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Perception of Pre-Service Teachers Regarding Digital Competencies in Indonesia

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Abstract – This article aims to evaluate the digital competencies of prospective teachers in Indonesia in the context of digital education. 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, consisting of 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 favorable 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. In conclusion, the perception of pre-service teachers towards digital competence is positive due to the support provided by the study program in offering technology-integrated courses.

Keywords: digital competencies; digital education; physics education; pre-service teachers; survey research

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I. INTRODUCTION

The rapid advancement of digital technology has brought about a paradigm shift in the field of education, replacing traditional learning methods with technology-based approaches (Drent & Meelissen, 2008; Fullan & Smith, 1999; Ghavifekr & Rosdy, 2015). This transformation has underscored

the increasing importance of conducting research to understand the role of technology in education. As educational practices evolve in response to technological advancements, it is crucial to investigate the impact of digital technology on teaching and learning processes to inform pedagogical strategies and enhance educational outcomes.

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 (Krumsvik, 2011; Yang et al., 2020). 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 (Puerling, 2012).

Prospective physics teacher education students, who belong to the generation immersed in the digital era (Liza & Andriyanti, 2020), possess a distinctive need for comprehensive digital competencies. This necessity arises from the intrinsic demands of the physics discipline, which require students to exhibit self-assurance, adeptness in critical thinking, and ingenuity in achieving educational goals (Ferrari et al., 2014; Rahim et al., 2020). Moreover, the effective utilization of technology is of paramount importance, as it plays a pivotal role in the learning and teaching processes (Darmaji et al., 2020; Svensson & Baelo, 2015). Additionally, physics education heavily emphasizes inquiry-based learning approaches, placing further emphasis on the

significance of equipping prospective teachers with the requisite knowledge and skills to integrate technology seamlessly into instructional practices (Sunardi et al., 2023).

One of the universities that offers a Physics Education program is Universitas Negeri Padang (UNP). In the past 5 years, the Physics Education program has undergone curriculum revision to align with global trends and stakeholder needs. Throughout the curriculum revitalization process, several courses have been removed and replaced with technology integration. However, there has been no research conducted to determine whether these updated courses truly support students' digital competencies or if they are merely equivalent to the previous ones.

Therefore, research is needed to explore the digital competencies possessed by prospective teachers in the Physics Education program at UNP. Previous studies have emphasized the importance of digital competencies in stimulating and practicing teachers from the early stages to familiarize them with optimizing the use of technology in teaching (Brevik et al., 2019; Fernández-Batanero et al., 2022; Gavaldon & McGarr, 2019; Merk et al., 2020; Moldavan et al., 2022; Peters et al., 2022). These studies highlight the crucial role of digital skills and knowledge in empowering educators to leverage various technological tools and platforms to enhance student engagement, facilitate personalized learning experiences, and address the evolving needs of learners in

the digital age. By equipping teachers with the necessary digital competencies, they are better prepared to navigate the rapidly changing educational landscape and effectively integrate technology into their instructional practices, ultimately leading to improved teaching and learning outcomes (Falloon, 2020).

Presently, there is a scarcity of precise literature focusing on the digital competencies required by aspiring physics teachers and the effectiveness of education technology courses in preparing them to incorporate technology into physics instruction. Hence, additional research is necessary to obtain a more comprehensive comprehension of the digital competencies possessed by students pursuing physics education and the influence of relevant courses on shaping the digital competencies of prospective physics teachers.

The main objective of this study is to examine how prospective physics teacher education students assess their own digital competency skills and evaluate the impact of education technology courses within the

physics education program in equipping them with the necessary abilities to effectively incorporate technology in their teaching practices. Additionally, the research seeks to gain insights into the viewpoints and opinions of these students regarding the development of digital competencies in their educational journey.

II. METHODS

This research was designed using a survey methodology, where data was collected and analyzed quantitatively. The survey approach was suitable for describing existing conditions, identifying benchmarks for comparison, or establishing relationships between specific events (Cohen et al., 2017). This approach provided descriptive, inferential, and explanatory information. Additionally, surveys are easily distributed to large groups, ensuring anonymity, and providing a general overview of a specific field (Johnson & Onwuegbuzie, 2004). Data collection involves several procedures. These procedures are depicted in Figure 1.

