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Digital Competencies of Pre-Service Teachers in Indonesia: Are They Qualified for Digital Education?

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Abstrak

Saat ini, pendidikan membutuhkan calon guru yang memiliki kompetensi digital untuk merencanakan, menjalankan, dan mengevaluasi proses pembelajaran yang lebih baik. Namun, masih sedikit penelitian yang menyelidiki secara menyeluruh mengenai kompetensi digital mahasiswa calon guru di Indonesia dalam konteks pendidikan digital terutama untuk mahasiswa calon guru Fisika. Artikel ini bertujuan untuk mengevaluasi kompetensi digital mahasiswa calon guru di Indonesia dalam konteks pendidikan digital. Penelitian ini merupakan penelitian kuantitatif. Metode survei digunakan untuk mengumpulkan data dari mahasiswa dan alumni program studi Pendidikan Fisika dari tahun 2017 hingga 2022. Total 248 responden terlibat dalam penelitian ini, dengan 202 mahasiswa dan 46 alumni. Data yang terkumpul kemudian dianalisis secara kuantitatif. Hasil penelitian menunjukkan bahwa mayoritas responden menunjukkan respons positif terhadap kemampuan mereka dalam semua dimensi kompetensi digital yang dinilai. Literasi informasi dan data, komunikasi dan kolaborasi, penciptaan konten digital, keamanan, serta pemecahan masalah mendapat penilaian yang baik. Namun, terdapat potensi untuk meningkatkan kemampuan dalam penciptaan konten digital. Secara keseluruhan, responden menunjukkan tingkat kompetensi yang baik dalam indikator kompetensi digital yang dinilai. Data juga menunjukkan bahwa mahasiswa dan alumni telah terbiasa menggunakan teknologi dalam kegiatan akademik. Mereka menggunakan Learning Management System (LMS) untuk mengakses materi kuliah, mengumpulkan tugas, dan mengikuti ujian. Selain itu, mereka juga menggunakan berbagai aplikasi dan bekerja secara online dalam kelompok. Program studi ini juga memberikan mata kuliah yang mendukung penggunaan teknologi dalam pembelajaran.

Kata kunci: *Digital Competencies, Digital Education, Physics Education, Pre-Service Teachers, Survey Research*

Abstract

In order to organise, carry out, and evaluate improved learning processes, education currently demands that prospective teachers have digital capabilities. However, there is still a lack of research that comprehensively examines, within the framework of digital education, the digital competences of prospective teacher students in Indonesia, particularly for those specialising in Physics teaching. The purpose of this article is to assess Indonesian prospective teacher students' digital literacy within the framework of digital education. The study's methodology is quantitative. A survey method was used to collect data from students and alumni of the Physics Education program from 2017 to 2022. A total of 248 respondents participated in the study, including 202 students and 46 alumni. The collected data were then analyzed quantitatively. The research findings indicate that the majority of respondents showed a positive response to their abilities in all assessed dimensions of digital competencies. Literacy in information and data, communication and collaboration, digital content creation, safety, and problem-solving received favourable ratings. However, there is potential to improve skills in digital content creation. Overall, the respondents demonstrated a good level of competence in the evaluated digital competency indicators. The data also revealed that students and alumni of the Physics Education program are accustomed to using technology in their academic activities. They utilize Learning Management Systems (LMS) to access course materials, submit assignments, and take exams. Additionally, they employ various applications and collaborate online in groups. The program also offers courses that support the use of technology in learning.

Keywords: Digital Competencies, Digital Education, Physics Education, Pre-Service Teachers, Survey Research

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1. INTRODUCTION

Currently, digital technology has emerged as a promising and powerful tool with transformative potential in the field of education, enabling the attainment of new educational objectives. There is a strong argument for replacing traditional teaching practices with technology-based learning and instruction tools, as the use of technology in education holds

great potential (Rachmadtullah et al., 2023; Rahim et al., 2023; Washington et al., 2020). Technology-enhanced instruction not only meets students' expectations for more dynamic learning experiences but also provides flexibility. Therefore, the integration of information, communication, and technology in education has become an essential and indispensable need that should not be overlooked. However, there are several issues and challenges that may be encountered by teachers, particularly those who are not accustomed to digital technology (Daniels et al., 2020; Nicol et al., 2018). Many teachers still lack the necessary skills to effectively utilize technology in the classroom. This situation highlights the importance of appropriate training and professional development for teachers to harness digital technology effectively. Skills in using hardware and software, the ability to select and integrate suitable technological tools for learning objectives, and the capacity to troubleshoot technical issues are referred to as digital competencies (Bravo et al., 2021; Yang, 2020).

