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DIGITAL LITERACY DEVELOPMENT OF UNDERGRADUATE STUDENTS FOR SOCIETY 5.0: PEDAGOGICAL IMPLICATION FOR LANGUAGE AND SCIENCE EDUCATION

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Abstract: The rapid advancement of technology in the era of Society 5.0 has reshaped education, leading this study to investigate how students develop and strengthen their digital literacy skills. This qualitative research was conducted among students from the Language and Science Departments of a state Islamic university in Tulungagung, Indonesia. From 174 students responding to the questionnaire, twelve were purposively selected for in-depth interviews based on their high level of digital literacy. Data were analyzed thematically using a systemic qualitative approach that involved cross-verifying interview findings with observational data. Findings reveal that internal factors such as curiosity

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about technology, intrinsic motivation, learning needs, and preference for digital tools strongly influence students' digital literacy. External factors—particularly social environment, academic culture, and lifestyle—were found to enhance these skills. Pedagogically, this study proposes transformative strategies such as the integration of online laboratories (OLABS), digital-based learning systems, and technology-oriented competitions. As a transformative study, it calls for Islamic higher education institutions to foster a digitally enriched learning ecosystem that aligns with the demands of Society 5.0.

Keywords: *digital literacy development, digital literacy skills, Society 5.0*

INTRODUCTION

Digital Literacy (DL) can be developed in line with the vast advancement of digital technology in almost all aspects including teaching and learning. It is essential to help students adapt to technological changes because it affects teachers' and students' attitudes toward the use of computers in education (Yeşilyurt & Vezne, 2023). DL also prepares them to work in digitalized fields (Khan et al., 2022) because it has a direct impact on the perceived ease of using technology in the workplace (Nikou et al., 2022). With good digital literacy, students not only find relevant information, but also process, analyze and present it critically, and make effective use of digital information. Digital literacy skills help students find relevant academic resources, and make wise decisions in the face of information flooding in the digital world as well. This is parallel to a study conducted by Ricoy et al. (2022) proving that primary school children acquired more efficient strategies for finding information online by using apps and developing content with digital tools. In addition, digital literacy also enhances students' creativity and innovation in the learning process, enabling them to utilize various digital platforms to

solve problems and produce effective solutions in language and science learning. This indicates the need for students to build and develop digital literacy skills.

Digital literacy skills, such as the ability to use information and communication technology effectively, cover the ability to find, evaluate, utilize, and create information using digital media. Students of language and science programs in this context need to develop these digital literacy skills to adapt to the demands of the modern world of education. For students of language study programs, the skills of accessing text-based information sources and utilizing digital technology to write, translate, and communicate across cultures can support their academic success. Meanwhile, students in science programs need to master digital skills related to data analysis, scientific simulation, and utilizing digital platforms for research. Yaacob et al. (2024) in their study disclosed the significant and direct impact of information and data literacy as part of digital skills to Industrial Revolution 4.0 adaptation. The balanced development of students' technological skills in higher education is also essential for their personal, social, and professional future and, in turn, for their quality of life (Rodrigues et al., 2021). Thus, the mastery of these skills help them to be better prepared for the challenges of the digitally connected Society 5.0 era.

Students with good digital skills show several important indicators that reflect their digital literacy. One of the key indicators is their ability to find and critically assess information from various digital sources. This is in line with Sparks et al. (2016), who state that digital information literacy is a set of integrated information processing skills that are essential for professional and academic success. Students should be able to select valid and relevant information from reliable sources and distinguish between accurate information and hoaxes. In addition, the skill to navigate in digital environments, such as hypertext and various search tools, is an important aspect of students' digital literacy skills. DL comprises not only the ability to operate a digital device; it includes a large variety of complex cognitive, motor,

sociological, and emotional skills like "reading" instructions from graphical displays in user interfaces, constructing knowledge from a nonlinear, hypertextual navigation, and have a mature and realistic understanding of the "rules" that are dominant in the cyberspace (Eshet, 2004). Another indicator of students with good digital skills is their ability to manage and use technology to technology-enabled collaboration, perceived creativity, and transfer of knowledge and skills (Alt & Raichel, 2020). The 21st-century students are not only expected to be proficient in using digital devices but should also be able to innovate using those technologies to support their learning. These skills include the ability to utilize various online collaboration tools, learning applications, and social media responsibly and ethically as well.