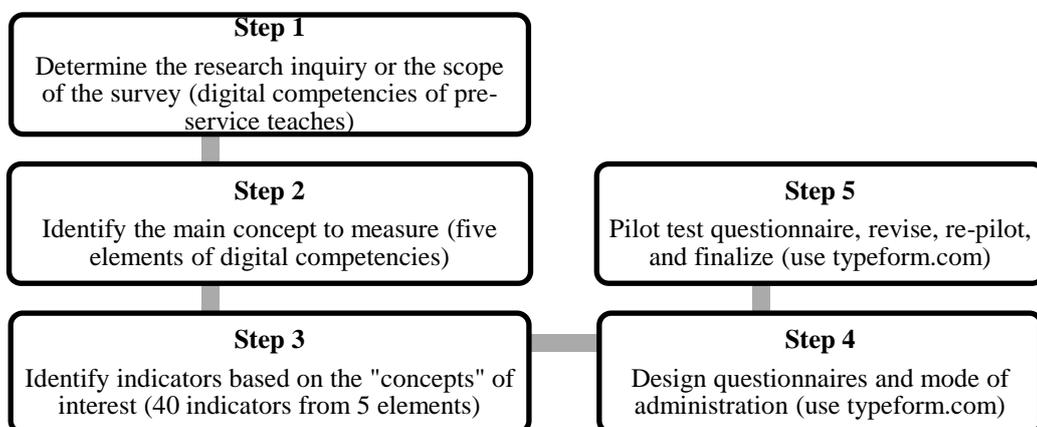


Figure 1. Data collection procedure

This research involved students and alumni from the Physics Education Study Program at Universitas Negeri Padang from 2017 to 2022. The total number of respondents was 248, with 202 (81.5%) being students and 46 (18.5%) being alumni.

The instrument used in this research was a systematic questionnaire. The questionnaire was developed based on the latest version of the digital competence framework by Stephanie (Carretero et al., 2017). 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. This included questions about how pre-service teachers assessed their overall level of digital competency, as well as their proficiency levels in five digital competency elements: information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving. Each element had a different number of items and internal consistency coefficients, ranging from 0.801 to 0.920. It was estimated to take 8-10 minutes to complete the questionnaire.

The third section of the questionnaire aimed to investigate the effectiveness of the courses offered to Physics Education students at Universitas Negeri Padang in preparing pre-service teachers to effectively use technology in the classroom. This section consisted of five open-ended questions that required respondents to describe which courses were related to educational technology and to what extent these courses provided a strong foundation for them to integrate technology in teaching. Additionally, there were questions about the positive attitudes of students toward developing digital competencies.

Pearson correlation was used to determine the relationship between the questionnaire items. The analysis revealed strong correlations between the research variables, with correlation coefficients (r) ranging from 0.502 to 0.772 (Turney, 2022).

The researcher employed the Chi-square test to determine if there were any differences between the research variables. Additionally, an independent sample test was conducted to investigate whether there were any variations among the study variables. All tests had an acceptable level of statistical significance ($*p$). The data obtained from the open-ended questions in the survey were used to interpret and discuss the results.

Table 1. 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

*p<0.001

III. RESULTS AND DISCUSSION

Based on the assessment results from Table 2, it can be inferred that the majority of respondents demonstrated positive responses to their abilities in all assessed dimensions of digital competence. This high level of satisfaction reflects their proficiency in information and data literacy, communication and collaboration, digital content creation, as well as safety. These findings indicate that the respondents possess a good understanding and skills in information and data literacy (A), communication and collaboration (B), digital content creation (C), safety (D), and problem-solving (E). However, there is still

room for improvement in digital content creation skills. Overall, the majority of respondents' positive responses indicate the success in developing their digital competencies within the context of this research.

In general, the findings indicate that most of the respondents demonstrate a high level of competence in the assessed digital competence indicators, with a considerable proportion providing positive responses. These positive responses include the categories of strongly agree, agree, and neutral, while the percentages for disagree and strongly disagree categories are relatively low.