Digital competencies refer to the ability to confidently, critically, and creatively use information and communication technologies to achieve learning-related goals (Blau et al., 2020; Rahim et al., 2020). Digital competencies encompass not only technical skills in operating hardware but also software. In the context of teaching, digital competencies arise from a combination of technological skills and knowledge, awareness of the methodological capabilities offered by technological resources, and individuals' attitudes toward the optimal use of information and communication technologies to develop and enhance the quality of education (Akram et al., 2022; Pertiwi et al., 2019).

In today's era, educators must demonstrate a high level of digital competence and preparedness to effectively utilize digital technology in the classroom. This is seen as a promising effort to meet the needs of the digital generation or the millennial generation (Asih et al., 2021; Liza & Andriyanti, 2020). In the present age, the progressions in digital technology have revolutionized the methods through which students acquire knowledge, engage with one another, and actively engage in societal affairs. Therefore, teachers who are capable of mastering and utilizing digital technology effectively will be able to provide relevant, engaging, and tailored learning experiences that align with the needs and preferences of the technology-driven generation. By having a high level of digital competence, teachers can effectively navigate the challenges and opportunities offered by the digital world and deliver innovative and comprehensive education to today's students (Gunantara et al., 2014; Manuaba, 2017).

Prospective teachers need to be prepared with adequate knowledge and skills to integrate digital technology in education. They should understand digital learning platforms and tools, utilize relevant hardware and software, and apply effective instructional design principles in digital environments. Additionally, they need to learn about digital ethics and online safety, as well as develop the ability to manage digital resources, including selecting and integrating relevant sources. Teacher education programs should offer a curriculum that is integrated with technology and provide adequate training and development opportunities (Falloon, 2020; Radia & Aulia, 2021). With proper preparation, prospective teachers can become agents of change in education, harnessing digital technology to create innovative and relevant learning experiences, and guiding students in an increasingly connected and advanced world. By embracing digital competencies, they can empower students to become active learners, critical thinkers, and effective problem solvers. Through their expertise in integrating technology into teaching and learning, they can foster creativity, collaboration, and digital literacy among students. As agents of change, they have the potential to transform traditional classrooms into dynamic and interactive learning environments that prepare students for the challenges and opportunities of the digital age.

Furthermore, for prospective physics teachers, digital competencies are becoming increasingly important in teaching. Developing strong digital competencies is crucial for

prospective physics teachers to effectively navigate the intersection of physics education and digital technology in the classroom. With strong digital competencies, physics teachers can utilize various digital tools and devices to visually explain physics concepts, conduct simulations, and adopt interactive teaching methods that involve technology (Darmaji et al., 2020; Puspitawangi et al., 2016). By incorporating digital tools and resources into their teaching practices, physics teachers can create dynamic and engaging learning experiences that foster scientific inquiry and problem-solving skills (Luh et al., 2019; Sunardi et al., 2023).

The novelty value of this research lies in its focus on the digital competencies of Physics Education students and the role of education technology-related courses in shaping these competencies. This research aims to analyze valuable insights into the current state of digital competencies among prospective physics teachers and offer recommendations for enhancing their preparation in integrating technology effectively in physics teaching.

2. METHODS

This research adopts a quantitative approach. A quantitative approach can be defined as a research approach based on positivism philosophy, used to study a specific population or sample with the purpose of describing and testing predetermined hypotheses (Sugiyono., 2014). In this study, data was gathered and quantitatively analysed utilising a survey method. The survey method was useful for outlining current conditions, choosing comparison points, or creating connections between certain events (Cohen et al., 2017).This strategy offered descriptive, illustrative, and explanatory data. Assuring anonymity and giving a broad perspective of a certain topic, surveys can also be simply transmitted to big populations. From 2017 through 2022, participants in this study included current students and graduates of the Physics Education Study Programme at Universitas Negeri Padang. There were 248 responders in all, 202 (81.5%) of whom were students, and 46 (18.5%) were graduates.

