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THE IMPACT OF DIGITAL LITERACY ON STUDENTS' LEARNING OUTCOMES: A COMPREHENSIVE REVIEW

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Abstract

Digital literacy is widely acknowledged as an essential competency in 21st-century education, but its direct correlation with learning achievement continues to present a multifaceted and often disputed area of study. This systematic review consolidates findings from diverse educational research to explore the relationship between digital literacy, encompassing operational, informational, and transformative competencies, and academic performance, student engagement, and higher-order learning outcomes across varied institutional and cultural contexts. Results indicate that digital literacy can significantly enhance learning when aligned with sound instructional design, robust institutional support, and metacognitive strategies. However, its effects are inconsistent and mediated by factors such as access, pedagogy, and educator readiness. The review further interrogates the limitations of the digital native discourse and advances conceptual models to better capture the intricate dynamics between technological proficiency and educational attainment, underscoring the need for more holistic and context-sensitive approaches in both research and practice.

Keywords: Digital Literacy, Learning Achievement, Academic Success, Educational Technology, Systematic Review

1. Introduction

Digitization of educational systems is one of the most important changes in the pedagogy and learning infrastructure in the 21st century. With the widespread adoption of information and communication technologies (ICT) in learning institutions, policymakers, teachers and scholars have been keen to find out whether and how educational practices such as digital literacy, or the skills needed to access, evaluate, create, and communicate information through digital technologies, affect student learning outcomes.

The premise on most technology integration programs is that the higher the level of digital literacy, the higher the academic performance and learning. Nonetheless, the reality as shown in empirical evidence depicts the situation differently. Some of these studies show significant positive effects of digital literacy on learning outcomes, but others show an insignificant positive impact or even negative outcomes in the case of improperly incorporation of technology (Valverde-Berrocoso et al., 2022).

This review is a critical assessment of how digital literacy and student learning outcomes have a relationship through a synthesis of current research in several educational settings, an investigation into the mechanisms of influence, and the factors of context that define effectiveness. This relationship is especially timely to understand because educational systems have grown investments in digital infrastructure and disparities in digital access are causing threats to educational equity.

2. Defining Digital Literacy in Educational Contexts

2.1 Conceptual Framework and Dimensions

Digital literacy is a multidimensional concept that includes much more than the ability of computer functioning. Modern definitions appreciate digital literacy to include technical skills, information literacy, communication and collaboration skills, ethical awareness, and critical thinking used in digital contexts (Aurangzeb & Asif, 2021; Yustika & Iswati, 2020).

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The construct also encompasses technological competence the ability to use hardware, software, and platforms, but goes beyond technical proficiency to include information literacy skills, such as the ability to use search tools efficiently, assess the credibility of the source, understand biasness in digital sources, and impossible to distinguish between quality and misinformation (Reid et al., 2023). As well, digital literacy includes cybersecurity awareness, digital-domain ethical behaviours, online communication skills, and the ability to resolve complicated problems with the aid of digital tools.

The studies have pointed out several elements of digital competence that determine the results of learning. They encompass self-directed learning skills, the willingness to collaborate in online space, creative expression with the use of digital media and computational thinking skills that can be used in various settings (Yustika & Iswati, 2020). Others, such as critical digital literacy and the capacity to engage in an increasingly digitally mediated world in a meaningful way focus on the aspect of citizenship.

2.2 Evolution of Digital Literacy Frameworks

The definitions of digital literacy have undergone a lot of transformation because of the transformations in technologies and education requirements. The initial conceptualizations were too limited and concentrated on computer use and simple navigation on the Internet. Modern theories acknowledge that digital literacy should be flexible in response to the quickly evolving technologies, allowing students to keep up with competency changes regular as new tools and platforms are introduced (Yustika & Iswati, 2020).

Notably, the study questions the belief that the younger generations have become inherently high-tech. The research problem of the digital native concept popularized at the beginning of the previous millennium to characterize youth who are enveloped in digital technologies on every side of life has been fully problematized in recent studies (Reid et al., 2023). Evidence shows that digital competence between young populations differs dramatically, with a significant number of them having only superficial knowledge of various popular platforms yet having a lack of competencies associated with information evaluation, cybersecurity, and critical analysis of digital content.

This insight has urgent consequences on educational design, implying that digital literacy will not be self-absorbed but should be actively learned and trained instead, in the form of structured pedagogic interventions (Reid et al., 2023).

3. Mechanisms Through Which Digital Literacy Influences Learning Outcomes

3.1 Direct Cognitive Pathways

Digital literacy enables learning in several different ways by means of cognition. To start with, digital technologies provide access to immensely larger sources of knowledge, and students can stop using the contents of the textbooks and have access to current scholarly work, multimedia explanations, and multiple views on the subject matter of the study (Rosa and Obillos, 2016). This is the increased access to information that can be used to aid in the process of understanding, especially when combined with critical analysis skills that allow the differentiation between sources that are available.

Second, digital literacy will empower students to use higher order thinking cognitive tools. Programs such as dynamic geometry, computational modelling, simulation environment, and data visualization platform enable students to externalize intellectual processes, manipulate complicated systems, and represent abstract ideas (Kim and Md-Ali, 2017). On that note, software in geometry allows students to create shapes and actively explore spatial relationships, which facilitates the comprehension of mathematical concepts by exploring interactive and not by seeing (Kim and Md-Ali, 2017).