Table 2. Percentage average of each digital competence indicator

No	Digital competency indicator	Percentage
	Overall	77.17%
1	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%
	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%

No	Digital competency indicator	Percentage
	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	Solution to problem	77.71%
	Strongly agree	20.24%
	Agree	50.32%
	Neutral	27.58%
	Don't agree	1.45%
	Strongly Disagree	0.40%

Here are five diagrams displaying the average scores for each descriptor in the digital competence indicators. These scores are based on the responses provided by pre-service teachers, where the number 1 represents the lowest level, and the number 5 represents the highest level. These diagrams provide a visual representation of the achievement level for each descriptor within the evaluated digital competence indicators as assessed by the pre-service teachers.

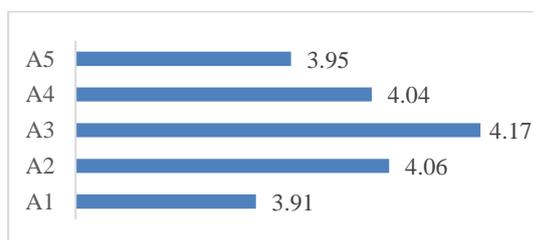


Figure 2. Information and data literacy

In the dimension of information and data literacy, students have developed the ability to use various sources of information, such as books, articles, and the internet. They can access and search for relevant information

related to the topics they are researching or studying. However, there is one aspect that still needs improvement, which is their ability to evaluate the accuracy of the information they obtain.

The ability to evaluate the accuracy of information is crucial in an era where information is easily accessible through the internet. Students need to learn how to identify reliable and valid sources and how to verify the information before using it in their studies. This enables them to distinguish between facts, opinions, or scientifically unsupported claims.

In the evaluation process, students need to consider various factors such as source reliability, credibility of the author or publisher, objectivity of the information, and whether there is evidence or support validating the claims made. They should also be aware of biases that may arise in the information they encounter, whether it be

author bias, vested interests bias, or other biases.

To develop these skills, students can be engaged in information literacy training that involves teaching critical skills in reading, analyzing, and interpreting information. They can also be given exercises in conducting research and verifying information using reliable sources. By improving their ability to evaluate the accuracy of information, students will become more capable of producing quality research, acquiring accurate knowledge, and avoiding the dissemination of false or unverified information. This will help them become smarter and more competent learners in a world driven by information.

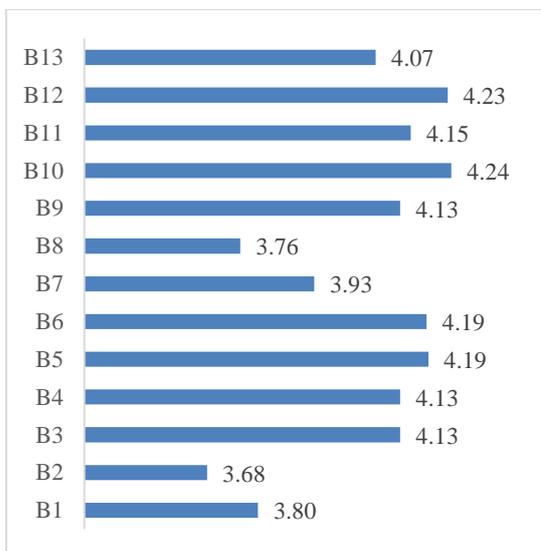


Figure 3. Communication and collaboration

In the dimension of communication and collaboration, it is evident that students have acquired the ability to use social media wisely and ethically. They are capable of understanding the importance of privacy protection, respecting copyright, and avoiding harmful online behaviors. Students can also

interact with others productively through social media platforms, such as sharing ideas, engaging in discussions, and collaborating on joint projects.

However, despite students mastering the technical and ethical aspects of social media usage, there is a deficiency in their ability to express opinions clearly and persuasively. This indicates that they have not fully developed the oral and written communication skills required to effectively convey their ideas. Expressing opinions clearly and persuasively is an essential skill in both academic and professional settings. Students need to learn how to structure and articulate their arguments with proper grammar, logical flow, and supporting evidence. Additionally, they should pay attention to writing style and choose appropriate words to ensure that the intended message is understood and has the desired impact.

To enhance these abilities, students can engage in various activities involving oral presentations, discussions, and writing. They can be given opportunities to speak in public, participate in study groups, or write essays and academic papers. Training in communication skills that encompass persuasive strategies and effective delivery techniques can also provide significant benefits to them.

By developing the ability to express opinions clearly and persuasively, students

will gain confidence in conveying their ideas, influencing others with strong arguments, and establishing effective relationships in academic and professional contexts. This will assist them in addressing complex communication challenges and making more meaningful contributions in the workplace and society.

