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Digital Information Literacy as A Foundation for E-Learning: A Study of Higher Education in West Nusa Tenggara

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ABSTRACT

This study contributes to the understanding of how digital information literacy (DIL) supports e-learning implementation in under-resourced higher education contexts. This study used a quatitative approach and ex post facto research. Data analysis in this study used descriptive methods (quantitative). The subjects of this study were 56 lecturers and 300 students of Biology Education programs from various universities in West Nusa Tenggara. Data were collected using questionnaires (sig. 0.00-0.04 and Cronbach Alpha=0.743) and documentation. The results of the study indicate that the level of implementation of DIL in universities in NTB has been moderately high, through three process: planning, implementation, and evaluation of learning. The majority of lecturers in NTB (82%) have a high level of DIL, with significant advantages in the aspects of understanding the purpose and meaning of information and the ability to evaluate information. On the other hand, students also have a fairly high level of DIL (68%), but the rest are still at moderate and low levels. Strengthening DIL, especially for students, still needs better attention, through optimal support from lecturers and universities. By improving overall digital information literacy, universities in NTB can be more prepared and effective in facing the challenges of digitalization of education in the Society 5.0 era.

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INTRODUCTION

The digital transformation triggered by the Industrial Revolution 4.0 and accelerated further in the era of Society 5.0 has significantly reshaped the educational landscape, pushing higher education institutions toward the integration of digital technology and e-learning (Carayannis, E.

G. & Morawska-Jancelewicz, J., 2022). This transformation positions students and lecturers as key actors in adapting to new modes of teaching and learning, including the increased reliance on e-learning platforms (Núñez-Canal, M. et al., 2022; Nikou, S. et al., 2022). While frequent exposure to technology, ranging from social media to artificial intelligence, might suggest digital readiness, several studies have shown that this does not automatically translate into strong competencies in digital information literacy (Nikou, S. et al., 2022; Anthonysamy, L. et al., 2020). Crucially, this global shift is also reshaping the educational landscape in developing countries like Indonesia, where digital learning initiatives face unique infrastructural, sociocultural, and pedagogical challenges (Amin, F., 2024). In provinces like West Nusa Tenggara (NTB), for example, disparities in internet connectivity, digital device ownership, and institutional digital capacity continue to impact the effectiveness of technology-based learning.

E-learning, as a pedagogical model dependent on digital platforms, inherently requires learners and educators to possess sufficient digital information literacy (DIL) (Wema, E.F., 2021; Pinto, M. et al., 2022). DIL serves as the foundational competency that enables individuals not only to access digital content, but also to evaluate its credibility, manage information overload, and use digital resources ethically and effectively, skills that directly determine the success of online and blended learning ecosystems (Kozyreva et al., 2020). Despite national efforts to integrate digital tools into the learning process, especially through national programs like Merdeka Belajar Kampus Merdeka (MBKM), the implementation of this policy in many universities in NTB shows that there is still a gap between the availability of digital technology and its meaningful pedagogical use (J Dontre, A. J., 2021). Many students and lecturers still use digital tools more for entertainment than for education (Haleem et al., 2022), which undermines the effectiveness of e-learning systems.

In addition, previous research, both in Indonesia and NTB, often focuses on general digital literacy without deeply exploring the specific role of digital information literacy as a foundational skill for effective e-learning (Holm, P., 2025; Puniatmaja, G. A. et al., 2024; Irwansyah et al., 2023). More explicitly, studies conducted in large urban areas in Java indicate relatively higher levels of digital readiness, stronger institutional digital ecosystems, and more consistent training programs for lecturers and students. Harisanty et al. (2021) stated that digital media literacy in East Java was classified as very high to high, especially in terms of ethical awareness, media evaluation, media production, and media access. This finding contrasts sharply with evidence emerging from rural

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and semi-rural areas such as West Nusa Tenggara (NTB), where digital infrastructure remains limited and DIL competencies are not yet evenly developed.

While research from universities in Java is increasingly examining the role of DIL in supporting online learning outcomes, similar in-depth investigations are still rare in NTB, resulting in underexplored contextual and empirical gaps. This gap is crucial given that NTB's socio-technical ecosystem does not yet reflect the advantages found in more digitally advanced provinces, rendering assumptions based on studies from urban centers inadequate and potentially misleading.