There have been studies concerning digital literacy that focus on three areas. They are the themes and research method used, the integration of digital literacy in education, and the relationship between digital literacy and academic performance. The studies found that there have been four major themes of research on digital literacy as revealed by (Tinmaz et al., 2022): The first is digital literacies, the competencies and skills required for navigating a fragmented and complex information ecosystem. The second is digital competencies consisting of five competence areas (dimension 1): (a) information and data literacy like browsing, searching, and filtering data; (b) communication and collaboration, such as interacting through digital technologies, (c) digital content creation, for example developing digital content, (d) safety, like protecting personal data and privacy, and (e) problem-solving, like solving technical problems (Carretero et al., 2017). However, in the context of the work field, there are twenty-five dimensions of DC for workers, one of which is netiquette, that are composed of a specific combination of knowledge, skills, abilities, and other characteristics needed to perform at today's digital workplaces (Oberländer et al., 2019). The third is digital skills which are identified into seven core skills: technical, information management, communication, collaboration, creativity, critical thinking, and

problem-solving (Van Laar et al., 2017). The fourth is digital thinking as mostly related to critical thinking and computational thinking (Barr et al., 2011; Yang, & Zhou, 2022).

Another area of research on digital literacy is its integration into education. The adoption of technology in education led to the maturity of learning at higher education in terms of an increase in accessibility and availability of learning contents and resources, new formats of sharing knowledge and information, and learning through multimedia which created a more engaging learning environment (Reddy et al., 2020). The evolution of the web tools and technologies from Web 1.0 to Web 3.0 has led to the evolution of education from Education 1.0-learning through behaviorism indicated by students taking notes and classrooms being teacher-oriented to Education 3.0, self-paced, self-determined, internet-based learning which is based on problem-solving, innovation, and creativity. Falloon (2020) stated that it is a necessity to expand teacher education students' understanding of some sorts of digital competencies like personal-ethical competencies and personal-professional competencies, required to function productively, safely, and ethically in diverse and increasingly digitally mediated environments. Meanwhile, studies about the relationship between digital literacy and academic performance revealed that digital literacy that can be elevated through metacognitive, resource management and motivational belief strategies (Anthonysamy et al., 2020) had significant effects on the communication skills, research skills, and confidence of the students, but it had no effect on their academic performance (Abbas et al.,2019). On the contrary, it was found that higher levels of digital literacy positively affected the high output of learning outcomes to student academic performance (Yustika & Iswati, 2020) as proved by Naz et al. (2022) that college students with digital knowledge or technological skills performed better than those without these skills. The digital literacy skills needed for student performance in preparation for their future job in this digital age (Bidin et al., 2021).

Despite the importance of digital literacy in Society 5.0, the portrait of digital literacy development of students in both language and science departments and the factors affecting its development are under-researched. Thus, to portray their digital literacy development is worthy not only to map out their digital literacy competence, skills, and thinking for facing society 5.0 which requires them to have critical thinking but also beneficial to set programs for equipping them with living in such a society. This article then aims to portray the digital literacy of students of the Language and Science Departments focusing on seven elements: digital skills, digital culture, digital ethics (Sá, et al., 2022), digital safety (Sandra, 2022), digital consumption, digital competencies, and digital security (Yashalova et al., 2019; reveal factors that make them digitally literate; and put them into teaching language and science. There were seven aspects of a DL in this context that can provide a foundational basis for crafting meaningful policies to prepare these students for active participation in Society 5.0.

METHOD

Research Design

The design used in this study is qualitative with the subjects selected through a questionnaire test on digital literacy. To elaborate, this research is on a specific group of individuals, namely students with quantifiable attributes, such as those enrolled in both the language and science departments at an Islamic state university in Tulungagung, Indonesia who have good digital literacy. These individuals can be of either gender. The questionnaire test items were developed based on relevant theories about indicators, methods, and factors affecting digital literacy development that refer to seven aspects of DL including digital skills, digital culture, digital ethics (Sá et al., 2022), digital safety (Sandra, 2022), digital consumption, digital competencies, and digital security (Yashalova, et al., 2019. Digital skills specifically consist of seven elements, namely technical skills, information management, communication, collaboration, creativity, critical thinking, and problem-solving (Van Laar et al., 2017). They were developed into

thirty-five items of questions comprising sixteen items about digital skills, two items concerning digital ethics, one item about digital culture, one item about digital safety, six items related to digital consumption, six items are about digital competencies, and three items asking digital security. Subsequently, the selected potential subjects were subject to in-depth interviews to ensure the completeness and accuracy of the data gathered from the questionnaires. Moreover, to obtain information regarding factors that support literacy development, interviews with specific respondents are deemed necessary. To ensure the reliability and credibility of the data, conducting interviews and observations with these selected individuals is essential. The data collected provide insights into the subjects' literacy development.

