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The Role of Digital Literacy in Online Teaching: The Lecturers' Perspectives

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Abstract. This research explores how educators view digital literacy in virtual instruction, examining the impact of both internal and external factors on digital skills. Through a combination of methods, information was obtained from surveys completed by 103 lecturers and from detailed interviews with 15 lecturers in Tangerang City. Results indicate that 76.7% of respondents feel external factors, such as institutional support and infrastructure, are primary drivers for successful digital integration. Additionally, 69.9% of lecturers reported that internal factors, including attitudes, beliefs, and intentions, directly impact their digital teaching effectiveness. Educators proficient in digital literacy supported interactive online environments, while those with limited skills faced challenges that impacted student engagement and comprehension. The findings highlight the significance of ongoing digital literacy education, backing from organizations, and establishment of policies to encourage effective digital incorporation. These results emphasize the key role of digital literacy in improving online teaching and provide guidance for institutions seeking to enhance teacher preparedness in digital education.

Keywords: Digital Literacy, Educational Technology, Higher Education, Lecturer Perspectives, Online Teaching

1 Introduction

In online teaching, lecturers must communicate reciprocally, transfer information virtually, and offer interaction opportunities. This was confirmed by M. Li & You (2022) that lecturers can use features in teaching such as drawing, pointing, selecting instant feedback, and chatting online so that teaching becomes more interesting.

According to Mathura[1], the lecturer's perspective in online teaching is associated with three ideas, namely (1) curriculum content and academic achievement, (2) sequence and readiness, and (3) the importance of transferring learning to students. In online teaching, digital competence must involve in-depth digital literacy, such as information technology, audio-visual, and communication [2], [3]. Thus, this encourages lecturers to use digital literacy in synchronous and asynchronous teaching to innovate with the help of information and communication technology.

Online learning can be defined as a teaching method that includes electronic devices and tools and interactions between lecturers and students related to the educational process. The lecturers can collaborate with other lecturers, with students, or students with other students. Furthermore, a big challenge in online teaching is that lecturers must acquire digital skills.

The problem that will be investigated are some lecturers in Tangerang City have low digital literacy skills. Most are observed to be less interested in reading internet content because of the difficulty of using digital technology even though the right information is available online [4]. Furthermore, many online learnings are hampered due to lecturers' lack of digital literacy. It leads to student protests involving too many assignments and tasks, which reduces the ability of the students to understand the lessons being taught [5]. Mardiana (2018) discovered that lecturers in some institutions rarely check the results of student assignments while several senior lecturers are still reluctant to change their system of teaching from face-to-face which they considered easier and more comfortable.

The change in teaching from face-to-face to online involves changing the learning organization. It is complicated by individual, institutional, and cultural factors [6], [7]. Examining the relationship with this, the

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factors of lecturers' readiness to teach online must understand the conditions of the culture of the institution. Moreover, according to Nyamapfene (2020) these factors do not affect lecturers in the same way because lecturers in higher education are not a homogeneous group, given different backgrounds with different digital technology experiences.

This study explores the influence of internal and external factors on lecturers' digital literacy and its impact on online teaching effectiveness. Given the study's focus on lecturers in Tangerang City, the findings may reflect specific regional conditions. This highlights the importance of future studies in broader contexts to enhance the generalizability of results.

2 Theoretical Framework

2.1 Lecturers' Perspective on Online Teaching

Schlenz et al. (2020) found that lecturers are satisfied with online education even though they like face-to-face learning and therefore grouped the factors influencing their perspective into internal and external.

2.1.1 Internal Factor influencing Lecturers' Perspectives

The internal factor influencing a lecturer's perspective is a strong predictor of behavioral intention which also determine the attitudes towards digital literacy [8]. Therefore, the lecturer is expected to possess digital literacy skills, which include the ability to access and understand information from different sources by utilizing information technology and the internet [9]. It is important to note that intention comes from within an individual and has the ability to change perspectives. It has also been discovered that digital literacy skills in online teaching have a mutual relationship with behavioral intentions and technology acceptance meanwhile, the changes in attitude due to emotions and thoughts are shown from an individual's perspective [10]. Lindvall & Ryve (2019) found that lecturers are able to effectively adapt and use digital technology through the development of online learning with a coherent strategy, and plans to retrain their skills in digital literacy. This is the reason several previous research investigated how digital literacy affects individuals' intentions and beliefs in using digital technology or how information literacy helps individuals find information.