This situations creates a conceptual and empirical gap, especially regarding how well DIL supports student engagement, critical thinking, independent research, and academic integrity within online learning ecosystems in regions with weaker digital ecosystems. In regions such as West Nusa Tenggara, Indonesia where digital infrastructure and training support may not be as robust as in urban centers, these issues are particularly pressing (Lestariani, N., 2023). Recent studies indicate that students and lecturers still face challenges in navigating digital information ethically and effectively, particularly in understanding the legal aspects of information use and preventing plagiarism (Balbaa, M. E et al., 2023; Zhao, Y. et al., 2014).

Therefore, this study aims to investigate the level of digital information literacy among students and lecturers in higher education institutions in NTB and to examine how this competency contributes to the success and quality of e-learning implementation. By identifying strengths, weaknesses, and contextual challenges, this research seeks to offer strategic recommendations for improving DIL in support of more effective, ethical, and meaningful e-learning practices. Strengthening digital information literacy is not just a technological imperative but an educational one, essential for preparing higher education institutions to thrive in the digital era of Society 5.0.

RESEARCH METHODS

This study uses a quantitative approach and an ex post facto research type. The research population is all lecturers and students at universities in NTB. The total sample was analyzed using the Slovin formula.

$$n = \frac{N}{(1 + (N \times e^2))}$$

Description:

n = Number of sample sizes

N = Number of population sizes

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e = 5% confidence level

The number of lecturer and student samples at each university was determined based on the Nazir formula (2015) with random sampling techniques.

$$ni = \frac{Ni}{N} x\, n$$

Description:

ni = Number of samples per location

Ni = Total population of each location

The subjects of the study were 56 lecturers and 300 students of Biology Education programs from various universities in NTB. Table 1 shows the research samples from four universities in NTB.

Table 1 Research Sample

No.	Universities	Lecturer	Students
1	State Islamic University of Mataram	20	155
2	Mataram University	29	64
3	Samawa University	7	19
4	Nggusuwaru University	13	32
	Total	56	300

The instrument used in the study was a self-assessment questionnaire distributed online via Google Form to respondents. The digital information literacy questionnaire for students and lecturers was compiled using a Likert scale (scale 1-5). The digital information literacy framework uses the framework from the Association of College and Research Libraries (ACRL) (2000) and Sparks et al. (2016), attached in Table 2. The questionnaire instrument was tested using the Pearson correlation validity test and Cronbach's Alpha reliability with SPSS 22 software. The total number of items was 45, of which 4 items were invalid. Validity and reliability analysis showed that 41 questions in the questionnaire were valid (sig. 0.00-0.04) and reliable (Cronbach Alpha = 0.743). All participants provided voluntary consent to participate before completing the questionnaire and were assured of confidentiality through a data anonymization process. Personal information is not included in the publication. The data was analyzed using descriptive statistics to determine the level of DIL achievement and its percentage.

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Table 2. DIL Framework

No	Element	Indicators
1.	Determine the purpose and meaning of the information needed.	1) Define the problem and determine information needs. 2) Identify the types and forms of potential information sources. 3) Consider the costs and benefits of the information needed. 4) Re-evaluate the authenticity and depth of information needs.
2	Access information effectively and efficiently.	1) Choose an investigation (search) method and organize the stored information. 2) Build and implement an effective information search strategy. 3) Re-access information online or use a variety of personal search methods. 4) Sort information search strategies if needed. 5) Take, record/document, and organize information and its sources.
3	Critically evaluate information and its sources, and sort selected information based on knowledge and value systems.	1) Summarize the main ideas obtained from the information that has been collected. 2) Define and use initial criteria to evaluate information and its sources. 3) Synthesize the main ideas to develop new concepts. 4) Compare new knowledge with previous knowledge to determine the added value, differences, and unique characteristics of the information (findings). 5) Determine whether new knowledge has an impact on the individual's value system and take steps to balance the differences in the information. 6) Validate the understanding and interpretation of information through discussions with colleagues, experts, and/or practitioners. 7) Determine the initial questions that need to be improved.
4	Individually or in groups, use information effectively to achieve specific goals (answer problems).	1) Apply new and old information for planning and forming products (concepts, solutions, answers) or academic performance. 2) Improve the development process of products or performance. 3) Communicate products or performance effectively to others.
5	Understand the economic, legal, and social aspects/issues related to the use of information and its access and the use of information ethically and legally.	1) Understand the ethical, legal, and socio-economic aspects of information and information technology. 2) Comply with laws, regulations, institutional rules, and ethics related to access and use of information sources. 3) Acknowledge the use of information sources in communicating products or performance.