Subject Selection

To identify students from the Language and Science Departments, a questionnaire test was conducted to assess their proficiency in digital literacy that focused on digital skills, digital culture, digital ethics, digital safety, digital consumption, digital competencies, and digital security. This survey test was distributed among students enrolled in various programs within these two departments, including Biology, Mathematics, Physics, Chemistry, English Education, Arabic Education, and Indonesian Language Education. The distribution of the test was facilitated with the assistance of the Coordinators of the Study Programs. Participation in this survey was entirely voluntary, and only those students who were genuinely interested in sharing and providing insights into their literacy skills chose to fill it out. This ensured that the survey was completed by individuals who were genuinely committed to sharing their literacy experiences. Among 174 students who filled the survey test on digital literacy, 9 students got the highest scores of 170 -175 out the total scores of 175 (See Figure 1).

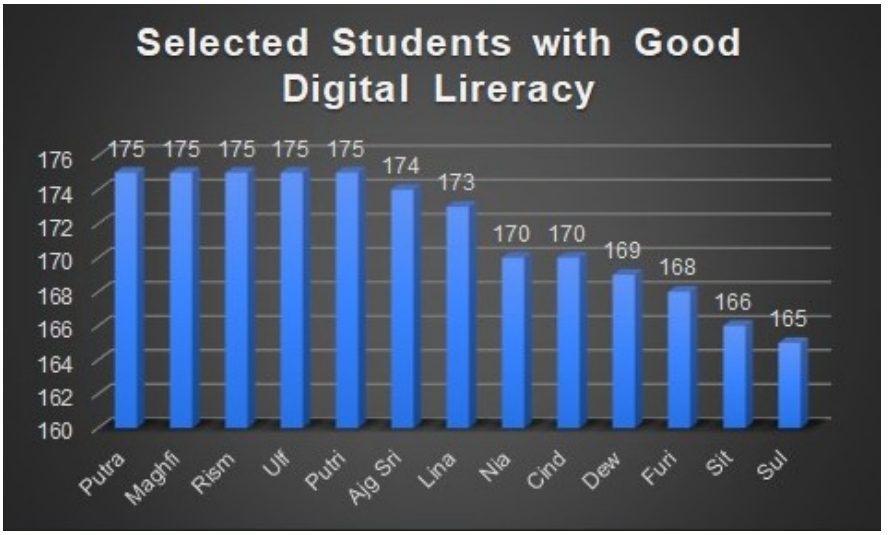

Figure 1. *The selected students with good digital literacy*

Data Collection

The primary method employed for gathering data in this research involved conducting in-depth interviews with the selected participants from the survey test with Cronbach Alpha score 0.972 for n=50 (See Table 1).

Table 1.
The results of validity and reliability test

N	Cronbach's Alpha	N of items
50	.972	35

The interviews were conducted following mutual agreements between the interviewers and interviewees, which encompassed decisions regarding the mode of the interview and the timing and location. Consequently, interviews were conducted in a face-to-face manner or remotely via online methods such as video calls, accommodating the respondents' availability and preferred settings. This data collection phase spanned from the end of June to July 2023. While the test aimed to assess students' digital literacy, the information derived from this instrument also serves as a valuable resource for

understanding the literacy skills of the selected subjects and the ways of developing these skills. Therefore, these data are also considered as the primary dataset for this research.

Data Trustworthiness

To ensure the credibility and reliability of the data collected from interviews with the selected subjects, a triangulation approach was adopted. This involved cross-referencing the information obtained from interviews with input from the subjects' friends and lecturers, as well as their literacy achievement. The observation of their literacy activities was also conducted to obtain the credibility and dependability of the collected data. This triangulation was carried out to enhance the trustworthiness of the information gathered during the interviews.