Rajeh et al. (2021) explained that the teaching strategy of using digital literacy explicitly deals with the transfer of online learning to each student, and it is through an active process of exploring ideas in different contexts with the assistance of the lecturer's flexibility to adapt and enhance lifelong learning [11]. Therefore, the lecturer's intention in adopting online teaching assists students in creating student-centered online classes that activate dialogue between students and lecturers thereby promoting a more authentic learning environment.

Pownall (2012) described that the lecturers' ability to think critically helps to effectively guide students' conceptualization in learning. However, several lecturers are not trained on how to incorporate visual, digital, or media text into teaching with some having a low level of information and communication technology (ICT) skills and understanding of online learning. This scenario was identified by Sailer et al. (2021) as an internal factor that affects the lecturer's perspective. Therefore, lecturers need to perform activities that require access, search, and multimodal text discovery in online teaching through the use of search engines, uploading, downloading files, creating media using word processing, image manipulation, screen-casting, and video editing.

It is important to note that belief plays a crucial role in an individual's perspective and it has been observed that lecturer's belief in digital literacy is weak because there is no reinforcement to build trust, which often comes from a person's mind and is accessible in the memory [12], [13]. Furthermore, this belief is spontaneously activated without much cognitive effort, indicating that lecturers are able to quickly control attitudes subconsciously. This is the reason Hill et al. (1977) & Van Twillert et al. (2020) concluded that individuals' beliefs define their attitudes, norms, or perceived control, and not their behaviors. Similarly, the outcome of belief in integrating digital technology into online teaching pedagogy is reflected in the lecturer's positive or negative attitudes. This implies that the lecturer's attitude is reflected through behavioral beliefs in mastering digital technology.

Lecturers are key players in the effective integration of technology into the learning process. Cheng et al. (2020) discovered that the role of technology is increasingly prominent with the more effective technology usage, and has led to the affordability of effective teaching. Therefore, the requirement for lecturers to incorporate technology into their duties is very important because it increases the usage of digital technology as related to digital literacy. However, those that are not passionate about technology involvement to achieve professional goals are likely to face difficulty in using this technology [14]. This is because they lack confidence and awareness of the technological benefits, therefore, they have to practice or get courses on digital technology [15], and also need to receive training in using digital technology to prevent weaknesses in online learning. Teo[16] found that computer-mediated activities remain peripheral and minimal for lecturers that do not know how to use technology effectively in their classrooms. Meanwhile, Chien et al. (2018) argued that the lack of clear institutional direction

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regarding teaching design and delivery was a major barrier that reduces lecturer's engagement in e-learning. This indicates that every lecturer must be trained and developed in digital technology usage in order to properly conduct online teaching.

2.1.2 External Factor affecting Lecturers' Perspectives

External factors have become a big influence in online teaching due to the advancement in technology and the availability of software related to network resources. These usually motivate lecturers to develop innovative teaching strategies in order to prepare for online learning in the 21st century [17]. Moreover, Guggemos & Seufert (2021) found that the direct impact of digital technology on effective and meaningful learning is still peripheral and not optimal. This simply signifies that to achieve learning, there is a need for training which serves as a driver and motivation to enforce teaching through digital technology and to influence the lecturer's intention in online learning.

According to Saini & Salim Al-Mamri (2019), the inability to integrate digital technology into learning is also a barrier to teaching. Meanwhile, to ensure competency, the lecturers need training, institutional infrastructure, curricula, and knowledge of online pedagogy that contributes to external factors, as well as the authority of practitioners and policymakers, which allows great flexibility between users (Fernández-Batanero et al., 2021). This implied that a learning model must be built to provide a framework for explaining the predictions of technology users as part of online pedagogy and curriculum.

Pratolo & Solikhati (2020) explained that lecturers need to take advantage of online learning by using digital literacy to assist students in creating student-centered online classes that activate dialogue between students and lecturers and promote a more authentic learning environment. Audrin & Audrin (2022) found that external factors affect teaching, institutional systems, and how lecturers perceive the benefits of digital technology. These benefits motivate lecturers and also enhance their activeness, independence, and attention to the teaching process.

Çebi & Reisoglu (2020) concluded that these contextual and cultural conditions influence lecturers' perceptions of the benefits of digital technology. This is in line with Cheng et al. (2020) that the learning perspective benefits approach enables the potential role of digital technology in supporting teaching.

External factors, such as institutional support, training, and access to infrastructure, are essential in shaping lecturers' abilities to adopt digital literacy. For example, Fernández-Batanero et al. (2021) highlight the role of infrastructure in supporting educators' digital skills. Internal factors, including attitudes, beliefs, and intentions, influence lecturers' willingness to embrace digital tools ([16]. This study builds on existing literature by examining not only these factors individually but also how they interact to impact digital literacy.