In the dimension of digital content creation, students recognize that the use of digital technology in learning has the potential to enhance student interest and participation. They acknowledge the added value that various types of digital content, such as blogs, websites, podcasts, and others, can bring in presenting information in an engaging and interactive manner.

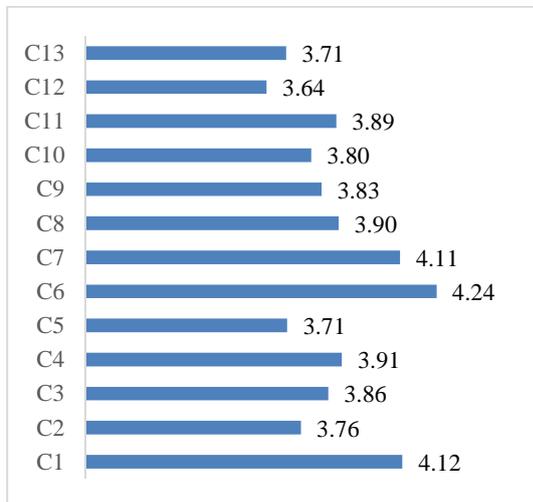


Figure 4. Digital content creation

However, despite students' belief in the benefits of using digital content in learning, they still face limitations in their ability to create compelling and useful digital content for students. They may not have fully mastered the technical skills required to create

and manage high-quality digital content. They may also lack a deep understanding of how to integrate academic content with creative elements that are appealing to students.

To address these limitations, students can engage in training and courses that focus on digital content creation. They can learn technical skills such as using blogging platforms, website creation, or podcast production. Additionally, they can learn effective design strategies and techniques to ensure that the digital content they create is engaging, well-structured, and beneficial to students.

Students can also collaborate with their peers in creating digital content. They can form teams or project groups to combine their expertise and ideas. Such collaboration can help students overcome individual limitations and produce richer, more diverse, and more beneficial digital content.

By developing the ability to create compelling and beneficial digital content for students, students will be able to produce more diverse and relevant learning resources. The digital content they create can enrich students' learning experiences, facilitate better understanding of concepts, and enhance their engagement in the learning process.

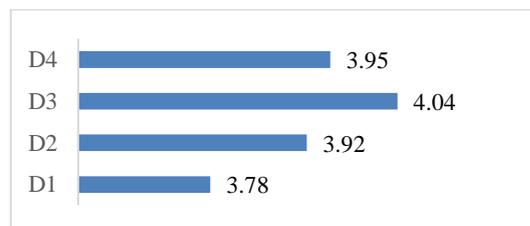


Figure 5. Safety

In the dimension of safety, students have developed the ability to distinguish between secure and insecure information or sources on the internet. They are able to use critical instincts and digital literacy skills to select trustworthy sources of information and avoid false or inaccurate information. Students may have also learned about basic safety practices, such as maintaining password confidentiality, avoiding sharing sensitive personal information, and securing their devices from digital threats.

However, although they can differentiate between secure and insecure information or sources, students still need to enhance their abilities to identify and avoid hazards that may arise when using digital platforms. They may not be fully aware of safety threats that can occur, such as phishing attacks, malware, or identity theft. Students may also lack an understanding of how to manage privacy and maintain boundaries when sharing information on digital platforms.

To improve understanding of digital safety, students need to be introduced to advanced concepts and practices related to online safety. They can participate in training or courses that cover topics such as data security, online privacy, cyber attack awareness, and necessary preventive measures. Real-life examples or scenarios involving digital safety threats can also be provided to students so that they can develop their abilities to identify and address potentially dangerous situations.

Additionally, it is important for educational institutions to ensure that the systems and digital platforms used by students have adequate safety measures. The use of secure technologies, such as firewalls, data encryption, and appropriate safety protocols, can help protect students from safety threats that may arise when using digital platforms.

By increasing understanding and awareness of hazards and safety measures in the use of digital platforms, students will be able to protect themselves and reduce the risks to their personal data security. They will become smarter and more responsible users in the evolving digital world.