Data Analysis

The data gathered through questionnaire tests were subject to coding and categorization. Irrelevant or redundant data were eliminated. This process of coding and categorization yielded potential subjects for further interviews and observations. The data were analyzed by adopting a systemic perspective in two different qualitative approaches: cross-checking and linking data from interviews with the data obtained from observation. They are thematically analyzed with reference to the research questions: the portraits of the undergraduate students' digital literacy development and factors affecting the development of their digital literacy. Following data analysis, the research results were to provide insights into the digital literacy development of undergraduate students in the Language and Science Departments of a state Islamic university in Tulungagung. These insights would be instrumental in shaping appropriate instructional programs that can support the academic vision of these study programs, positioning them as centres for study, research, and community development.

FINDINGS

The Portrait of Digital Literacy Development of the Students in the Language and Science Departments

The result of this study portrayed that the students' good digital literacy was indicated by four elements, namely using Online applications and social media for various benefits, frequent use of digital tools, setting time management in using social media, having the ability to protect personal data, finding reliable references, and the curiosity of using Internet and access through it showing their digital skills, digital culture, digital safety, digital consumption, digital competencies, and digital security (See Table 2).

Table 2.
The Portrait of the Students' Digital Literacy Development

No	Elements	Sub elements
1.	Using Online applications and social media for various benefits (Digital Skills and Competencies)	to widen the student's horizon
		to keep up to date with the technology advancement
		to channel education; to develop online test; and to express the students' knowledge
2.	Frequent use of digital tools (Digital Consumption)	Frequent browsing relevant journals and school assignments
		Frequently used several applications to support educational activities
		Frequent access to the digital world for various purposes
3.	Having the ability to protect personal data (Digital Safety and Security)	Protecting privacy and security of data
		Setting task priority
4.	The curiosity about using and accessing the Internet (Digital Culture)	Curiosity to use and access the Internet for browsing additional references after having a laptop in elementary school
		curiosity to use various platforms to support improving knowledge, science, and achievement.

Using Online applications and social media for various benefits

The students' good digital literacy was indicated by utilizing online applications and social media platforms for various purposes. One of them is to expand the horizons of knowledge.

Excerpt 1

"With the availability of online media or social media application like google and Instagram, I feel like easily to get through a wide horizon through which I can find out new and important anything that I must know today and that I do not know yet, either specific information about a certain knowledge or any current information published nationally and internationally." *(Ajg Sri)*

Acknowledging the importance of staying updated by cultivating digital literacy is another purpose of using digital tools and social media. This skill is essential for providing students with a wealth of up-to-date references tailored to their specific needs.

Excerpt 2

"…I also implement digital literacy activities in which the development of technology and communication is developing rapidly, making me keep updated..." *(Lina)*

Excerpt 3

"In my opinion, digital literacy is indeed very important which can be used as a reference to keep learning new things and add insight that can be applied in the world of writing and reading literacy." *(Lina*)

Moreover, facilitating educational endeavors, conducting online tests, and expressing knowledge are other purposes of using Online applications and social media as the quoted interview below.

Excerpt 4

"I channel education about Biology through my Instagram social media related to the development of chicken embryos, the fungus found in tempeh or called the mushroom Aspergillus sp. etc. In addition, in the era of the Covid-19 pandemic, I did online-based questions which can be accessed via Google form, Testmoz, Quizizz

> and so on. I also use the internet network as an intermediary medium for my digital literacy, where I use the blogspot website to channel my knowledge regarding biology which I am currently studying in college." *(Lina)*.

Social media plays an important role during the pandemic because it provides opportunities for students to enhance collaborative learning and to improve learning performance (Khan et al.,2021). The term social media in this context refers to Leyrer-Jackson and Wilson's definition as websites and technological applications that allow its users to share content and/or to participate in social networking (Aichner et al., 2021). Another study revealed by Cepeda-Carrion et al. (2023) that the use of social media is essential for acquiring external information and knowledge. Ansari and Khan (2020) also found that using social media is also proved to useful for transferring resources, interactivity with peers, teachers and online knowledge sharing behavior. Instagram, for example, is proven to be an important social media that helps students access information, distinguish credible information from the vast sea of data available, and adapt to the dynamic digital landscape necessary for their academic success.

Students with good digital literacy can use digital tools and social media for several purposes meaningful to support living in the digitalized era. It is stated that digital literacies are not solely about technical proficiency but about the issues, norms and habits of mind surrounding technologies used for a particular purpose (Belshaw, 2012).

Frequent and skilful use of digital tools

The second component of the portrait of students with good digital literacy involves frequently using digital tools, such as regularly browsing relevant journals, frequently employing a variety of applications to support educational activities, and consistently accessing the digital realm for diverse needs. The regular utilization of digital tools has become an integral part of their daily lives, with individuals relying on these resources for a multitude of reasons such

as academic success. This can be explicitly stated in this quoted interview below.