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RESEARCH RESULT

Overall DIL for lecturers in NTB is presented in Table 3. Table 3 presents the frequency and percentage of lecturers' digital information literacy (DIL) levels. The data indicate that 82.1% of lecturers possess a high level of DIL, while 17.9% fall into the medium category. This finding demonstrates that, overall, the DIL of lecturers in West Nusa Tenggara is categorized as high.

Tabel 3. Lecturer DIL

Category	Frequency	Percentage (%)
Medium	10	17.9
High	46	82.1

Digital information literacy encompasses five core dimensions, as outlined in Table 6: (A) understanding the purpose and meaning of information, (B) skills in accessing information, (C) skills in evaluating information, (D) skills in applying information, and (E) awareness of information ethics and legality. These dimensions serve as a comprehensive framework for assessing the level and quality of DIL among lecturers.

Table 4. Lecturer DIL per Aspect

Aspect	Category	Frequency	Percentage (%)
A	Medium	3	5.4
	High	53	94.6
B	Medium	21	37.5
	High	35	62.5
C	Medium	5	8.9
	High	51	91.1
D	Medium	9	16.1
	High	47	83.9
E	Medium	7	12.5
	High	49	87.5

Table 4 presents the levels of DIL among lecturers across all measured aspects. The data reveal that the majority of lecturers in West Nusa Tenggara demonstrate high proficiency in understanding the purpose and meaning of information, as well as in accessing, evaluating, and applying digital information. Only a small proportion of lecturers are categorized as having moderate levels of DIL. These findings indicate that most lecturers possess sufficient digital information literacy to support the acceleration of educational digitalization in higher education institutions.

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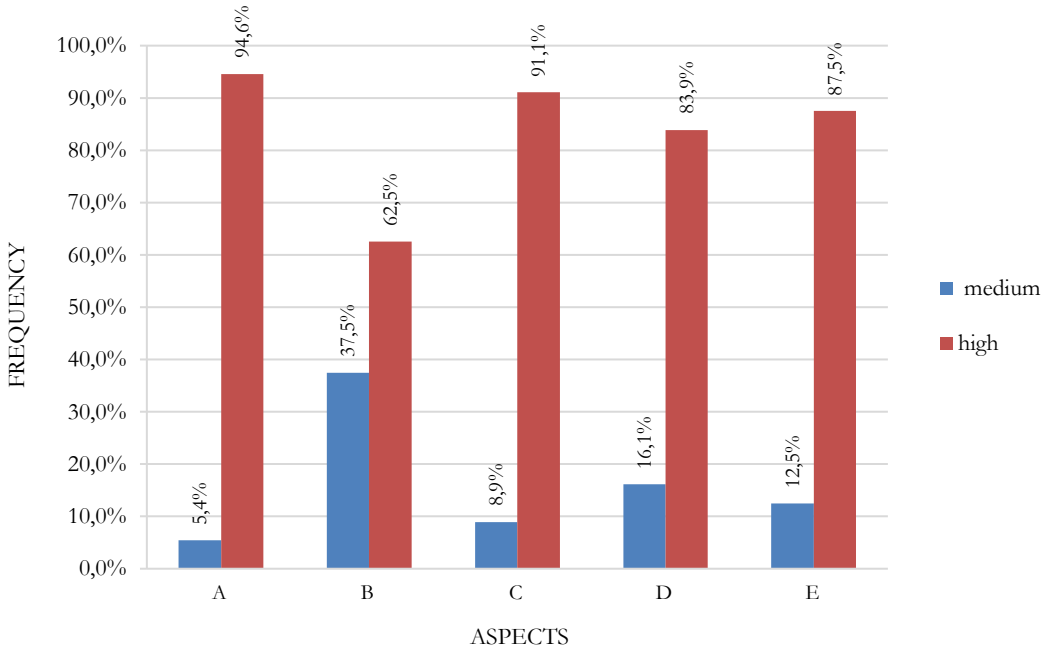

Figure 1. Lecturer's DIL

Figure 1 shows among the five assessed aspects, the highest level of proficiency (94.6%) was observed in understanding the purpose and meaning of information. This aspect includes the ability to discern the significance and urgency of information, identify the types and formats of information sources, determine appropriate search strategies, and assess the level of need for digital information. We also observed high levels of DIL proficiency in the evaluation of information and the understanding of information ethics and legality. The aspect requiring the least improvement was the ability to access information (62,5%).