The instrument used in this research was a systematic questionnaire. The questionnaire was developed based on the latest version of the digital competence framework. The survey included a combination of closed-ended questions and a single open-ended question, utilizing a Likert scale with five response options. The questionnaire had three sections: the first section collected demographic information about the participants, while the second section focused on digital competencies. Table 1 presents the details of indicators and descriptors used in the Digital Competence evaluation instrument.

Table 1. Details of Indicators and Descriptors in the Digital Competence Instrument

Indicator	Descriptor	Code
Information and Data Literacy	1. Able to evaluate the accuracy of acquired information.	A1
	2. Able to search for necessary information to complete academic tasks.	A2
	3. Able to utilize various sources of information, such as books, articles, and the internet.	A3
	4. Able to manage information effectively, including storing and organizing documents.	A4
	5. Able to utilize tools such as word processing software, spreadsheets, and presentations in creating reports and presentations.	A5
Communication and Collaboration	1. Able to communicate effectively with peers and professors.	B1
	2. Able to express opinions clearly and persuasively.	B2
	3. Able to listen to and understand the opinions of others.	B3

Indicator	Descriptor	Code
	4. Able to collaborate with peers in completing academic tasks.	B4
	5. Able to use technology to communicate and collaborate with peers and professors.	B5
	6. Able to contribute to teams and complete group tasks.	B6
	7. Able to provide and receive constructive feedback.	B7
	8. Able to effectively manage conflicts within a team.	B8
	9. Able to build good relationships with peers and professors.	B9
	10. Able to use social media wisely and ethically.	B10
	11. Able to use technology to organize and manage group tasks.	B11
	12. Able to use technology to communicate with parents and guardians.	B12
	13. Able to use technology to organize and manage personal schedules and tasks.	B13
Digital Content Creation	1. Able to use technology to create engaging and effective presentations.	C1
	2. Confident in creating captivating digital content that captures students' attention.	C2
	3. Capable of creating interesting learning materials using digital technology.	C3
	4. Able to select and use the appropriate digital tools and applications to create learning materials.	C4
	5. Skilled at integrating visual and audio elements in creating digital learning materials.	C5
	6. Believes that the use of digital technology in teaching can enhance students' interest and participation.	C6
	7. Enjoys and feels inspired to create new digital learning materials.	C7
	8. Capable of evaluating and improving the quality of created digital learning materials.	C8
	9. Able to create engaging learning materials using digital applications.	C9
	10. Proficient in creating engaging and easily understandable instructional videos for students.	C10
	11. Competent in creating engaging and effective digital presentations to deliver to students.	C11
	12. Capable of creating captivating and beneficial digital content (e.g., blogs, websites, podcasts) for students.	C12
	13. Proficient in creating compelling media assets (such as images, graphics, or short videos) to effectively convey information.	C13
Safety	1. Able to identify and avoid potential hazards when using digital platforms.	D1
	2. Capable of using digital platforms safely and maintaining privacy.	D2
	3. Able to differentiate between safe and unsafe information or sources on the internet.	D3
	4. Competent in securing accounts and personal information when using digital platforms.	D4

Indicator	Descriptor	Code
Problem-Solving	1. Able to identify issues related to the use of technology in learning.	E1
	2. Capable of utilizing available resources such as guides, tutorials, or forums to resolve technology-related issues in learning.	E2
	3. Able to seek alternative solutions when encountering technology-related problems in learning.	E3
	4. Competent in resolving technology-related issues in learning quickly and effectively.	E4
	5. Proficient in asking questions or seeking assistance when facing technology-related problems in learning.	E5

The third part of the survey attempted to find out how well pre-service teachers were being prepared to use technology in the classroom by the courses that Universitas Negeri Padang's Physics Education students were enrolled in. Five open-ended questions made up this section, which asked respondents to list the educational technology-related courses they had taken and to what extent those courses had given them a solid foundation on which to base their integration of technology into the classroom. To determine whether there were any differences between the research variables, the researcher used the Chi-square test. In order to determine whether the research variables varied in any way, an independent sample test was also run. The statistical significance (*p) for each test was at an acceptable level. The information gathered from the survey's open-ended questions was utilised to analyse and discuss the findings. Correlation between dimensions of digital competence is show in Table 2.