> Excerpt 5
> "The development of this digital literacy may develop when I often read and select relevant journals when I have college assignments, look for true, up-to-date news, health journals, and websites related to the world of health on my cellphone or laptop." *(Nike).*

Additionally, the use of diverse applications to aid educational activities has become commonplace, streamlining tasks such as note-taking, making ppt, photo and video editing as mentioned in the quoted interview*:*

> Excerpt 6
> "…my digital literacy skill get improved, I try to use several applications that make it easier for me to make teaching materials, p0pt, photo editing, videos, etc. Now I'm trying to learn AI that is growing so as not to be left behind by the growing flow of times."*(Nia)*

Furthermore, people regularly access the digital world for a wide range of purposes, from online learning and social networking to information gathering and entertainment. This is reflected in this quoted interview below.

> Excerpt 7
> "I often access the digital world to find references for lecture needs, look for updated or trending news on any topic that I want to know about at the time, download several applications to facilitate activities and mobility such as online shopping, m-banking, games as entertainment, social media. Even various Microsoft applications to make it easier to do tasks while away from the laptop. This is the development of my digital literacy." *(Ulfah)*

This study confirms a previous study by Brailovskaia et.al (2020) showing that in addition to using digital applications for social interaction, beat of boredom and pastimes, and to search for positive emotion, searching for information and inspiration is the most frequent

purpose. This ongoing dependence on digital tools underscores their pivotal role in this information-rich society, offering efficient means of staying informed, connected, and productive in an increasingly digitalized world.

Having Digital skills

The portrait of students' good literacy is identified by having good skills of protecting their privacy and keeping their data safe, as explicitly stated in a quoted interview below.

> Excerpt 8
> "Protect my own privacy and security to keep important data safe." *(Putra)*

In addition, they can set time to use social media for some meaningful tasks and avoid using digital tools unnecessarily. This finding is reflected in a quoted interview.

> Excerpt 9
> "This is what I prioritize the most because nowadays many people are addicted to social media and its excessive use. I don't really like playing social media or whatever it is in digital form if it doesn't benefit me. If it's only for upholstery, it's better for me to do activities that are more useful for me." *(Putra)*

This finding supports a study by Purnama et al. (2021) stating that low digital literacy skills can result in children becoming addicted to using gadgets. People who have good digital-age literacy skills will avoid also hoax in the form of news or information (Mujtahid et al. 2021). Moreover, Morris and Rohs (2021) unravel that digital technologies offer affordances that can be compared to a two-edged sword. Digital technologies facilitate self-directed learning by offering convenient access to information. However, the growing amount of available information necessitates the development of information literacy skills, which are essential for competent self-directed learning and enable the ability to navigate information meaningfully.

The curiosity of using and accessing the Internet

Students' good digital literacy is identified by curiosity about using and accessing the Internet. Such an indicator is found in the student's quoted interview claiming that curiosity is an essential step in building and developing digital literacy because it challenges them to try using new digital platforms for some advantageous purposes like education.

> Excerpt 10
> "The development of my digital literacy started when I started MI when I already had a laptop. From that laptop, I started to be curious about various digital platforms,..I tried using various digital platforms until I understood what the advantages and disadvantages of these platforms were. If I feel that the platform provides more disadvantages than advantages for me, then I don't use the platform anymore. Currently, technology is advancing and more digital media and devices are being developed especially to support education." (*Risma)*

The effective use of digital platforms to support academic success for example identifies the development of the student's good digital literacies. Various digital tools used by students provide them with a beneficial learning experience, as proved by Schroeder et al. (2010) that applications like weblogs, wikis, videocasting applications can significantly contribute to the educational experience of a student.

In a nutshell, students with good digital literacy can be identified by having positive attitudes like using online applications and social media for diverse benefits and having curiosity to use and access the Internet wisely in terms of the content and time of access. Moreover, they also have good digital skills like protecting their privacy and data safe, using various digital platforms to support their academic success and some other benefits, and using time wisely to access the Internet.

Factors Supporting the Development of Digital Literacy among Students

This study revealed that two significant factors influence students' digital literacy (See Table 2). The first factor pertains to internal factors covering students' strong personal curiosity, their preference to digitalization, individual's desire and educational needs, and their curiosity to browse new and worthy things through digital platform. The second factor is external including the students' environment and lifestyle, economic demands, and educational needs.