Based on these previous researches, it was observed that the independent variable is the lecturers' perspective, and it is related to their views on conducting online teaching using digital literacy. This view determines the extent to which the lecturers are able to use digital literacy and their perspective as a driving force in determining the use of online teaching with digital literacy.

2.2 Digital Literacy in Online Teaching

Teo[16] found that lecturers are responsible for using digital technology to create digital literacy for students, prioritizing technical skills when using digital tools and systems considered appropriate for the educational environment, as well as identifying skills that are useful in online learning. This approach involves equipping lecturers with the basic transferrable competencies during online classes because their ability to focus on digital technologies is still low, due to lack of practice and failure to use the technology, thereby leading to ineffective online teaching designs. It has also been discovered that limitations in training, intention to practice, ethics, collaborative elements, and reliable trainers are often ignored [18]. Therefore, the reconceptualization of online teaching must emphasize digital literacy that focuses on skills, broad digital competency models, knowledge, abilities, and dispositions needed by lecturers for online teaching.

In learning, digital literacy has to be integrated into the context to be studied, indicating that lecturers need to know, be knowledgeable, capable, and understand how to manage, manipulate and articulate all digital technology tools into teaching practice [19]. Furthermore, digital technology requires that lecturers develop online teaching skills and assist students in understanding lessons by distributing information needed to build their knowledge [1]. This simply implies that lecturers need to understand how to utilize and develop digital literacy and useful online tools stated by the institution.

It should be pointed out that the communicative interactions between humans and machines differ from that of human-to-human. This implies digital literacy requires a way of thinking and teaching and the ability to apply good digital literacy in creating a meaningful learning environment [20]. It has been observed that when using digital literacy, the absence of limited institutional policies is a barrier to the continuity of teaching. Also, the use of technological tools that helps to improve and strengthen teaching standards is hampered due to limited

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institutional infrastructure. This is in line with Wen & Hua (2020) that the teaching infrastructure that does not meet technology characteristics such as information, audio-visual, and communication hinders learning. Therefore, in addition to encouraging lecturers to use digital technologies, the role of institutions in providing digital technology infrastructure also needs to be fulfilled. The information provided by the statements from these previous studies showed that digital literacy as well as its characteristics in online learning are the dependent variables.

3 Conceptual Framework and Research Methods

This study adopted a mixed-methods approach, combining surveys and semi-structured interviews, to capture both quantitative breadth and qualitative depth of lecturers' perspectives. The survey allowed for a broad analysis of general trends among 103 lecturers, while interviews with 15 lecturers provided richer insights into specific challenges and motivations. This approach was essential for understanding the complex factors that influence digital literacy.

A mixed-method approach was used in this research by employing semi-structured qualitative and quantitative methods through a questionnaire to determine the analysis of digital literacy's role and lecturers' perspectives in utilizing digital literacy [21]. The questionnaire was distributed from January to March, 2022 via Google Forms, e-mail, Facebook, and Instagram, as well as in private and group WhatsApp chat. Furthermore, the semi-structured qualitative method is in the form of interviews conducted with 15 lecturers for 2-3 hours from January to March 2022. The data for the independent or predictor variable includes 5 questions in external factor of lecturers' perspectives, 5 questions in internal factor of lecturers' perspectives, and 5 questions in online teaching with digital literacy. The sample consisted of 103 lecturers spread across Kota Tangerang, and out of the 150 questionnaires given, 103 questionnaires were returned as a convenience sampling technique.