Table 2. Correlation between Dimensions of Digital Competence

No.	Pearson Correlation	1	2	3	4	5
1	Information and Data Literacy	1				
2	Communication and Collaboration	0.715**	1			
3	Digital Content Creation	0.558**	0.720**	1		
4	Safety	0.502**	0.618**	0.612**	1	
5	Problem-Solving	0.502**	0.772**	0.729**	0.700**	1

3. RESULTS AND DISCUSSION

Results

The average percentage for each aspect of digital competence is show in Table 3.

Table 3. Percentage Average of Each Digital Competence Indicator

No.	Digital Competency Indicator	Percentage
1	Overall	77.17%
	Information and data literacy	80.48%
	Strongly agree	32.74%
	Agree	41.53%
	Neutral	22.50%
	Don't agree	1.85%
	Strongly Disagree	1.37%
2	Communication and collaboration	80.93%

No.	Digital Competency Indicator	Percentage
	Strongly agree	31.67%
	Agree	44.54%
	Neutral	21.71%
	Don't agree	0.96%
	Strongly Disagree	1.12%
3	Digital content creation	77.67%
	Strongly agree	22.36%
	Agree	47.55%
	Neutral	27.14%
	Don't agree	1.95%
	Strongly Disagree	0.99%
4	Safety	78.43%
	Strongly agree	25.30%
	Agree	45.77%
	Neutral	25.91%
	Don't agree	1.81%
	Strongly Disagree	1.21%
5	Problem-solving	77.71%
	Strongly agree	20.24%
	Agree	50.32%
	Neutral	27.58%
	Don't agree	1.45%
	Strongly Disagree	0.40%

Base on Table 3 show an overview of the performance or level of skill in many areas of digital competence is given in this table. It offers helpful insights into the distribution of abilities across multiple dimensions by acting as a visual representation of the information gathered and analysed in the study. The average scores for each descriptor in the digital competency indicators are shown in the following diagram as show in Figure 1.

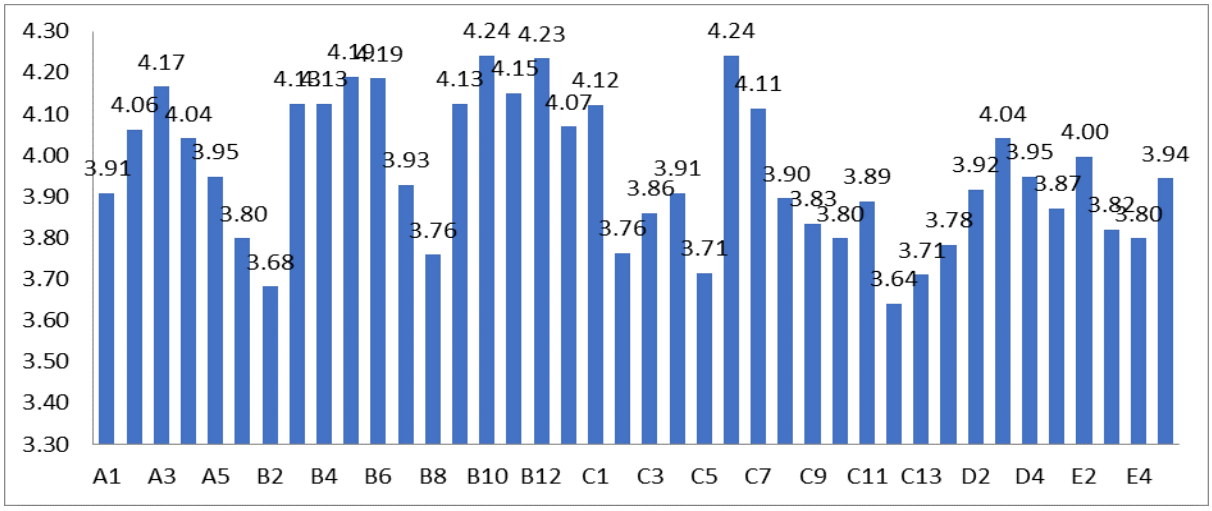

Figure 1. Average Scores for Each Descriptor in the Digital Competence Indicators

Base on Figure 1, the number 1 denotes the lowest level, and the number 5 denotes the highest level in these scores, which are based on pre-service teachers' responses. The achievement levels for each description within the examined digital competence indicators as

determined by the pre-service teachers are represented visually in these diagrams. The majority of respondents indicated good replies to their abilities in all measured dimensions of digital competence, it may be concluded based on the evaluation results from Table 3. Their skill in information and data literacy, communication and teamwork, the development of digital material, and safety may be shown in the high level of satisfaction they report. several results show that the respondents had high knowledge and abilities in several areas: information and data literacy, communication and teamwork, creation of digital material, safety, and problem-solving. The ability to create digital content, however, still has space for development. The majority of respondents provided favourable feedback, which suggests that the research's focus on enhancing respondents' digital competencies has been successful overall.