Table 3.
Factors Affecting the Development of Students' Digital Literacy

No	Factors	Sub Factor
1.	Internal Factor	The students' strong personal curiosity
		The students' preference to digitalization
		Individual's desire
		Students' curiosity to browse new and worthy things through digital platform
2.	External Factors	The students' Environment and lifestyle
		Economic demand
		Educational needs

Internal Factors

Students' personal curiosity about digitalization emerges as a crucial element motivating them to develop robust digital literacy skills. Sun and Gao (2020) revealed that even though intrinsic motivation had no direct effect on students' behavioural intention in MALL, it positively impacted students' behavioural intention through the two intervening factors, perceived usefulness and task technology fit. When students possess a genuine curiosity for technology and digital tools, they are more inclined to proactively explore digital resources, applications, and platforms. This self-driven exploration not only enhances their technological proficiency but also deepens their understanding of the digital landscape, enabling them to effectively

apply these skills in various aspects of their academic and personal lives. This is explicitly reflected in the quoted interview below.

Excerpt 11

"The biggest factor comes from myself, which is a strong desire and curiosity that comes from within myself." *(Ajg Sri)*

She established "English Bermuda Course" and has her own YouTube channel available at https://youtu.be/1FPP-Vgq-Do, which is used to teach English. Therefore, fostering students' innate curiosity and providing opportunities for them to explore and learn in the digital realm is essential for cultivating strong digital literacy.

The second influential internal factor is students' preference for digitalization, specifically their inclination toward tools and platforms that can keep pace with the rapid and extensive innovations in technology. This can be seen in the quoted interview below.

Excerpt 12

"my preference for digitalization is because I realize that digitalization is very developing and starting to enter people's daily lives so that there will be many things that I can do and know by utilizing digital and digitalization so that this supports the development of my digital literacy. Besides that, my activities related to and using digital such as for lectures, online shopping or other activities also support the development of my digital literacy." (*Ulf*)

Students' attraction to digital resources that embrace and adapt to technological advancements is crucial in nurturing and advancing digital literacy. A study by Blau et al. (2020) presented that the importance of self-regulation and learning new technologies is as an integral part of digital literacies. These adaptable tools not only cater to diverse learning needs, but also encourage students to explore and experiment with emerging technologies. This proactive approach not only deepens their digital literacy, but also fosters resilience and adaptability in an ever-evolving digital landscape. By aligning educational strategies with students' current preference for technology, educators can effectively support the development of digital literacy

and equip students to navigate the swiftly changing technological world.

The other internal factors are students' desire and educational need which are claimed to nurture their digital literacy. Browsing some e-reading sources has proved to support their learning needs, especially when printed books and references are not available for them. They can even find any information they need for their daily lives, such as about health. To do e-consultation with their doctors is also more meaningful to tackle their health problems. The following quoted interview clearly states these facts.

> Excerpt 13
> "The development of digital literacy is influenced by myself, who usually feel inadequate if I only read from books or I don't have books to refer to when doing assignments. So I also often search for and select relevant online journals, e-books, or websites on the internet for reading sources. I also often read information on websites/the internet, especially about the world of health such as halodoc, *hellodokter*, *hellosehat*, and others. In my opinion factors of desire and educational needs that influence it." (*Nike)*

The students' desire and dependence on using the Internet indicate their digital literacy skills and how they are developed. In addition, students' curiosity to browse new and worthy things through digital platforms helps them develop their digital literacy, as explicitly stated in the quoted interview below.

> Excerpt 14
> "Factors supporting the development of my digital literacy come from internal factors where I like to find out about things that are new and useful for me on digital platforms, especially matters related to knowledge in science and culinary knowledge because I like cooking." (*Rism)*

External Factors

External factors such as the students' surroundings and lifestyle play a vital role in supporting the development of digital literacy. The environment encompasses access to technology, the internet, and digital resources, which significantly shape a student's growth in digital literacy. This is reflected in the quoted interview below.

> Excerpt 15
> "However, my environment and lifestyle also influence and make me more demanding to broaden and broaden my horizons so that I can be a person who is aware of knowledge and information for both myself and those around me." *(Ajg Sri)*.

