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**Exploring the Relationship between Digital Literacy Skills and
Student Success in Online Science Courses in Indonesia**

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Abstract

Purpose: The aim of the study was to investigate the exploring the relationship between digital literacy skills and student success in online science courses in Indonesia.

Methodology: This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

Findings: Recent research on digital literacy skills and student success in online science courses in Indonesia indicates a strong link between proficient digital skills and academic achievement. Students who demonstrate competence in areas like information literacy and online collaboration tend to perform better and show higher levels of engagement in their courses. This highlights the significant impact of digital literacy on enhancing learning outcomes and fostering self-directed learning among Indonesian students in online science education.

Unique Contribution to Theory, Practice and Policy: Theoretical framework, technology acceptance model (tam) & community of inquiry framework may be used to anchor future studies on the exploring the relationship between digital literacy skills and student success in online science courses in Indonesia. Institutions should integrate digital literacy training into science curricula from early educational stages to higher education. Advocate for the development and adoption of national or institutional standards for digital literacy in education.

Keywords: *Relationship, Digital Literacy Skills, Student Success, Online Science Courses*

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INTRODUCTION

Academic performance and course completion are crucial metrics in evaluating the effectiveness and success of educational programs, particularly in online and distance learning environments. Academic performance typically refers to the attainment of learning outcomes, mastery of subject matter, and achievement of educational goals set by institutions and educational standards. In developed economies like the USA and the UK, academic performance and course completion in online learning environments are critical metrics for evaluating the effectiveness of digital education initiatives. For instance, a study by Allen and Seaman (2019) reported that the online learning landscape in the USA has seen a steady increase in both enrollments and course completions over the past decade. This trend reflects advancements in technology and the growing acceptance of online credentials by employers and educational institutions alike. In the UK, a similar pattern has been observed, with a significant rise in the number of students opting for online courses to complement traditional education. According to data from the Office for National Statistics (ONS, 2020), the proportion of individuals participating in online learning has steadily risen, indicating a positive correlation between online education uptake and academic success.

In Japan, online education has gained traction as a means to address educational challenges and accommodate diverse learning styles. According to a report by the Ministry of Education, Culture, Sports, Science and Technology (MEXT, 2020), there has been a notable increase in online course enrollments, particularly in higher education institutions. This growth is supported by investments in digital infrastructure and the integration of interactive learning technologies. The emphasis on quality assurance and accreditation frameworks has also contributed to higher academic standards and increased course completion rates among online learners in Japan.

In Germany, the adoption of online learning has been steadily increasing, particularly in professional development and continuing education contexts. According to a study by Kehrwald (2020), German universities have been integrating online courses to accommodate diverse student needs and enhance flexibility. The research highlights that effective course design and strong institutional support contribute significantly to high completion rates and positive learning outcomes among online learners in Germany. Australia has witnessed a significant rise in online education offerings across its universities and vocational education sectors. Research by Nguyen and Palmer (2017) discusses how Australian institutions have leveraged technology to deliver engaging and interactive online courses. The study emphasizes that personalized learning experiences and robust student support services are key factors influencing academic success and course completion rates in the Australian online education landscape.

In contrast, developing economies such as India and Brazil are witnessing a transformative shift towards online education, albeit with unique challenges and opportunities. Research by Mishra and Sharma (2018) highlights that in India, while access to online courses has expanded rapidly, issues such as internet connectivity and digital literacy remain barriers to achieving high academic performance and course completion rates. Similarly, in Brazil, the adoption of online learning has been influenced by socioeconomic disparities and infrastructural limitations, as noted by Silva (2020). Despite these challenges, there is a growing recognition of the potential of online education to democratize access to quality learning opportunities, particularly in remote and underserved regions.

In Indonesia, the expansion of online education has been driven by efforts to improve access to quality learning opportunities in remote areas. Research by Widyantoro (2019) indicates that while challenges such as internet connectivity persist, initiatives like mobile learning platforms have facilitated higher engagement and completion rates among students. Government policies promoting digital literacy and affordable access to technology have further bolstered the adoption of online courses, contributing to enhanced academic outcomes across various educational levels.

China's online education sector has experienced rapid growth, driven by technological advancements and government support for digital education initiatives. According to Li and Zhang (2018), the proliferation of Massive Open Online Courses (MOOCs) and mobile learning platforms has democratized access to education across urban and rural areas. The research highlights that adaptive learning technologies and data-driven instructional strategies play crucial roles in improving academic performance and retention rates among Chinese online learners. In Mexico, online education has emerged as a viable solution to address educational inequalities and expand access to higher education. Research by Ramírez-Montoya and Sánchez-Ruiz (2019) underscores the impact of online learning platforms in facilitating flexible learning opportunities for diverse student demographics. The study shows that initiatives promoting digital literacy and inclusive educational policies have contributed to higher completion rates and academic achievements in Mexican online education programs.

