are essential for their academic and professional development in geographic studies. or more sophisticated tasks, geography education students should develop advanced digital skills such as using Geographic Information Systems (GIS) for complex spatial analyses, hydrological modeling, and disaster hazard assessments. This includes proficiency in ENVI software for satellite image processing (Abbas et al., 2024) utilizing the Blender application for visualizing 3D geospatial data, conducting big data analysis within GIS, applying artificial intelligence for satellite image interpretation and geospatial predictions (Song et al., 2023), and developing web-based GIS applications. However, according to the data presented in Table 5, these students currently exhibit a low proficiency in advanced digital skills. To align with the expected graduate profiles—such as geography teachers, disaster analysts, environmental analysts, and learning technology developers—the geography education programs must enhance both intermediate and advanced digital skill levels among their students.

Relative to other social sciences, students in history education programs exhibit lower proficiency in digital skills at the basic, intermediate, and advanced levels. History education department primarily emphasize the analysis of primary and secondary textual sources, including historical documents, books, letters, and other archival materials. Consequently, history students tend to rely on traditional methods such as text reading, literature research, and narrative construction. Given the focus on narrative studies, which require extensive interpretation of narratives, events, and chronologies, digital skills related to statistical data analysis are deemed less critical for their academic pursuits. History students generally lack specific intermediate and advanced digital skills. At the intermediate level, their skills are largely foundational, including the use of the Google Classroom platform for educational purposes, video creation with Canva, conducting Zoom meetings, and utilizing Quizizz for assessments. However, tools like Omeka or ArchivesSpace, which facilitate the creation of simple digital archives, could enhance these intermediate digital competencies. Despite these opportunities, advanced digital skills among history students remain categorized as "low" (refer to Table 5). History education programs could enhance these advanced skills by incorporating the use of Geographic Information Systems (GIS) and 3D modeling for historical reconstructions, employing text mining for textual analysis in historical sources (Brown & Shackel, 2023), developing augmented reality (AR) or virtual reality (VR) content to create immersive historical environments (Zhang et al., 2024), utilizing big data techniques for analyzing extensive historical datasets, and applying artificial intelligence (AI) to process large historical archives.

The proficiency of Indonesian language education students aligns with that of students in other programs, with intermediate digital skills including the use of electronic dictionaries and Grammarly for text checking. These skills are categorized as "moderate" on average (see Table 5), indicating a variance in skill distribution among students within the program. The curriculum in Indonesian language education shows a notable deficiency in integrating technology into its learning processes, which contributes to the "low" level of advanced digital skills observed. To enhance these advanced skills, students could benefit from learning to use text analysis tools such as Voyant Tools and AntConc for handling large volumes of text (Alhudithi, 2021), spaCy for natural language processing (Wiącek et al., 2024), and developing augmented reality (AR) or virtual reality (VR) content to foster interactive learning environments in Indonesian language education.

Students in the English education department exhibit digital skills that are largely comparable to those observed in Indonesian language education programs. At the basic level, however, English education students achieve a "high" category, reflecting their frequent use of technology in daily coursework and learning processes. To further enhance their advanced-level skills, students could benefit from employing Voyant Tools for the analysis of English literature texts (Rothwell et al., 2023), utilizing Natural Language Toolkit (NLTK) for the automatic analysis of English texts (Spring & Johnson, 2022), developing mobile applications tailored to English learning, and creating web-based electronic dictionaries. These advancements would significantly bolster their digital competencies in the field of English education.

The curriculum of the primary school teacher education (PSTE) department, primarily focuses on fostering the fundamental competencies required to become an elementary school teacher. This includes an emphasis on developing traditional teaching skills and interpersonal abilities, such as classroom management and effective communication with students. Consequently, the integration of advanced digital technologies is not a priority within this curriculum framework. This approach aligns with the professional expectations for prospective elementary teachers but results in an average level of digital skills among students in PGSD that does not attain a high category. The PSTE study program incorporates STEM education at the elementary level, necessitating the development of digital skills to effectively implement this curriculum. Therefore, it is essential for students to enhance their digital competencies to support STEM learning in elementary schools. Suitable digital skills for this educational context include the creation of multimedia content and simple animations with Canva, the development of augmented reality (AR) content to visualize STEM concepts, the use of Scratch for introductory programming aimed at elementary students, and the application of LEGO and mini robots for teaching foundational robotics and engineering principles (Araujo et al., 2024; Kalaitzidou & Pachidis, 2023). These skills are critical for facilitating a robust STEM education in elementary settings.