3.1 Conceptual Research Framework

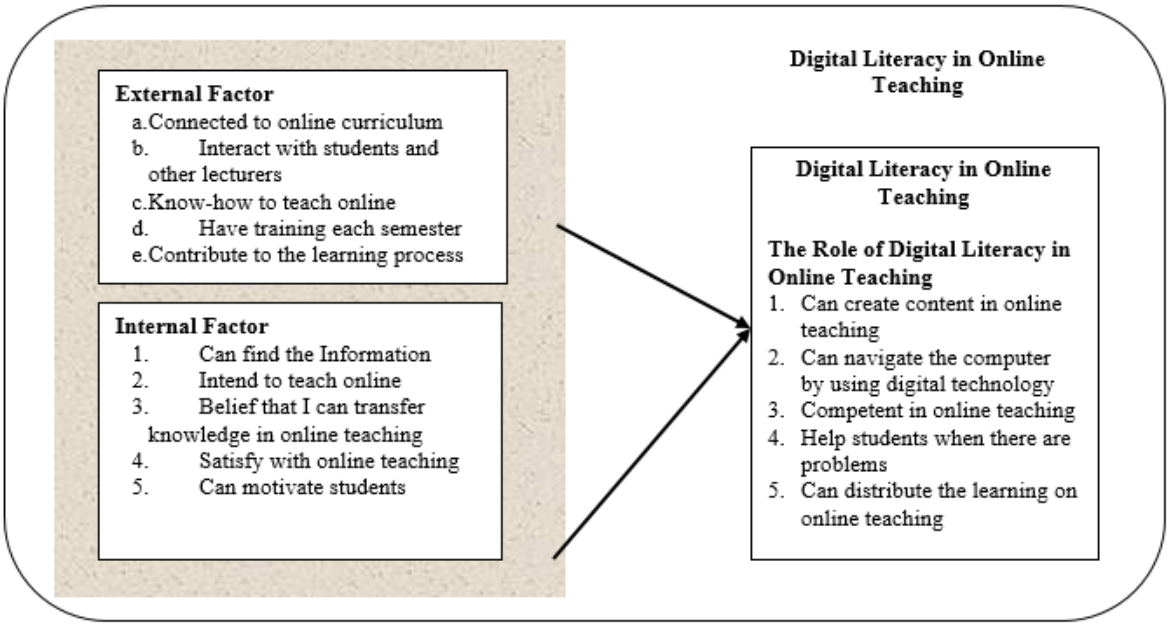

Figure 1. Conceptual Research Framework

3.2 The Questions in this Research Include

RQ1: What are external and internal factors influencing lecturers in implementing digital literacy?
RQ2: What is the relationship between the lecturer's perspective and the role of digital literacy in online teaching?
RQ3: What impact does the lecturers' perspective have on online teaching of digital literacy?

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3.3 Hypothesis

a. There is a statistically significant relationship between lecturers' external factors and the role of digital literacy in online teaching (H1).
b. There is a statistical relationship between lecturers' internal factors and the role of digital literacy in online teaching (H2).
c. There is a statistically significant relationship between lecturers' perspectives and digital literacy in online teaching (H3).

3.4 Data Analysis

The main purpose of conducting and disseminating this research is to gain significant perspectives of lecturers in using digital literacy and its impact on online teaching. There are five questions which are based on 1) lecturers' perspectives on external factors when using digital literacy, 2) lecturers' perspectives on internal factors when using digital literacy and their impact on online teaching, and 3) the role of digital literacy related to online teaching. In the analysis, the reliability and correlation among the data were determined. Table 1 shows the reliability and correlation among the external factors of the lecturer's perspective, the internal factors of the lecturer's perspective, and online teaching using digital literacy.

Table 1. Descriptive Statistics Reliability and Correlation of the Role of Digital Literacy and External Factor and Internal Factor of Lecturers' Perspective

No	Variables	Correlation				Reliability
		External Factors	Internal Factor	Digital Literacy	Ext-Int and dig. lit	
1	External Factor	1	0.277	0.681		0.667
2	Internal Factor	0.277	1	0.695		0.692
3	Digital Literacy	0.133	0.188	1	0.670	0.730
4	Ext-Int and dig. Lit.	0.681	0.695	0.670	1	0.760

According to the measurements in table 1, it was observed that the reliability of external factors is 0.667, the reliability of internal factors is 0.692, and digital literacy reliability is 0.730. Also, the correlation between external factors and digital literacy is 0.681, internal factors and digital literacy is 0.695, and the correlation between the three variables and digital literacy is 0.670, thereby, indicating they are reliable and correlated.

4 Findings

Frequency analysis was used in the investigation of lecturers' perspectives on online digital learning to show the number of occurrences of each response selected by the respondents. Exploratory techniques were used and the findings were presented clearly to understand the statistical assumptions and conclusions [22]. The findings suggest a strong interaction between institutional support (external factor) and lecturers' motivation (internal factor). For instance, lecturers who received regular training reported higher confidence and a greater willingness to integrate digital tools into their teaching. Conversely, those without adequate support expressed lower motivation, highlighting the importance of these interdependent factors in effective virtual instruction

Table 2 shows the frequency of lecturers' perspectives, external factors, internal factors, and the use of digital literacy in the online teaching process.