Sub-Saharan African economies, including Kenya and South Africa, are also navigating the integration of online learning into their educational landscapes. Studies by Gakindi (2017) and Mlambo-Ngcuka (2021) underscore the role of online education in expanding access to higher education and improving academic outcomes. In Kenya, for example, the government's initiatives to promote digital literacy and infrastructure development have contributed to an uptick in online course enrollments among university students (Gakindi, 2017). Similarly, in South Africa, where distance education has a long-established history, advancements in online platforms have enhanced course completion rates and academic achievement among diverse student populations (Mlambo-Ngcuka, 2021).

Nigeria has seen significant growth in online education, supported by initiatives to leverage technology for educational advancement. According to a study by Akinsolu and Olakanmi (2018), the proliferation of online platforms has expanded access to higher education and vocational training, particularly among underserved populations. The integration of multimedia resources and interactive learning tools has improved learning experiences and fostered higher completion rates. Despite infrastructure challenges, the evolving digital landscape in Nigeria underscores the transformative impact of online education on academic performance and workforce readiness.

Ghana has made strides in integrating online education to enhance educational access and quality. According to a report by the Ministry of Education (Ghana, 2020), initiatives such as the Ghana Learning Management System (LMS) have been pivotal in delivering online courses and supporting remote learning during challenging times. The adoption of digital resources and interactive learning tools has facilitated higher engagement levels and improved course completion rates among Ghanaian students, particularly in tertiary education.

Uganda's online education landscape is evolving, with initiatives aimed at leveraging technology to overcome educational barriers. Research by Nsubuga-Kyobe (2020) discusses the impact of online learning platforms in enhancing educational outcomes and employability skills among Ugandan youth. The study emphasizes the role of collaborative learning environments and

mentorship programs in fostering academic success and increasing graduation rates in Ugandan online education initiatives.

Digital literacy skills encompass the abilities and competencies required to effectively navigate, evaluate, and utilize digital technologies for various purposes. These skills include information literacy, which involves the ability to locate, evaluate, and use digital information effectively (Martin, 2018). Secondly, digital communication skills are essential for interacting and collaborating online, encompassing proficiency in email etiquette, social media engagement, and virtual communication platforms (Haste, 2019). Furthermore, digital citizenship skills are crucial for understanding ethical and responsible use of technology, including issues of privacy, security, and digital rights (Ribble, 2017). Lastly, technical proficiency involves the ability to effectively use digital tools and software, ranging from basic computer operations to specialized applications relevant to academic and professional settings (Eshet-Alkalai, 2020).

These digital literacy skills significantly impact academic performance and course completion in online and traditional educational contexts. Students proficient in information literacy can conduct thorough research, critically evaluate sources, and integrate credible information into their academic work, thereby enhancing the quality of their assignments and academic achievements (Martin, 2018). Effective digital communication skills enable students to participate actively in online discussions, collaborate with peers, and engage meaningfully with course content, which contributes to improved learning outcomes and higher retention rates (Haste, 2019). Moreover, digital citizenship skills promote responsible online behavior, fostering a safe and respectful learning environment conducive to focused learning and reduced distractions (Ribble, 2017). Technical proficiency ensures that students can navigate learning management systems, utilize digital resources, and troubleshoot technical issues independently, thereby facilitating smoother academic progress and timely completion of coursework (Eshet-Alkalai, 2020).

Problem Statement

In recent years, the integration of digital technologies in education has transformed learning environments, particularly in online science courses. However, the extent to which students' digital literacy skills contribute to their academic success in these courses remains underexplored. Digital literacy skills encompass a range of competencies crucial for navigating online platforms, accessing digital resources, and engaging with scientific content effectively (Eshet-Alkalai, 2020). Despite their importance, there is limited empirical research examining how these skills influence student performance, retention rates, and overall success in online science education (Martin, 2018; Haste, 2019).

As online science courses continue to grow in popularity, understanding the relationship between students' digital literacy skills and their academic outcomes becomes increasingly pertinent. This study seeks to address this gap by investigating how varying levels of digital literacy—such as information literacy, digital communication skills, digital citizenship, and technical proficiency—impact students' ability to comprehend complex scientific concepts, complete assignments, and achieve learning objectives in virtual learning environments (Ribble, 2017). By exploring these dynamics, educators and policymakers can better tailor instructional strategies, support services, and digital literacy interventions to enhance student success and engagement in online science education.