Similarly, Putri (2024) in her study revealed that schools contribute to enhance students' digital skills. Lifestyle choices, including the extent to which students engage with digital tools for both educational and recreational purposes, further influence their proficiency in the digital realm. Reynolds (2016) in his study stated that a change in student engagement in one dimension, sosialize, relates to change in other dimensions such as Research, Surf-Play, Create, Manage, and Publish. Information and digital skills are intercorrelated. Students' peer engagement, feedback, dialogue and sharing (Socialize), and their review of existing games and web tools at school (Surf) are linked with a greater motivation for home use. Additionally, a study proved that in the digital storytelling condition, children's literacy skills increased significantly (Maureen et al., 2018). This highlights the inherently social nature of the social constructivist intervention and the social nature of those activities to support the development of digital literacy.

Furthermore, social and economic pressures have been proven to be other external factors contributing to enhancing students' digital literacy as clearly stated in the quoted interview below.

Excerpt 16

"…the development of my digital literacy is due to economic demands. Through this increasingly advanced technology I can save expenses when I teach." *(Putra).*

Recent research emphasizes the increase in the level of digital literacy of vocational college students promotes the growth of their employment quality. This is because human behavior can be influenced by digital literacy, and increasing digital literacy indicates an improvement in college students' digital sensitivity, which allows them to more accurately detect shifts in the labor market's structure in the digital age and move into higher-paying jobs. It also signifies the growth in vocational college students' digital adaptability, which enables them to better adjust to the new business models resulting from advancements in digital technology (Xiong, & Yu, 2023). In today's fast-evolving landscape, digital literacy has become an indispensable skill, influenced by societal expectations and economic necessities.

Lastly, educational requirements stands as another supporting factor for the development of students' digital literacy skills. As stated in the quoted interview.

Excerpt 17

"Besides that, the supporting factor for developing my digital literacy was the demands of education a few years ago, to be precise during the pandemic, which demanded that I or anyone else be able to compete in the media. Of course since then I feel interested and happy to use technology that can be useful, especially in the field of education." *(Putra)*

To sum up, students' digital literacy is shaped by both internal motivations and external influences. Personal curiosity, educational needs, and economic or societal expectations all play a crucial role in fostering digital skills.

The pedagogical implementation of digital literacy development in the Teaching and Learning of Language and Science

This study resulted in students' views on some digital tools and learning environments that support the development of their digital literacy (See Table 4). Artificial intelligence (AI) is the tool that they expect to help them nurture good digital literacy because making use of AI can enrich the students' learning experience and as a helpful tool to support the teaching and learning activities. As stated in the quoted interview: "In my opinion, artificial intelligence will be very helpful as a tool and support in the teaching-learning process and enrich the learning experience" *(Ajg Sri).*

Table 4.
Digital Tools and Learning Environments to Equip Students with Living in Society in 5.0

No	Elements	Sub Elements
1	Digital Tools	Artificial Intelligence
2	Supporting Learning environment	Need to provide practicality and effectiveness of application and web like Online Laboratories (OLABS) to support teaching and learning science
		Integrating technology and creativity
		Creating interesting sets of materials and interactive learning media like Duolingo
		Providing access to technology
		Providing digital learning platform with materials
		Learning model with Learning outcome
		Providing digital college system

Such a digital tool can work well if it is supported by creating a digitally-learning environment like providing students with practicality and effectiveness of applications and web like OLABS to support teaching and learning sciences. In addition, integrating technology and creativity; creating interesting sets of materials and interactive learning media like Duolingo; providing access to technology; providing free digital learning platforms with learning materials; learning models with learning outcomes; and providing

a digital college system are of some ways to build digitalized-learning environment to trigger students' digital literacy.

DISCUSSION

The results of this study uncovered that students with strong digital literacy demonstrate responsible online behavior, curiosity for digital learning, and effective time management. They leverage digital tools for academic success while ensuring their safety and security in the digital landscape.

In today's technology-driven world, digital literacy is more than just the ability to use a computer or browse the internet—it involves critical thinking, ethical engagement, and adaptability to new technologies. These students do not merely consume digital content passively; instead, they actively engage with it in ways that benefit their education (Chen et al., 2022; Martinez et al., 2022; Su & Yang, 2022; Su et al., 2022; Talan et al., 2020; Wang et al., 2022). A study found that digital technology provides positive learning outcomes, inspiring and motivating to students as learners in a digital world beyond the constraints of the classroom (Taylor et al., 2021). Moreover, several studies documented the advantages of digital literacy on specific language learning areas, such as writing (Wen & Walters, 2022), as well as reading and comprehension (Schwabe et al., 2022).