Table 2. Descriptive Statistics Frequency of Lecturers' External Factors and Internal Factors and Its Role of Digital Literacy in Online Teaching

Variables	Means	SD	Frequency	Percentage (%)
External Factor				
Find Online Curriculum	3.39	0.962	64	62.1
Know-How to Use the Internet	3.28	0.879	62	60.2
Have Training Each Semester	3.37	0.874	58	56.3
Lecturers and Students Interaction	2.97	0.980	41	39.8
Contribute to the Online Learning	3.40	0.883	27	26.2

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Internal Factors				
Intent to Teach Online	3.52	0.698	65	63.1
Able to find the Information	3.43	0.824	60	58.3
Belief in the Ability to Transfer Knowledge	3.22	0.838	56	54.4
Satisfy to Teach Online	3.11	0.875	51	49.5
Have skills in Online Teaching	2.94	0.898	34	33
The Role of Digital Literacy in Online Teaching				
Master in Content Knowledge	3.49	0.803	65	63.1
Competent in Teaching Online	3.43	0.892	65	63.1
Can Navigate Computer	3.13	0.926	50	48.5
Help Students in Online Learning	3.20	0.890	46	44.7
Can Distribute the Learning	3.90	0.912	52	50.5
The Impact of Lecturers' Perspectives on Digital Literacy in Online Teaching				
Internal Factor of Lecturers' Perspectives	16.22	2.516	72	69.90
External Factor of Lecturers' Perspectives	15.41	2.636	79	76.69
Digital Literacy in Online Teaching	16.33	2.826	75	72.81

Table 2 shows descriptive statistics that described the frequency of lecturers' external factors and it was observed that the highest frequency is "find the online curriculum" with 64 respondents representing 62.1%, as well as a mean and SD of 3.39 and 0.962, respectively. This implied that 64 out of 103 respondents found the online curriculum on the Internet, while 39 were unable to find it online, even though they all knew that curriculum, syllabus, and lesson schemes are available online.

The second highest frequency is "know-how to use the Internet" with 62 respondents, representing 60.2%, as well as a mean of 3.28 and SD of 0.879. The interview with respondents revealed that when teaching online, lecturers need to know and understand the use of the Internet. It should be noted that the high penetration rate of new technologies for online teaching creates new beliefs and challenges and has solutions to address them. Therefore, it is possible to implement online teaching based on the understanding of internet usage with digital technology.

The third highest frequency is to "have training each semester" with 58 respondents representing 56.3%, 3.36 mean, and 0.874 SD. Interviews with these respondents showed that lecturers were willing to receive digital technology training every semester due to the belief that digital technology is constantly changing, therefore, they need to be retrained every semester.

The fourth highest frequency is the "interaction between lecturers and students" with 41 respondents, representing 39.8%, 2.97 mean, and 0.980 SD. These respondents explained that there is a need for interaction between lecturers and students, as this is able to assist the lecturer to know whether the students understand the teaching. It is, therefore, safe to conclude that the lecturer-student interaction greatly affects students' ability to change for the better and have good relations with peers.

The fifth highest frequency is to "contribute to the online learning" with 27 respondents representing 26.2%, as well as a mean and SD of 3.40 and 0.883, respectively. In the interview, respondents stated that contributing to online learning requires institutional support and adequate infrastructure facilities. It was observed that only 27 out of 103 respondents selected this because not all institutions are fully contributing to online learning.

Lecturers' attitudes towards digital literacy greatly influence their teaching methods. Those with positive beliefs about the value of digital skills are more likely to adopt student-centered approaches. For instance, a lecturer mentioned, 'I believe digital literacy allows me to connect better with students, so I always try to use interactive tools in my lessons.' Conversely, lecturers with limited confidence in digital tools tend to adopt more traditional, less interactive approaches, which may hinder student engagement

In the internal factor, the highest frequency is "intending to teach online" with 65 respondents indicating 63% of the total number, as well as a mean of 3.52, and SD of 0.698. The respondent stated that the lecturer intended to teach even though they are sick or had personal problems. This implies that strong intentions and beliefs provided the best teaching to students and subsequently increase their excitement.

The second highest frequency in the internal factor is "able to find the information" with 60 respondents representing 58.3%, as well as a mean and SD of 3.43 and 0.824, respectively. In the interview, respondents explained that lecturers need to learn to use digital technology and literacy to obtain the correct information from accurate sources in order to provide useful learning information to students.

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The third highest frequency is “belief to transfer the knowledge” with 56 respondents representing 54.4%, as well as a mean and SD of 3.22 and 0.838, respectively. In this interview, respondents described lecturers believed that knowledge is transferable through online teaching.

The fourth highest frequency in this category is “satisfied to teach online” with 51 respondents representing 49.5%, as well as a mean of 3.11, and SD of 0.875. In the interview with respondents, it was observed that lecturers are quite satisfied with current online learning, have studied online learning platforms, and understand the use of digital technology to ensure students understand the learning provided. Furthermore, the subsidized internet data packages from the institution meet the teaching needs such that lecturers no longer need to buy or search for internet data packages for teaching. Therefore, online learning is increasingly being used in all educational institutions to enable teachers to teach more effectively.