Table 5. Students DIL

Category	Frequency	Percentage (%)
Low	3	1
Medium	92	30.7
High	205	68.3

The digital information literacy of students is presented in Table 5, categorized into three levels: high, medium, and low. A total of 68.3% of students fall into the high category, followed by 30.7% in the medium category, and 1% in the low category. These figures suggest that students in West Nusa Tenggara (NTB) generally possess a good level of DIL, although there remains room for improvement and further development.

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Table 6. Students DIL per Aspect

Aspect	Category	Frequency	Percentage (%)
A	Low	4	1.3
	Medium	47	15.7
	High	249	83.0
B	Low	2	0.7
	Medium	147	49
	High	151	50
C	Low	2	0.7
	Medium	89	29.7
	High	209	69.7
D	Low	2	0.7
	Medium	90	30
	High	208	69.3
E	Low	3	1
	Medium	185	61.7
	High	112	37.3

Table 6 provides a more detailed breakdown of student DIL across various dimensions. Most students (83%) exhibit strong abilities in understanding the purpose and meaning of information. However, significant gaps persist in other key areas. For instance, only 37% demonstrate high proficiency in understanding the ethics and legality of information, while 50% have high-level skills in accessing digital information. Additionally, 69% of students are proficient in evaluating and applying digital information. These disparities highlight the need for targeted interventions to strengthen student competencies, particularly in ethical use, access strategies, and practical application of digital resources.

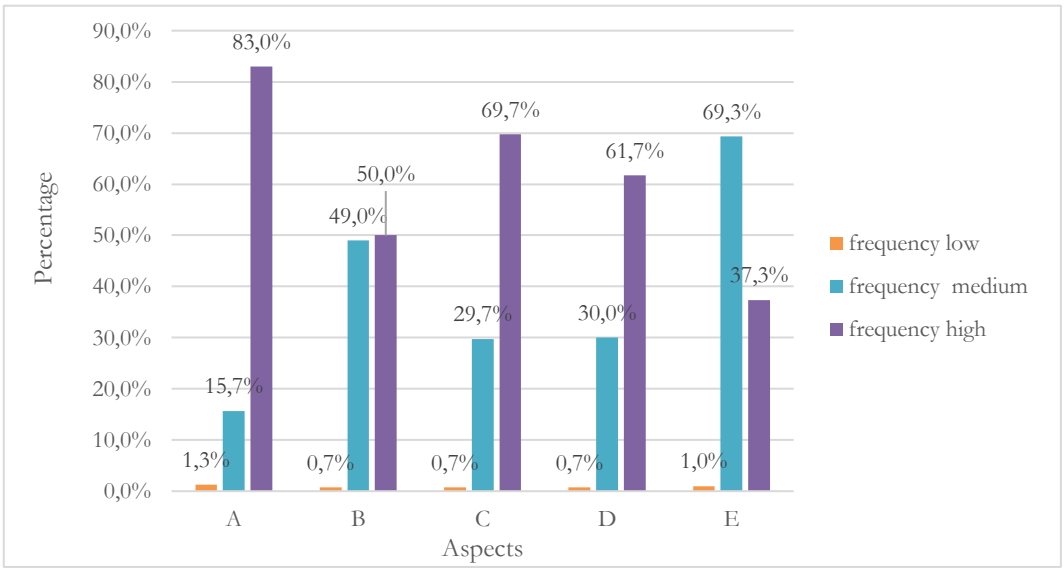

Figure 2. Students DIL

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Figure 2 illustrates the variation in students' digital information literacy (DIL) across its various dimensions. The majority of students demonstrated a high level of proficiency in understanding the purpose and meaning of information (83%). However, several other aspects of DIL, such as understanding the ethics and legality of information (37,3%), accessing information (50%), applying information (61,7%), and evaluating information (69,3%), showed relatively low levels of mastery. This suggests that, while students excel in understanding the purpose and meaning of information, other dimensions of DIL still require further development.