Theoretical Framework

Constructivist Learning Theory

Originated by Jean Piaget and further developed by Lev Vygotsky, Constructivist Learning Theory posits that learners actively construct their own understanding and knowledge of the world through experiencing things and reflecting on those experiences (Bodrova & Leong, 2018). In the context of digital literacy skills and student success in online science courses, this theory is relevant as it emphasizes the role of learners in constructing knowledge through interaction with digital tools and resources. Students with strong digital literacy skills are better equipped to navigate online platforms, critically evaluate scientific information, and collaborate effectively with peers, thereby enhancing their learning outcomes and academic success (Yilmaz, 2021).

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), developed by Davis in 1989 and extended by Venkatesh and Davis in 2000, explores how users come to accept and use technology based on perceived usefulness and ease of use (Venkatesh & Davis, 2000). Applied to online science courses, TAM is relevant because it examines how students' perceptions of the usefulness and ease of using digital tools and platforms impact their engagement and success in learning scientific concepts. Students' digital literacy skills influence their perceptions of technology, affecting their willingness to engage with online course materials and contribute to discussions, which in turn influences their academic achievement (Lee et al., 2020).

Community of Inquiry Framework

The Community of Inquiry (CoI) Framework, developed by Garrison, Anderson, and Archer in 2000, explores the elements of cognitive presence, social presence, and teaching presence in online learning environments (Garrison et al., 2000). This framework is pertinent to studying the relationship between digital literacy skills and student success in online science courses because it highlights the importance of social and cognitive engagement facilitated by digital literacy. Students who possess strong digital literacy skills are more likely to actively participate in online discussions, critically analyze scientific information, and collaborate with peers, thereby fostering a sense of community and enhancing their academic performance (Garrison & Cleveland-Innes, 2021).

Empirical Review

Brown and Wilson (2018) explored digital literacy barriers and their impact on student success in online science courses. Published in the *Journal of Online Learning Research*, their study aimed to identify challenges students face due to inadequate digital literacy skills. They conducted focus groups and surveys with 150 students from various online science programs to gather qualitative and quantitative data on the barriers. Findings revealed that common issues such as limited access to technology, insufficient training in digital tools, and disparities in digital literacy levels hindered students' engagement and academic performance. Brown and Wilson recommended institutions improve infrastructure and provide targeted digital literacy support to enhance student success in online science education.

Chen and Wu (2019) investigated the role of digital literacy in fostering critical thinking skills among students in online chemistry courses. Their study, published in *Chemistry Education Research and Practice*, utilized a quantitative approach involving pre- and post-tests administered to 200 students. The purpose was to examine how digital literacy influences critical thinking abilities, crucial for scientific inquiry and problem-solving. Results indicated a significant positive correlation between enhanced digital literacy skills and improved critical thinking, with students demonstrating better ability to analyze scientific information and apply it effectively. Chen and Wu recommended integrating digital literacy training early in science curricula to cultivate students' analytical skills and enhance academic performance in online settings.

Johnson and Brown (2019) explored the impact of information literacy on student success in online science courses. Published in the *Journal of Educational Technology Systems*, their research combined surveys and qualitative interviews with 50 students to investigate how information literacy skills contribute to academic achievement. They found that proficient information literacy enabled students to critically evaluate scientific literature, synthesize complex information, and effectively apply findings to assignments. Johnson and Brown highlighted the importance of integrating comprehensive information literacy training into online science courses to support student learning and success in navigating digital resources effectively.

Kim (2022) examined the relationship between technical proficiency and student satisfaction in online science courses. Published in *Computers & Education*, their cross-sectional study surveyed 400 students and analyzed performance data to understand how technical skills impact learning experiences. Their research aimed to identify factors influencing student satisfaction, course completion rates, and overall academic success in online environments. Results indicated that students with higher technical proficiency reported greater satisfaction with online learning platforms, leading to improved engagement and academic outcomes. Kim et al. recommended enhancing technical support services and providing structured training to develop students' technical skills and optimize learning experiences in online science education.

Martinez and Gomez (2021) Investigate the influence of digital citizenship on student engagement and retention in online science education. Published in *Educational Technology Research and Development*, their research spanned two academic years and involved analyzing data from a cohort of 300 students. Their objective was to examine how digital citizenship skills contribute to online participation, retention rates, and academic performance. Findings indicated that students with strong digital citizenship demonstrated higher levels of engagement, lower dropout rates, and improved academic outcomes in science courses. Martinez and Gomez recommended integrating digital citizenship education into curricula to promote responsible online behavior and support student success in online learning environments.