The fifth highest frequency in internal factor is to “have skill in online teaching” with 34 respondents representing 33%, as well as a mean and SD of 2.94 and 0898, respectively. The respondents stated that the biggest problem was the sudden change from classroom to online learning. They highlighted technical problems as the most important issues followed by the lack of technical and teaching skills required in the online environment. Also, the lack of interaction between lecturers and students, as well as the poor communication has a big impact on skills in teaching online. It is critical to note that the role of digital literacy in online teaching is to navigate the new technology paradigm in which the community operates. This implies that effective learners in an online environment are useful for digital literacy. Moreover, lecturers must have the skills and understanding of the tools and platforms used for learning to take place smoothly.

Lecturers with limited digital literacy face significant challenges, including technical difficulties, lack of experience with digital tools, and reduced engagement in online settings. One lecturer noted, ‘Without proper training, I often struggle to make the lessons engaging for my students, which impacts their learning experience.’ Such challenges underscore the need for institutional support to address these gaps. Respondents suggested that more frequent digital skills training and accessible technical assistance could help them overcome these obstacles.

Based on Table 2, two dimensions including “competent in online teaching” and “creating content in online teaching” have similar frequency of 65 respondents, representing 63.1%. The mean and SD for creating content online teaching were 3.49 and 0.803 while those for competent in teaching online were 3.43 and 0.892, respectively. Interviews conducted on respondents showed that lecturers must be competent in online teaching, even though they are knowledgeable in basic learning theory, have distance learning knowledge, have an organized curriculum, provide verbal and non-verbal teaching, and work collaboratively in teams. This indicates that there are still many more things that lecturers need to master, and that all lecturers have to undergo continuous training.

In the interview on “content knowledge”, respondents explained that content knowledge refers to a collection of knowledge and information imparted by lecturers, such as the topics in mathematics, science, or social studies. Furthermore, teachers must master content knowledge that refers to facts, concepts, theories, and principles learned in online classes and appropriate pedagogy in order to impart such knowledge. This policy analyzes the various policies that help to improve and control mastery of content. Several lecturers argued that content knowledge is different from skills and also debated about the one that is more important for higher institutions in the delivery of knowledge or skills.

The fourth highest frequency is to “help students in online learning”, which has 46 respondents representing 44.7% with a mean and SD of 3.20 and 0.890, respectively. In the interview, respondents explained that in the case of online learning, in which the lecturers and students are not in the same location, maintaining virtual face-to-face contact as much as possible is very important to keep students engaged in learning.

According to UNICEF (2020), lecturers need to be aware of students' questions and concerns by using chat rooms as feedback for online learning or forums that enable students to arrange questions, comments, and concerns arising due to the evolving nature of online learning. This denotes that institutions must strive to think outside the box, innovate to engage students, and provide solutions for future preparation.

The impact of the lecturer's perspective on digital literacy in online learning is shown in the results of the relationship between internal factors and digital literacy, which entails 79 respondents representing 76.69%, with a mean and SD of 15.41 and 2.636, while the relationship between external factors and digital literacy in online teaching entails 72 respondents representing 69.90% with a mean and SD of 16.22 and 2.516, respectively. It was also observed that the role of digital literacy in online teaching entails 75 respondents representing 72.81% with a mean and SD of 16.33 and 2.826, respectively.

The descriptive statistical measurements showed that the external factors influencing the lecturer's perspective are the main determinants of online teaching followed by the role of digital literacy which contributes to online teaching. It was observed from the interview that internal factors exist within the lecturers which drive their attitudes and increase their motivation to use digital literacy in online teaching. The next step was to measure the relationship between external factors, internal factors, and the role of digital literacy in online learning as shown in Table 3.

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The second highest frequency is to “distribute the learning” with 52 respondents which represents 50.5% and a mean and SD of 3.90 and 0.912 respectively. In the interview, the respondents explained that lecturers must have the time, effort, and resources to distribute online learning. Moreover, the policies in each institution are different such as lecturers' working as contracts staffs, lack of experience in teaching, and lecturers' income. In distributed learning, the lecturer refers to the learning plan and distributes the information to be learned during the session using the learning method that has been mastered.