DISCUSSION

Overall, the DIL of lecturers in West Nusa Tenggara is categorized as high. One of the primary factors contributing to this high level of literacy is the strong demand for digital technology and information in academic activities. The integration of digital resources in teaching and learning processes requires lecturers not only to possess DIL but also to maintain it at an adequate and functional level (Mardiana, H., 2024; Tang, C. M., & Chaw, L. Y., 2016). This necessity fosters greater awareness among lecturers regarding the importance of digital information (Wu, D. et al., 2022; Zakharov, K. et al., 2021), enhances their curiosity to develop creative learning strategies, and promotes a sense of digital autonomy. Collectively, these factors support the improvement of DIL among lecturers in West Nusa Tenggara, Indonesia.

The increasing need for digital technology and their frequent exposure to it have significantly contributed to the enhancement of digital information literacy (DIL) (Liesa-Orús, M., et al., 2020; Hidayat-ur-Rehman, I. et al., 2020). These diverse and growing demands motivate lecturers to seek relevant, high-quality, and effective digital information through the application of DIL. This competence is instrumental in strengthening their professional capacity and also contributes to the broader professional development and performance of academic institutions (Nikou, S.,et al., 2022).

Most lecturers possess high DIL to support the acceleration of educational digitalization in higher education institutions. Professional responsibilities and academic activities serve as major driving forces for lecturers' engagement with digital technologies, contributing significantly to their DIL development (Zakharov, K. et al., 2021). Additional contributing factors include the convenience and affordability of digital access, habitual digital use, and accumulated digital experiences that enhance lecturers' confidence in utilizing digital resources (Hidayat-ur-Rehman, I. et al., 2020; D'Ambra, J. et al., 2022). Moreover, lecturers' familiarity with various types,

structures, and formats of digital information further strengthens their DIL (Wu, D. et al., 2022; Bury, S., 2016). The presence of a strong digital literacy culture within academic environments and supportive institutional policies also elevates lecturers' awareness of the importance and function of digital information (Gouseti, A., et al., 2024; Wu, D. et al., 2022).

In contrast, the aspect of accessing digital information was identified as the area with the lowest level of proficiency among lecturers. This suggests that the ability to select and implement effective search strategies, retrieve and organize information, and refine search processes still requires significant development. Several factors may contribute to this limitation, including unequal access to digital technologies, limited self-efficacy and readiness in adopting new technologies, language barriers, restricted access to high-quality academic journals, and suboptimal digital collaboration among lecturers (Moshia, A., M & Mosimaneotsile, M., 2024; Ozor, A., & Toner, J., 2022).

In terms of evaluating information, applying information, and understanding the ethical and legal dimensions of digital information, approximately 83% to 91% of lecturers demonstrate high levels of proficiency. The ability to critically evaluate information is largely supported by lecturers' academic backgrounds, a strong academic culture, and adequate cognitive competencies (Dang, T. D. et al., 2024; Muammar, S. et al., 2023). These strengths translate into enhanced analytical capabilities, critical thinking skills, and the ability to compare various scholarly perspectives, key elements in the evaluation of digital content, including assessing source credibility, data objectivity, and content relevance (Jones-Jang, S. M. et al., 2021).

Furthermore, lecturers' engagement in research practices significantly contributes to their DIL (Sulehri, I. G., et al., 2024). Academic research requires competencies such as literature evaluation, literature review construction, data validity and reliability assessment, and data interpretation. These experiences foster the use of systematic and critical evaluation methods (Matos, J. F. et al., 2023). In addition, regular exposure to scientific information enhances lecturers' discernment in distinguishing between credible and non-credible digital sources (Cooper, G., 2023).

The strong capacity of lecturers to apply digital information is largely influenced by professional demands, adaptive behavior, and specific academic needs. Their obligations to conduct teaching, research, community engagement, and active participation in academic forums significantly shape their competence in utilizing digital information. The widespread availability of

digital technologies and the growing necessity for technology-enhanced learning—especially in the post-COVID-19 era—have accelerated lecturers' proficiency in using a variety of digital learning platforms and tools, such as Google Classroom, Zoom, Learning Management Systems (LMS), Turnitin, and AI-based applications. These factors collectively enhance lecturers' abilities to effectively apply digital information in academic settings.