The data as a whole demonstrates that most respondents had a high level of competence in the evaluated indicators of digital competence, with a sizable proportion of positive responses. While the percentages for disagree and strongly disagree replies are not particularly high, these positive responses include the categories of agree and neutral. Students have mastered using a variety of information sources, including books, articles, and the internet, in the dimension of information and data literacy. They have access to and the ability to look up information pertinent to the subjects they are learning about or researching. Their capacity to assess the accuracy of the information they get, however, is one area that still requires development.

Discussion

In a time when information is readily available online, the capacity to assess the accuracy of information is essential. Before employing information in their studies, students need to understand how to recognise legitimate sources and how to validate it. They can now differentiate between facts, opinions, and assertions that lack solid scientific evidence. During the review process, students must consider a number of factors, such as the reliability of the source, the reputation of the author or publisher, the objectivity of the information, and if the claims made are backed up by proof (Rasvani & Wulandari, 2021; Wahyuni et al., 2021). Additionally, individuals need to be aware of any biases that might be present in the information they come across, including author bias, vested interest bias, and other biases. Students can participate in information literacy training, which emphasises the teaching of critical skills in reading, analysing, and understanding information, to help them improve these abilities. Exercises in research and using reputable sources to verify information can also be offered to them.

Students may be adept at the technical and moral facets of using social media, but they lack the communication skills necessary to persuade others of their points of view. This shows that they still need to improve their ability to communicate effectively both orally and in writing. In both academic and professional settings, the ability to articulate ideas eloquently is crucial (Sivam et al., 2019; Susanti & Kristin, 2021; Toro et al., 2018). It is important for students to understand how to organise and present their arguments using good syntax, logical reasoning, and supporting data. To ensure that the intended message is understood and has the desired impact, they should also pay attention to writing style and select the right words.

Although they can distinguish between secure and unsecure sources of information, students still need to improve their capacity to recognise and steer clear of potential risks when using digital platforms. They might not be completely informed of potential safety risks including phishing attempts, malware, or identity theft. Additionally, it's possible that students don't know how to respect limits and manage privacy when sharing information online. Students need to be exposed to more complex ideas and methods linked to online

safety in order to improve their understand of digital safety (D. Oktafiani et al., 2020; Suartini et al., 2014). They can take classes or training sessions that include subjects like data security, internet privacy, awareness of cyberattacks, and required precautions. Students can also be given real-world examples or scenarios involving digital safety hazards in order to help them build their capacity to recognise and deal with potentially hazardous situations (Antari et al., 2013; Dian. dkk Oktafiani, 2020).

Students need to participate in exercises and activities that allow them to practise coping with a variety of difficult technical scenarios if they want to improve their ability to solve technology-related problems in learning. They may be assigned assignments or projects that require them to solve technological problems, and they will be required to use the ideas they have learned to get around new limitations. Every student must be proficient in problem-solving, which is also a key element of effective technical competence (Cahya et al., 2022; Suartini et al., 2014). It's crucial for teachers to develop a wider range of problem-solving abilities, including critical thinking, situational analysis, and problem-solving techniques. These abilities extend beyond the technical side and include the capacity to assess data critically, consider the context and contributing components of an issue, and come up with efficient solutions (Rahim, 2019; Rahim et al., 2019). They want instruction in developing pertinent inquiries, locating the cause of issues, and organising methodical procedures for remedies. Students can gain from a deeper comprehension of the software, hardware, networks, and operating systems they use in the context of technology.

According to other studies globalisation has encouraged prospective teacher students to build their digital abilities in order to prepare themselves for the challenges of technology-based learning (Ata & Yıldırım, 2019; Lindfors et al., 2021; Masoumi, 2021; Štemberger & Konrad, 2021). But according to research, both prospective and working teachers lack the necessary digital education preparation (An et al., 2021; Sepulveda-Escobar & Morrison, 2020). Therefore, the main goals of this study are to determine whether the Universitas Negeri Padang undergraduate programme for prospective physics teachers is able to produce graduates who can use digital technology in future teaching, as well as to assess prospective teacher students' digital competence from their own point of view.