The third highest frequency is to “navigate the computer” which has 50 respondents (48.5%) with a mean and SD of 3.13 and 0.926 respectively. In the interview, lecturers stated that computers need to be integrated into learning by cultivating the habit of teaching with different methods, such as using computers to update subjects on knowledge and teaching skills, develop lesson plans, prepare additional teaching materials, search for relevant information via the internet, and prepare question banks.

Table 3. Descriptive Statistics of the Relationship Between External Factors, Internal Factors, and the Role of Digital Literacy in Online Learning

Variables	R	R^2	F-Change	Sig. Change
External Factors	0.781	0.564	97.321	0.000
Internal Factors	0.795	0.583	94.337	0.000
The Roles of Digital Literacy in Online Learning	0.770	0.549	82.826	0.000

Table 3 shows the descriptive statistics of the relationship among external factors, internal factors, and the role of digital literacy in online learning. It was observed that for external factor, R is 0.781 indicating the prediction of the learning process, while R2 is 0.564, representing the proportion of external factor variables from lecturer attitudes. The proportion of external factors of lecturers' attitudes is 56.4%, and the remaining 43.6% are from others that are not included in this research, while F-Change shows 97.321 > 0.05, and the significant change is 0.000. This answered hypothesis 1 that external factors are the attitude of lecturers and the role of digital literacy in online learning, indicating that Ho is rejected while Ha is accepted. This indicates that there is a relationship between external factors of lecturers' attitudes and the role of digital literacy in learning (H1).

Concerning the internal factor, R is 0.795, indicating the prediction of the online learning process, while R2 is 0.583 which is the proportion of internal factor variables from the lecturers, shown in their attitudes toward the role of digital literacy in the online learning process. It was also observed that the proportion of internal factors of lecturers' attitudes is 58.3%, and the remaining 41.7% comes from other parties not included in this research, while F-Change is 94,337 > 0.005, and Significance Change is 0.000. This answered hypothesis 2 that the internal factors of lecturer attitudes and the role of digital literacy in online learning, thereby, leading to the rejection of Ho and acceptance of Ha. This implies there is a relationship between the internal factors of lecturers' attitudes and the role of digital literacy in online learning (H2).

Furthermore, the role of digital literacy in online learning shows that R is 0.770, indicating the prediction for the online learning process, while the variable proportion of digital literacy’s role in online learning denoted as R2 is 0.549. It was observed that the proportion of digital literacy’s roles is 54.9%, and the remaining 45.1% comes from other parties not included in this study, meanwhile, F-Change is 82,226 > 0.005, and Significance Change is 0.000. This answered hypothesis 3 that the role of digital literacy on online learning, namely Ho, is rejected, and Ha is accepted. This simply indicates that there is a relationship between the role of digital literacy and online learning (H3).

5 Result and Discussion

Lecturers and institutions need to be committed to online and offline learning across the student lifespan. Guerrero-Roldán, & A., Noguera (2018) argued that it is not possible for teachers to only solve the problem of the learning subject, but they need to believe and understand the value of the learning subject. According to Biku et al. (2018), the institutional leadership and policies need to support students of all ages, to prevent time wastage in meetings that are meant to change their minds. This simply implies that lecturers must take a strong stance on teaching online learning.

It is important to be pointed out that the lecturer's attitude either shows an encouragement or hindrance to the implementation of online education. Wang et al. (2021) found that the internet is a site of theoretical knowledge and concepts that challenge the differentiation of knowledge, while Schlenz et al. (2020) showed that the online curriculum contains lesson plans in the form of online learning scenarios and it is able to collaborate with the roles of other lecturers and students in the online learning process. This siginifies that digital technology mastery and the lecturer’s adaptation to the online curriculum are very important. This is in line with Alawamleh et al. (2020)

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that the mastery of technology using desktops, laptops, and various media types is a reference in the online curriculum. Therefore, the online learning process must be conducted to enable students to continue to receive education even when the curriculum is not complete. Also, mastering digital literacy allows lecturers to read, write, and communicate online.

Pratolo & Solikhati (2020) discovered that lecturers need to map students based on their distance from home, ownership of cellphones, internet networks, and internet packages or abilities and opportunities in learning activities in order to overcome several obstacles in the delivery of materials either online, offline or combination of these two. It should be noted that the effectiveness of a lecturer when imparting knowledge allows students to gain experience, however teaching style is often associated with their preference as the student often prefers discursive rather than authoritative teaching. It was observed that students appreciated the lecturer even though the discursive manner of teaching was not popular, this is the reason Burkholder & Krauskopf (2021) concluded that lecturers need to divert teaching to the discussion. This indicates that the contribution of lecturers in teaching provides benefits, consistent learning, and helps to discover teaching resources through technology.