Department of Physical, Sports, and Health Education (PSHE) primarily concentrate on cultivating physical abilities. However, with the advent of technologies capable of measuring physical performance—such as smartwatches and fitness trackers—and monitoring nutritional intake through applications like MyFitnessPal, Yazio, and Lose It, there is a growing need for proficiency in utilizing these technologies (Weech et al., 2023). Such capabilities are considered part of the digital skills required for PSHE tudents, where their competency is currently assessed as moderate. To enhance their digital skills further, PSHE students could benefit from learning to use software like Dartfish, Kinovea, or Coach's Eye for movement analysis (Slopecki et al., 2023), as well as tools designed for injury rehabilitation. This development of digital skills is crucial for effectively integrating technology into their professional practice.

Challenged in Enhancing Digital Skill

Based on the background of the existing study programs in Faculty of Teacher Training the cause of the low digital skills of FETT students has been found. These causes are a challenge for Faculty of Teacher Training in improving students' digital skills.

Challenge 1 – Eliminating the perception that technology is not a priority for Faculty of Teacher Training students (pre-service teachers) can be considered the first challenge in enhancing digital skills. Students often overlook that departments in FETT are not solely focused on producing teachers; there are other graduate profiles related to the content of each program. For example, science programs such as biology, chemistry, physics, and mathematics offer additional career paths, including researcher, lab technician, instructional content developer, and entrepreneur. Achieving these profiles requires not only basic and intermediate digital skills but also advanced skills. For instance, researchers need proficiency in using statistical data analysis software or Python for processing large datasets, while content developers must be skilled in creating instructional materials such as e-modules, video tutorials, interactive quizzes, and AR/VR-based digital media production. Similarly, even though social science programs, particularly history education, may tend to use traditional methods, they can still benefit from technology to archive and analyze historical data sources and develop VR environments to create immersive historical experiences. This is applicable to other programs as discussed in previous chapters. The key point is that the perception that technology is not a focus of Faculty of Teacher Training must be dispelled.

Challenge 2 – The limited time available for formal learning in courses related to digital practice presents another significant challenge. As mentioned earlier, students from science programs tend to have more practical experience with technology compared to those in social science programs, which contributes to the disparity in digital skill levels between study programs. However, this gap should not appear at the basic and intermediate levels, as the technologies at these levels are relatively easy to integrate into courses. The gap may arise due to insufficient integration of basic and intermediate technology in the learning process. A solid understanding of technology by lecturers is also essential so that students can become accustomed to using it. It is undeniable that some lecturers are less adaptive to the rapidly evolving technology. Therefore, a strong motivation among lecturers is also needed to effectively integrate technology into their teaching practices.

Challenge 3 – Faculty of Teacher Training students (pre-service teachers) come from a wide range of economic backgrounds, with many not owning personal computers or laptops, and some even lacking smartphones. These resource limitations hinder students' ability to develop their digital skills. While students can access computers or submit assignments involving technology by using rental services or other means, this option is inadequate for advancing their skills. On the other hand, the university provides computer lab facilities, but the time allocated for lab use is limited. Technological practice should ideally be integrated not just into one or two courses but across all courses, which is impractical with limited lab access. The resource challenges described here primarily affect the basic and intermediate skill levels. However, advancing to the next level requires computers with higher specifications and more demanding applications. Most of the devices owned by students and the university are standard machines suitable only for daily tasks. For example, developing AR and VR technologies requires high-performance computers and heavy software like Blender and Unity.