Beyond technical usage, lecturers also demonstrate a solid understanding of academic integrity and scholarly ethics. This includes awareness of plagiarism, correct citation practices, and the importance of using valid and credible sources. The expectation that all digital academic outputs adhere to rigorous scientific standards further supports the responsible use of information (Cooper, G., 2023). Advancements in plagiarism detection systems and the enforcement of strict academic policies and sanctions have fostered a culture of accountability among lecturers, thereby positively contributing to the development of their digital information literacy (DIL).

The majority of students demonstrate a high level of proficiency in understanding the purpose and meaning of information. This can be attributed to several factors. First, academic demands significantly increase the need for digital information. Learning activities such as completing assignments, writing papers, producing reports, publishing scientific articles, and developing media content necessitate frequent and intensive engagement with digital information sources (Guo, J., & Huang, J., 2021). Furthermore, the ease of accessing digital content has made these resources particularly attractive to students (Avcı, Ü., & Ergün, E., 2022). Digital media are perceived as more practical, offering quicker and more affordable access to information compared to traditional methods, such as printed books. This practicality reinforces students' reliance on and engagement with digital information.

Second, students' exposure to digital content is greatly enhanced by accessible digital infrastructures. As a result, they become familiar with the different types and formats of digital information needed to complete their academic tasks (Guo, J., & Huang, J., 2021). Many students also demonstrate awareness of current digital platforms, media, and AI tools, which contributes to a deeper appreciation of the strategic value of digital information. Additionally, participation in research activities, student organizations, and academic forums further promotes their understanding of the relevance and importance of information in the digital age.

Conversely, students tend to lack proficiency in applying ethical and legal considerations when using digital information. This remains a critical issue among students in West Nusa

Tenggara. Many students do not yet fully grasp the necessity of adhering to academic standards and ethical norms in information usage. Cases of plagiarism, improper use of AI, and high levels of similarity in student submissions are still commonly reported (Avcı, Ü., & Ergün, E., 2022). Often, students prioritize the speed of task completion over the quality and integrity of their work. These factors significantly undermine their digital information literacy. Addressing this issue requires lecturers to provide explicit instruction in paraphrasing and critical reading strategies, enabling students to reformulate digital texts into original expressions without losing their intended meaning (Roe, J., & Perkins, M., 2022; Svensson, T. et al., 2022).

While students generally possess basic skills in accessing and utilizing digital information, many struggle to optimize and expand these abilities. Several contributing factors have been identified. First, access to digital technologies and resources remains uneven. Students in remote or rural areas often face limited internet connectivity and lack essential tools such as laptops, smartphones, or stable digital networks. Economic disparities further exacerbate this issue, affecting students' ability to engage consistently with digital platforms (Asongu, S. A. et al, 2024). These inequalities in access contribute to differences in digital adoption and slow the progress of digital learning among students (Timotheou, S., et al., 2023).

Limited exposure to quality digital content also affects students' ability to discern credible information. Additionally, the rapid influx of digital content from diverse sources often leads to information overload, making it difficult for students to distinguish between scientific and non-scientific sources. This confusion is worsened by students' tendency to complete assignments hastily, neglecting to verify the credibility or accuracy of the information used. The preference for speed and convenience results in shallow information searches with little emphasis on critical analysis or cross-referencing, ultimately weakening students' information evaluation skills.

A notable discrepancy exists between the DIL of lecturers and students. In general, students' DIL falls within the moderate range, suggesting that although they are considered part of the digital-native generation, their ability to critically and effectively use digital information remains underdeveloped. This finding contrasts with 21st-century educational expectations, which call for students to master multiliteracies, (including digital, informational, multimedia, visual, and audio literacies) alongside critical thinking and a nuanced understanding of ethical, legal, social, and cultural issues within the digital ecosystem (Lim, F. V. et al, 2021).