Hill et al. (1977) found that intentions and beliefs are strongly related because when people have a positive belief toward an object, they tend to behave positively. Intention and belief are defined as a person's position on a subjective probability dimension, which involves the relationship between the individual and an action [9], [23], [24]. Therefore, intentional behavior and beliefs refer to a person's subjective likelihood to perform a behavior, denoting that lecturers' intentions and beliefs must be accompanied by deeper pedagogical learning and commitment to the use of digital literacy.

Furthermore, lecturers' satisfaction with online teaching suggests they are focused on transferring knowledge to students based on diffusion innovations. This is in line with M. Li & Yu (2022) and Rajeh et al. (2021) that lecturers that have a way of delivering instructions with a rich social environment in the classroom are able to improve student learning abilities. This simply indicates that teachers' interest in online learning helps them to easily and quickly adapt to digital literacy. It was observed that the lecturer's satisfaction arises after knowing that students are interested in the teaching, implying that those conducting online learning provide useful input to the institutions. Therefore, the collaboration between lecturers and students, lecturers and lecturers, or students and students creates useful online learning.

To support digital literacy among lecturers, institutions should consider implementing regular, semester-based digital training programs and providing ongoing technical support. Additionally, policies that ensure access to necessary infrastructure, such as high-speed internet and up-to-date software, can significantly impact lecturers' engagement with digital literacy over time. Sustained support from institutions not only improves teaching effectiveness but also promotes long-term integration of digital literacy

Cheng et al. (2020) defined digital literacy as the ability to understand and use various forms of information and comprehensive resources, which are accessible through computer devices. Zheng et al. (2020) also explained that digital literacy is the knowledge and skills of using digital media to find, evaluate, create, and use information wisely in a healthy and law-abiding manner. Darling-Hammond et al. (2020) further concluded that lecturers must have the knowledge, ability, and digital skills for virtual learning to run smoothly. This inferred that the students need to be taught the knowledge about the ethical use of digital resources, understanding of digital footprints, online self-protection, as well as handling digital communication and cyberbullying in order to ensure the utilization of digital literacy. Therefore, lecturers can provide students with the ability to access, understand, and use digital literacy in online learning.

6 Conclusions

The lecturer's perspective is important when teaching online, and their abilities, skills, as well as an understanding of digital technology were also observed to be useful in teaching students how to safely use digital technology. Therefore, lecturers need to improve their knowledge, abilities, skills, and understanding of digital technology to become digitally literate.

This research examined the external and internal factors influencing lecturers' attitudes toward applying digital literacy in online learning and the result showed that the external factors are the main determiner of the success of online teaching because it helps the lecturers to get an online curriculum, know the use of digital technology, and interact with students. Meanwhile, institutions need to also provide digital literacy training every semester in order to contribute sustainably to online teaching. Concerning the internal factors, it was discovered that lecturers must have strong intentions and beliefs about applying the digital skill in order to understand how to get information. This often enhances their satisfaction with teaching online and, more importantly, motivates the students. Furthermore, it is possible to create course content through digital skills to ensure easy distribution online and navigation.

Lecturers that contribute effectively to online teaching normally assist students to gain online learning experiences, collaborate, and increase their discursive ability. This indicated that lecturers provide the benefits of

constant learning by relying on technology. It was also observed that the existence of digital technology training in institutions provides a conceptual framework to develop digital skills for the lecturers and this is the reason educational institutions need to keep organizing digital literacy training.

In this research, many policies were formulated by institutions and the Indonesian Ministry of Education. This is considered feasible because it is likely to affect online teaching in the future. In addition to pedagogical knowledge, curriculum, and teaching methods, lecturers also need knowledge, abilities, skills, and understanding to teach comfortably through infrastructure assistance from educational institutions.

In the future, the involvement of institutions in handling online teaching needs to be examined to ensure the smooth running of the learning system. This institution must also be able to properly maintain the recruitment of lecturers. Furthermore, policymakers must accept those that understood digital technology, and training must be organized every semester for lecturers that teach online. The Indonesian government needs to keep providing learning platforms that make it easier for teachers and students, based on the institution's condition as well as the times and usage. This indicated that the policies for the use of digital literacy need to be more flexible in order to assist digitally-illiterate lecturers to utilize online teaching. Also, lecturers need to be trained continuously and must not be hindered from practicing and teaching online.

This study's focus on Tangerang City limits the generalizability of the findings. Future research should consider diverse samples across regions to assess whether the identified factors and challenges are consistent in different educational and geographical contexts. Additionally, longitudinal studies could examine the long-term effects of institutional support on digital literacy development among educators.

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