Opportunities to Improve Digital Skill

Faculty of Teacher Training has several strategic opportunities to enhance its students' digital skills, including curriculum innovation, leveraging available technology, and forming partnerships. The current curriculum in departmentes of Faculty of Teacher Training is designed to align with advances in science and technology. While each departments offers courses dedicated to educational technology, curriculum innovation requires that technology be incorporated into all courses, not just those specifically focused on it. This integration should extend to both core and elective courses (Parsons et al., 2020). Moreover, the emphasis on team-based projects and the case method across all courses in higher education presents an opportunity to integrate digital skills into the curriculum. By engaging students in solving projects and case studies through the use of digital technologies, they are encouraged to develop familiarity with digital tools as part of their learning (Balleisen et al., 2024). This approach helps establish technology not as a supplementary tool but as an essential and integral element of the educational process. As a result, it is essential for every course to integrate theoretical knowledge with practical applications of digital technology in a more holistic way. In this regard, what is required is a commitment from educators to fully integrate technology into their teaching. Mostly, the primary limitations in technology utilization stem from the insufficient adaptation of teaching staff. In certain cases, providing intensive training for instructors on the effective use of educational technology is necessary.

In terms of technological facilities, Samudra University has developed a new Learning Management System (LMS) called SPADA UNSAM, though it has not yet been fully utilized. The LMS has the potential to become a central platform and a key opportunity for enhancing students' digital skills in their daily learning activities, especially at the intermediate level. SPADA UNSAM can facilitate the distribution of course materials, assignment management, online discussions, and digital-based assessments. Fully integrating the LMS into the learning process will help students become more proficient with digital platforms and tools that are widely used in contemporary education (Simelane-Mnisi, 2023). To improve students' digital skills, each lecturer could incorporate the LMS into their course delivery. Lecturers should be encouraged to make more extensive use of the LMS, particularly for tasks like assignment management, content delivery, and online discussion forums. By doing so, students will gain valuable experience working within a digital learning environment that reflects the demands of 21st-century education.

Additionally, the university has partnerships with industries and government institutions that could be more effectively implemented. Through these partnerships, the university could offer specialized training programs aimed at advancing digital skills, such as training in AR or VR application development. These programs will not only improve students' technical competencies but also create opportunities for employment and internships in rapidly growing industries (Kayyali, 2024). By engaging industry partners and government more actively, pre-service teacher can benefit from direct insights from professionals in the field and gain exposure to technologies commonly applied in the professional environment. Partnerships with educational technology providers can offer training and certification programs for lecturers, helping them improve their ability to integrate technology into their teaching practices. These certifications provide professional validation, enhancing lecturers' credibility. As a result, lecturers will be better equipped to deliver high-quality education to their students. Additionally, the university can engage in partnerships to facilitate the provision of media and technological infrastructure that enhances digital learning (Vishnu et al., 2024). Consequently, the partnership between Universitas Samudra and various technology providers offers a valuable opportunity for the university to strengthen students' digital competencies.

Conclusion

Research result obtained variations of digital skill mastery at each level among pre-service teacher. The average basic and intermediate digital skills of pre-service teachers fall under the 'moderate' category, and for advance digital skill are categorized as 'low'. Overall digital skills of pre-service teacher still require significant improvement and focused attention. This is necessary to align students' abilities with the graduate profiles of each study program, which extend beyond preparing future teachers. This research identified 3 challenges in enhancing digital skill the pre service-teacher: eliminating the perception that technology is not a priority for pre service teachers, limited time available for formal learning in courses related to digital practice, and limited resources. There found several strategic opportunities in imporvemnet digital skill of pre-service teacher, including: innovating the teacher education curriculum by integrating digital pedagogy and technology-enhanced learning modules; leveraging available technologies such as learning management systems, augmented reality, virtual reality and AI-based tools for instructional practice; and forming partnerships with schools, EdTech providers, and government agencies to provide hands-on digital training and sustainable support systems. The overall digital skills of FKIP students still require significant improvement and focused attention. This is necessary to align students' abilities with the graduate profiles of each study program, which extend beyond preparing future teachers. Skills initially acquired by some students through training should be further developed and shared with others. Establishing small communities focused on specific skills is essential to ensure these abilities are maximized and sustained. For instance, forming a community dedicated to the development of AR and VR-based instructional media, where members regularly engage in informal activities to create AR/VR products, could foster continued growth and innovation.

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The authors declare no conflict of interest.

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