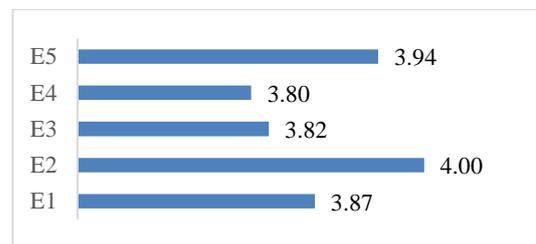


Figure 6. Problem-solving

In the dimension of problem-solving, students have acquired the ability to utilize various available resources, such as guides, tutorials, or forums, to solve technology-related problems in the context of learning. They can search for the necessary information, follow provided steps, and try recommended solutions. This ability demonstrates that students possess fundamental skills in seeking solutions and overcoming technological challenges they may encounter.

However, despite their ability to utilize available resources, students still face challenges in efficiently and effectively solving technology-related problems in learning. They may lack a deep understanding of the relevant technical concepts or struggle to apply the solutions they find accurately and efficiently.

To enhance their ability to solve technology-related problems in learning, students need to engage in exercises and activities that allow them to practice confronting various complex technological situations. They can be given tasks or projects involving technology problem-solving, where they are expected to apply the concepts they have learned to overcome emerging constraints. Proficiency in problem-solving is an absolute obligation for every learner and a crucial component of effective technological competence (Cahya et al., 2022). Additionally, it is important for students to develop broader problem-solving skills, such as critical thinking, situational analysis, and problem-solving strategies. These skills go beyond the technical aspects and encompass the ability to evaluate information critically, analyze the context and factors surrounding a problem, and devise effective strategies to address it (Rahim, 2019; Rahim et al., 2019). They need to be trained in formulating appropriate questions, identifying the source of problems, and planning systematic steps for solutions. In the context of technology, students can also benefit from a deeper

understanding of the operating systems, hardware, networks, and software they use.

Through practice and the development of problem-solving skills in technology, students will be able to enhance their speed and effectiveness in addressing technological constraints in learning. They will gain more confidence in facing technological challenges and can focus better on the learning process without being hindered by technical issues that arise.

Previous research has shown that globalization has prompted prospective teacher students to develop their digital competencies in order to prepare themselves for the challenges of technology-based learning (Ata & Yildirim, 2019; Lindfors et al., 2021; Masoumi, 2021; Štemberger & Konrad, 2021). However, research indicates that both prospective and active teachers are not adequately prepared for digital education (Al Khateeb, 2017; Mulhim, 2014). Therefore, the main objective of this study is to investigate whether the prospective physics teacher undergraduate program at Universitas Negeri Padang is able to produce graduates who are capable of using digital technology in future teaching and to evaluate the digital competence of prospective teacher students from the perspective of the students themselves.

Overall, the majority of prospective physics teacher students rate their level of digital competence as sufficiently good, with an average score of 3.86 (77.17%). However,

self-reported assessments of digital proficiency by participants may not necessarily reflect their actual ability to effectively use technology in their teaching practices or its sustained use in teaching (Gudmundsdottir & Hatlevik, 2018). The available data indicates that prospective teacher students who rated their level of digital proficiency as very good had significantly higher average scores compared to those who rated their digital proficiency level as moderate in all five areas of digital competence examined.

Based on the data analysis, prospective teacher students showed the highest response in digital competence in the field of communication and collaboration compared to other areas of digital competence examined. This finding is consistent with previous research that suggests prospective teacher students are already accustomed to using communication tools and digital resources (Štemberger & Konrad, 2021). Other studies also indicate that communication and collaboration skills rank second, indicating ease of use and widespread utilization of social networking for social interactions (Ata & Yıldırım, 2019; Çebi & Reisoglu, 2020; Esteve-Mon et al., 2020).

On the other hand, in the perspectives presented by aspiring teachers, the digital content creation indicator occupies the lowest position. This indicates that prospective teachers face challenges or difficulties in terms of their ability to create digital content.

This may be due to a lack of understanding or skills in producing engaging and meaningful digital content. Placing this indicator in the last position can serve as a focal point for improvement and enhancement of the prospective teachers' competence in digital content creation. With awareness of this position, strategic steps can be taken to provide the necessary training or resources for prospective teachers to enhance their ability to create quality digital content.