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Overall, the findings of this study suggest that both lecturers and students in West Nusa Tenggara (NTB) are progressing positively in their mastery of digital information literacy (DIL). However, further reinforcement is necessary, particularly for students, to enhance their capacity in this domain. Digital information literacy is not only integral to academic development but also constitutes a critical life skill for meaningful participation in the digital society (Haider, J., & Sundin, O., 2022). This is especially relevant for prospective educators at all levels (from pre-service teachers in schools to lecturers in higher education) who play a vital role as facilitators in transmitting knowledge and fostering the competencies of future generations. Proficiency in digital literacy is essential for effectively navigating the complex digital landscape and mitigating the risks of information overload, misinformation, and disinformation (Paletta FC & da Silva AM., 2018).

In this regard, it is imperative to incorporate DIL comprehensively into the educational curriculum. The integration of information literacy into teaching and learning processes has been shown to enhance students' abilities to locate, evaluate, and use information critically and ethically (Haider, J., & Sundin, O., 2022). Furthermore, DIL development strengthens research capabilities, critical thinking, and problem-solving skills, core competencies required in the 21st-century knowledge economy (Asongu, S. A. et al, 2024; Ozor, A., & Toner, J., 2022). By systematically improving the DIL of both students and lecturers, higher education institutions in NTB will be better positioned to respond effectively to the demands and challenges of educational digitalization within the framework of Society 5.0.

Gilster (1997) defines digital literacy as the ability to understand and use information from various digital sources. This theory focuses on cognitive skills, including critical thinking, decision-making, the ability to search and navigate information, and the ability to synthesize knowledge. This perspective is very relevant to the DIL construct, which emphasizes the ability to access, critically evaluate, and process information before applying it in the knowledge synthesis process. Thus, Gilster's theory provides a strong conceptual foundation for understanding how DIL becomes a fundamental competency in the context of digital learning.

In its implementation, e-learning requires students to interact with various digital sources (Koh, J. H. L., & Kan, R. Y. P., 2021), ranging from online modules, learning videos, scientific articles, discussion forums, and learning management systems (LMS). Therefore, mastery of digital literacy directly influences the success of e-learning implementation in higher education. The smoothness of the digital-based learning process is greatly influenced by the ability of lecturers and

students to access, evaluate, and integrate information ethically and responsibly (Lestariani, N., 2023). In other words, DIL forms the foundation of cognitive readiness that enables effective learning, while simultaneously bridging potential epistemic and pedagogical barriers that often arise from the digital divide and weak information ethics.

From a practical perspective, DIL is not merely positioned as a supporting skill in e-learning but has become a core competency that should be integrated into e-learning curriculum design. This integration can be achieved through the provision of authentic assignments, the use of problem-based learning approaches, and assignments based on exploration and management of digital resources. In terms of evaluation, assessment rubrics should include indicators of information ethics and academic integrity to ensure that students are not only technically skilled but also responsible in using digital information.

The findings of this study also have practical implications for higher education institutions in West Nusa Tenggara (NTB). First, the results indicate the need to improve equitable digital infrastructure to support information access. Second, intensive training for lecturers and students regarding digital technology skills, including the use of artificial intelligence and anti-plagiarism tools, needs to be strengthened. Third, institutions need to develop internal policies that emphasize ethical literacy and responsible information management as part of the curriculum and campus academic culture. Thus, strengthening DIL at the institutional and individual levels can contribute directly to improving the quality of e-learning implementation in the local context of NTB.

CONCLUSION

Overall, findings indicate that digital information literacy (DIL) among lecturers and students in West Nusa Tenggara (NTB) is generally high, with lecturers demonstrating stronger competencies, particularly in interpreting meaning and critically evaluating digital sources. Students, meanwhile, demonstrate a solid but still weak understanding of digital ethics and information legality, as reflected in persistent issues of plagiarism and inappropriate use of AI. Despite these positive trends, challenges remain, including limited access skills among a small proportion of lecturers and a marked ethical gap among students, highlighting the need to strengthen competencies related to responsible information access and practices. The study's reliance on self-report data, limited institutional coverage, and lack of contextual analysis also limit the generalizability and depth of the findings, underscoring the importance of future research that broadens the participant base, utilizes performance-based assessments, and explores ethical digital

behaviors in greater depth. Strengthening these areas will not only yield a more accurate understanding of DIL in NTB but also inform the development of more effective policies to support a responsible, ethical, and sustainable digital learning ecosystem.

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