Wang and Chen (2020) explored the role of digital communication skills in fostering collaborative learning among students in online science courses. Published in the *International Journal of Science Education*, their case study approach involved observations and interviews with 30 students enrolled in an online biology course. They aimed to understand how digital communication skills influence collaboration, knowledge sharing, and learning outcomes in virtual environments. Results highlighted that proficient digital communication enhanced students' ability to engage in meaningful discussions, collaborate effectively on group projects, and contribute positively to learning communities. Recommended integrating interactive and collaborative

activities into online science courses to develop students' digital communication skills and promote successful learning outcomes.

METHODOLOGY

This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low-cost advantage as compared to field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

FINDINGS

The results were analyzed into various research gap categories that is conceptual, contextual and methodological gaps

Conceptual Gaps: While studies like those by Chen and Wu (2019) focused on critical thinking in online science courses, there's a need to explore how digital literacy intersects with other subject-specific skills (e.g., problem-solving in physics or data analysis in biology). Understanding these intersections can provide insights into holistic skill development in digital environments. Martinez and Gomez (2021) conducted a longitudinal study on digital citizenship but there's a lack of longitudinal studies examining the sustained impact of digital literacy interventions (such as training programs) on academic outcomes over multiple semesters or academic years. Longitudinal studies can reveal trends and changes in student performance and engagement as digital skills evolve and are reinforced.

Contextual Gaps: Brown and Wilson (2018) identified general barriers to digital literacy, but more research is needed on context-specific challenges faced by students in different educational settings (e.g., urban vs. rural, high-income vs. low-income areas). Understanding these variations can inform targeted interventions that address specific local needs. Research predominantly focuses on general student populations. There's a gap in understanding how digital literacy impacts diverse student groups, including those with disabilities, non-traditional students, or students from underrepresented backgrounds. Exploring these dynamics can help tailor educational strategies to promote inclusivity and equity in online science education.

Geographical Gaps: Wang and Chen (2020) explored digital communication skills in science courses, but there's limited research on how cultural factors influence the adoption and effectiveness of digital literacy skills in online education. Investigating these cultural nuances can provide insights into culturally relevant approaches to digital literacy education. Most studies are from developed economies (e.g., USA, UK). There's a scarcity of research from developing regions (e.g., Africa, Latin America) and how digital literacy influences student success in online science courses within these contexts. Comparative studies across different global regions can uncover unique challenges and effective practices applicable globally.

CONCLUSION AND RECOMMENDATIONS

Conclusions

Exploring the relationship between digital literacy skills and student success in online science courses reveals a complex interplay that significantly influences educational outcomes. Research

consistently demonstrates that proficient digital literacy skills enhance critical thinking, collaboration, and engagement among students, essential for navigating and succeeding in digital learning environments. Studies such as those by Chen and Wu (2019) underscore the positive correlation between enhanced digital literacy and improved academic performance, emphasizing the pivotal role of these skills in fostering analytical abilities crucial for scientific inquiry.

Moreover, findings from studies like those conducted by Martinez and Gomez (2021) highlight the broader impacts of digital citizenship on student engagement and retention, indicating that well-developed digital literacy supports sustained academic success. Addressing digital literacy gaps identified in studies by Brown and Wilson (2018) and Johnson and Brown (2019) through targeted interventions and comprehensive educational strategies emerges as a critical pathway to enhancing student outcomes in online science education.

As educational institutions worldwide continue to embrace online learning platforms, understanding and integrating effective digital literacy practices are essential. Future research should focus on addressing contextual, conceptual, and geographical gaps identified, thereby fostering inclusive educational environments that empower students from diverse backgrounds to excel in online science courses. Ultimately, advancing digital literacy skills not only supports individual academic achievement but also contributes to building resilient and adaptable learners prepared for the complexities of the digital age.

Recommendations

Theory

Conduct more theoretical research to deepen the understanding of how specific aspects of digital literacy (e.g., information literacy, technical proficiency) interact with academic success in science courses online. This includes exploring theoretical frameworks that integrate digital literacy into existing educational theories like constructivism or connectivism, providing a robust foundation for future empirical studies.

Practice

Institutions should integrate digital literacy training into science curricula from early educational stages to higher education. This integration should emphasize practical skills such as critical evaluation of digital content, effective use of digital tools for scientific research, and collaboration in virtual environments. Faculty development programs should support educators in integrating these skills seamlessly into online science courses. Implement comprehensive support services that address diverse digital literacy needs among students. This includes providing access to technology resources, offering tailored training programs, and fostering a supportive online learning environment that encourages digital engagement and skill development.

Policy

Advocate for the development and adoption of national or institutional standards for digital literacy in education. These standards should outline clear learning objectives and benchmarks for digital literacy skills across different educational levels, ensuring consistency and quality in digital education. Governments and educational bodies should provide funding and incentives for research on digital literacy in online education. This support would encourage the development of evidence-based practices and innovative approaches to enhance digital literacy skills among students in science courses.

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