To meet the demands of the modern classroom, students must be equipped with the necessary digital competencies. It is stressed in a study by Yustika & Iswati (2020) that higher levels of digital literacy positively affected the high output of learning outcomes to student academic performance. There are three key factors in digital literacy in learning and education: 1) digital literacy, 2) digital learning and 3) twenty-first-century digital skills (Audrin & Audrin, 2022). Thus, highlighted the focus on digital literacy adaptability and industry-relevant experience within a curriculum especially in higher education needs to be increased (Darling-Hammond & Hyler, 2020; García-Peñalvo et al., 2021; Hadar et al., 2020; Morgan et al., 2022).

The findings of this study demonstrated that good digital literacy skills are developed from internal factors like strong curiosity towards digital technology, individual desires, and educational needs for digital, students' preference for digitalization, and keeping up to date through using digital technology. A study conducted by Siswanto et al. (2022) highlighted the relationshiop between internal motivation and digital literacy that leads to students' proactivity, resulting in better academic achievement (Hwang & Oh, 2021; Kara, 2022). Moreover, several studies embark the better the level of students' digital literacy, the higher the readiness for enterpreneurship in this digital era as it means the higher the digital literacy levelof a student, the more life skills they will have (Almi & Rahmi, 2020; Fauzi et al., 2020; Neumeyer et al., 2020).

External factors like the student's environment and lifestyle also contributed to good digital literacy development. Exposure to digital environment plays a significant role on development of someone's digital literacy. A study conducted by Yustika & Iswati (2020) reported that the easier the accessibility of digital enviroment, the easier for someone to achieve a high level of digital literacy. This finding supports the previous study proving that technologies navigate the Learning Management Systems (LMS) to engage and contribute to knowledge creation to achieve better academic success (Kumi-Yeboah et al., 2020).

Digital literacy equips students with the ability to navigate the ever-expanding world of online information, ensuring they have access to a wealth of current references that cater to their requirements. Building knowledge and providing preservice and practicing teachers with information, strategies, and resources is patently a clear task for literacy educators (Bacalja et al., 2022; Maharani et al., 2023). The evolving landscape of education has witnessed an increasing reliance on digital tools and resources, making digital literacy a fundamental requirement for academic success (Abbas et al., 2019; Naz et al., 2022). This can be pedagogically implemented in teaching language and

sciences such as building college OLABS, digital college system, digital-based learning, and digital-based competitions.

In short, these digital tools have revolutionized communication, enabling global connections easily and offering invaluable support in professional settings, marketing, and collaborative projects. They also serve as vital sources of information, ensuring users can remain informed, access educational resources, and share knowledge with communities. While these benefits are well-documented, acknowledging potential drawbacks, including privacy concerns and misinformation, is important. Nevertheless, the benefits of these platforms in terms of connectivity, productivity, and information dissemination are undeniable in the digital era.

CONCLUSION

This research study uncovered three key findings, which include an examination of the portrait of good digital literacy of students in the Language and Science Departments at a state Islamic university in Tulungagung, Indonesia. It is unveiled that students with good digital literacy have positive awareness of the importance of equipping themselves with digital literacy and digital competence. They also have digital skills like using online applications, and social media appropriately and protecting their privacy and personal data. Additionally, it explored the factors that support students' literacy development and their expectations regarding digital applications and learning environments, which prepare them for life in Society 5.0. Two significant factors impacting students' digital literacy were revealed: internal factors (inherent curiosity and a preference for digitalization) and external factors (environment, lifestyle, societal demands, economic pressures, and educational requirements).

Finally, these two findings can be pedagogically implemented by making use of digital tools like AI and building a digitalized-learning environment. In short, this study provided insights into the literacy development of students, factors supporting their literacy growth, and their expectations regarding digital applications and learning

environments, all with a focus on preparing them for Society 5.0. However, these findings do not assess specifically a digitalized learning environment toward students' DL skills and students' language competencies. Thus, it is suggested that further researchers experimentally study those points.

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DECLARATION OF AI AND AI-ASSISTED TECHNOLOGIES

The researchers acknowledge the use of ChatGPT (OpenAI) solely as a writing support tool to enhance clarity and language quality. All conceptualization, methodology, analysis, and findings were independently developed by the researchers. No AI tool was used to generate data or results. The use of ChatGPT followed ethical academic writing standards, and the authors remain responsible for the study's originality and integrity.

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