Further research findings indicate that prospective teachers rate the curriculum program as adequately equipping them to integrate technology in teaching, both for field practice and their future teaching careers. This aligns with previous research, which suggests that in the current digital era, prospective teachers are gradually developing attitudes toward digital competence (Ata & Yıldırım, 2019). Therefore, prospective teachers may be motivated to enhance their own digital skills. Other research indicates that 97.2% of the respondents claimed to have digital competencies (Hartman et al., 2019). Therefore, the findings of this research support the relationship between the positive attitudes of prospective teachers towards technology and their motivation to acquire knowledge and skills in this field. In the Physics Education Study Program at Universitas Negeri Padang, students have been introduced to the use of technology. In both offline and online lectures, students use an LMS (Learning Management System) to

access course materials, submit assignments, take attendance, and participate in mid-semester and final semester exams. Additionally, students are familiar with using applications such as Canva for creating presentation media and videos, as well as working collaboratively online using Office Online. The study program also provides facilities to students with courses such as Algorithm and Computer Programming, Physics Learning Media, and Classical and Modern Physics Experiments that utilize computer-based sensor devices for research. All of these courses are mandatory for students.

Students are also given the opportunity to choose 7 out of 15 elective courses, in which the majority of these courses use technology as a process and learning product. Examples include Applied Physics, Computer-Based Assessment, Physics e-Learning, and Technology-Based Learning and Disasters. With a variety of courses that fully support the use of technology in learning, students become accustomed to using technology in their daily activities and develop a positive attitude towards technological advancements.

Previous research has explained the correlation between the benefits students gain and their technological skills, as well as the attitudes of teachers towards the use of technology in their teaching processes (Wastiau et al., 2013). These findings indicate that when teachers familiarize students with

technology-based learning, it also assists prospective teachers in successfully integrating ICT (Information and Communication Technology) into their future careers (Çebi & Reisoglu, 2020; Tezci, 2011; Wastiau et al., 2013). By teaching students to use technology in the learning process, teachers provide them with opportunities to interact with tools and applications relevant to the digital world today. Through this experience, students can develop essential technology skills such as digital literacy, problem-solving, creativity, and collaboration.

In the context of prospective teachers, understanding and being able to integrate ICT into teaching practices are highly important. In an increasingly connected world with rapidly advancing technology, teachers who can effectively use ICT have a competitive advantage in preparing students for a constantly changing workforce. They can create more engaging and relevant learning experiences for students, facilitate access to broader educational resources, and enhance teaching efficiency through the use of digital tools.

Furthermore, the use of ICT in learning can also expand the scope of education, providing students with access to various educational resources beyond the classroom, such as interactive learning materials, online tutorials, and discussions with experts in the field (Asad et al., 2020). Therefore, prospective teachers who are skilled in

integrating ICT can harness the unlimited learning potential offered by information and communication technology. By understanding the importance of technology-based learning for students and prospective teachers, we can see how it has a sustainable impact in supporting educational development and career preparation in the future. Through a successful integration of technology and education, we can shape a generation that is prepared to confidently face the challenges of the digital world with competitive abilities.

IV. CONCLUSION AND SUGGESTION

The research findings indicate that the majority of prospective teachers in Indonesia possess a good level of digital competence in the field of digital education. They demonstrate understanding and proficiency in various aspects of digital competence, including information literacy, communication and collaboration, digital content creation, safety, and problem-solving. However, there is room for improvement in digital content creation skills. The data also suggests that students and alumni of the Physics Education program are adept at utilizing technology for their academic activities, such as using Learning Management Systems (LMS) and engaging in online collaboration. This reflects their successful adaptation to technological advancements in the education sector.

To meet the evolving demands of digital education, it is crucial for prospective

teachers to continually enhance their skills in digital content creation. By doing so, they can effectively contribute to the implementation of digital education in Indonesia. Therefore, ongoing efforts and support are necessary to provide training and prepare prospective teachers to navigate the challenges posed by ever-evolving technology.

As a recommendation, it is essential to consistently make efforts in granting teachers access to appropriate and current training programs, workshops, and resources that cater to the latest advancements in educational technology. These initiatives can help teachers develop the confidence and competence to adapt to new technologies and effectively leverage them for instructional purposes. Moreover, ongoing support and mentorship should be available to teachers to address any challenges they may encounter while implementing technology in their teaching. This could involve peer collaboration, coaching, and access to a network of experienced educators who can provide guidance and share best practices.

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