Overall, with an average score of 3.86 (77.17%), prospective physics teacher students rate their digital competence as adequate. However, self-reported ratings of participants' digital aptitude may not always accurately reflect their actual capacity to integrate technology into their instruction or to do so over the long term (Andika et al., 2017; Gudmundsdottir & Hatlevik, 2018). The data provided shows that in all five of the categories of digital competence investigated, prospective teacher students who described their level of digital proficiency as very good had significantly higher average scores than those who ranked their level as moderate. According to the data analysis, compared to other areas of digital competence looked at, prospective teacher students demonstrated the highest response in the area of communication and collaboration. This result is in line with earlier studies that indicate prospective teachers' students are already acclimated to using digital tools and resources (Štemberger & Konrad, 2021). Other research indicates that these abilities rank second, demonstrating the accessibility and pervasiveness of social networking for social interactions (Ata & Yıldırım, 2019; Çebi & Reisoglu, 2020; Esteve-Mon et al., 2020).

According to additional research, prospective teachers believe the curriculum programme has effectively prepared them to integrate technology into their classrooms, both for field experience and in their future jobs as teachers. This is consistent with earlier research, which indicates that prospective teachers are gradually changing their attitudes regarding digital competency in the contemporary digital environment (Ata & Yıldırım, 2019; Núñez-Canal et al., 2022). Therefore, future educators might be inspired to improve their own digital skills. According to other studies, 97.2% of respondents said they had digital

competencies (Hartman et al., 2019). The results of this study therefore confirm the hypothesis that prospective teachers' ambition to learn about and master technology is correlated with their positive attitudes towards technology. Students have been exposed to technology at the Universitas Negeri Padang Physics Education Study Programme. Students access course materials, submit assignments, record attendance, and take part in midterm and final exams using an LMS (Learning Management System) in both offline and online lectures. Students are also comfortable with working collaboratively online using Office Online as well as developing presentation media and videos using programmes like Canva (Asad et al., 2020; Ngo et al., 2022).

Previous studies have clarified the relationship between the advantages students experience and their technological proficiency as well as teachers' views towards the integration of technology into the classroom. These results show that teachers' exposure to technology-based learning helps prospective teachers effectively integrate ICT (Information and Communication Technology) into their future careers (Akram et al., 2022; Çebi & Reisoglu, 2020). Teachers give students the chance to interact with tools and apps that are pertinent to the modern digital world by teaching them how to use technology in the learning process. Students can learn crucial technological competencies including digital literacy, problem-solving, creativity, and cooperation through this experience.

From the results of this research, it is expected to identify the level of digital competencies among Physics Education students, evaluate the effectiveness of education technology-related courses in developing these competencies, and provide recommendations for curriculum enhancement. The findings will contribute to the development of existing research by shedding light on the digital competencies required for prospective physics teachers and informing the design of effective technology integration strategies in physics education. Ultimately, this research aims to enhance the quality of physics education by equipping future teachers with the necessary digital competencies to meet the demands of modern teaching practices.

Several strategies can be used to improve future research in this field and reduce the possible limitation of relying only on self-reported data. These include using objective assessments to assess participants' actual digital competencies, obtaining peer or expert opinions for additional viewpoints, conducting classroom observations to observe participants' technology integration in real teaching settings, conducting longitudinal studies to track digital competency growth over time, using a mixed-methods approach to gather thorough insights, and conducting comparative studies to identify any discrepancies. Future research can fill the gap between participants' perceptions of their own digital competencies and actual competency by using these techniques to give participants a more accurate and comprehensive view of their digital competencies. By employing these approaches, future research can provide a more accurate and holistic understanding of participants' digital competencies and bridge the gap between self-perception and actual proficiency.

4. CONCLUSION

According to this study's findings, the majority of Indonesian future teachers possess a high level of digital proficiency in the context of digital education. The majority of respondents gave positive responses to all questions about digital competence, indicating that they had a solid understanding of and skills in problem-solving, communication, teamwork, and information and data literacy. However, there is room for improvement in terms of digital content generating abilities. The research also shows that graduates of the Physics Education programme and current students are accustomed to using technology for academic

purposes, including using the Learning Management System (LMS) and working together online.

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