3.2 Motivational and Engagement Pathways

The digital tools and environments can tend to increase the motivation and curiosity of students towards the learning material. The gamification strategies, which involve the application of game-builds in the learning environment, have proven beneficial in student motivation and learning performance, especially in language learning environments (Boudadi & Gutiérrez-Colón, 2020). Gamified learning environments when well executed create an engaging learning process due to instant feedback, incremental challenge, and a chance to gain recognition of achievement.

Student autonomy and agency can also be enhanced through technology mediated learning. Such computer-based language learning strategies as, e.g., allow students to engage in independent learning, self-

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directed learning, and personal feedback responding to personal learning requirements (Rosa and Obillos, 2016). This independence favours intrinsic motivation and long-term orientation to learning, which can be more important than short-term mastery of content.

3.3 Accessibility and Equity Pathways

Technology-enabled learning and digital literacy can enhance access to education among some student groups that would be restricted to geography, socioeconomic status, and disability. A study of immigrant youth mathematics performance established that generic patterns of ICT access as well as the particular educational patterns of ICT use had positive impacts on mathematics achievement (Kim, 2018). Thoughtful implementation of technology-mediated learning can contribute to the reduction of achievement gaps between groups when its implementation is properly designed to overcome certain impediments.

Also, digital tools offer accessibility options that suit the disabled students, such as screen readers, text-to-speech features, customizable screens, and alternative input. These technological affordances are capable of significantly enhancing the learning outcomes of students who have various learning needs and disabilities.

4. Empirical Evidence: Variable Effects on Academic Achievement

4.1 Systematic Review Findings on ICT and Academic Performance

Extensive systematic reviews that have been conducted on the relations between ICT integration and student academic achievement exist with mixed results, with key caveats. In a systematic review of 100 studies concerning the education resources information centre (ERIC) database, the authors discovered the evidence of the positive impact of the implementation of ICT-enriched educational practices on the overall academic performance, yet the overall effects were of varying significance (Valverde-Berrocoso et al., 2022).

The analysis demonstrated some critical disciplinary disparities, in which mathematics and science had the highest evidence regarding positive ICT impacts (Valverde-Berrocoso et al., 2022). Such areas of study are more specifically the ones where technology-driven visualization, dynamic modelling, and problem-solving possibilities can be of use. However, studies on the impact of ICT in other curriculum disciplines reveal a less coherent outcome, and this indicates that the efficacy of technology hinges heavily on the domain-specific variables, and the pedagogical use thereof.

Notably, the systematic review found inconsistencies between large-scale international research by bodies like the OECD and smaller-scale research investigations, where macro-level research more often yields no results and micro-level studies more often presents positive results (Valverde-Berrocoso et al., 2022). This deviation indicates that the quality of local implementation, teacher readiness and teacher approach could have a significant mediating role in technology effectiveness.

4.2 Computer-Based Assessment and Learning

Computer-based assessment of learning (CBAfL) can be described as a certain type of technology implementation that shows promising similar results in terms of improvement in learning. Studies of CBAfL in elementary and secondary education settings revealed that the application of computer-based assessment typically helped students to learn in a variety of content areas, such as biology, mathematics, and programming (Shute and Rahimi, 2017). The best implementations involved formative feedback that was neither too simple nor too complicated and focused on misconceptions by students instead of being overly simplistic or overly sophisticated.

Notably, this study proposes that it is not passive consumption of technology but intentional use of technology that leads to its benefits in the context of facilitating active learning, responsive instruction, and individual learning processes (Shute and Rahimi, 2017).

4.3 Domain-Specific Applications and Effects

Studies on the use of particular technologies display more reliable positive impacts compared to the general ICT integration research. Mathematics education Dynamic geometry software like GeoGebra has also shown itself to be beneficial to student problem-solving skills, abilities in visualizing space, and the acquisition of higher-order thinking skills such as analysing, evaluating, and creating (Kim and Md-Ali, 2017). GeoGebra users generated work that included evidence of critical, creative, and innovative thinking when compared to control groups and students indicated that they had found GeoGebra to be an appealing learning method that

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allowed them to meaningfully interact with mathematical concepts.

Likewise, computer-assisted language learning (CALL) has demonstrated such positive effects as a rise in motivation, improvement in achievement, more interaction of students, individualization of learning, and lack of reliance on one source of information (Rosa and Obillos, 2016). The benefits of network-based CALL include specifically the experiential learning and the use of the authentic language which is relevant to the modern requirements of intercultural communicative competence and multilingual skills (Elboubekri, 2017).

5. Digital Literacy, Pedagogical Approach, and Implementation Quality

5.1 The Critical Role of Pedagogy

One important conclusion drawn during the studies on technology and learning outcomes is that technology does not necessarily lead to a better learning process, and the quality of provided pedagogical implementations has to define how technology will either stimulate or limit the learning process. The interaction between technology use and the academic outcomes is inherently intervened by the way teachers use technology in their pedagogical instruction.

The studies on integrating technology within the educational ecosystem underline that the mere provision of technological infrastructure or the belief that students are digitally literate will not result in any better outcomes (Gu et al., 2019). Rather, long-term positive outcomes rely on the abilities of teachers to use technology in pedagogically appropriate ways, students to actively learn instead of passively use technologies, and the organization support systems that would allow continuous improvement.

Notably, the technology does not change education itself but the social and pedagogical context, in which technology is implemented, dictates its impact (Aurangzeb et al., 2021; Gu et al., 2019). An old picture of a geography lesson which happened in an airplane in 1930s makes it clear: simply bringing teaching to new settings will not lead to the educational changes provided that the pedagogical strategies will stay passive and based on transmitting.

5.2 Teacher Perception, Attitude, and Readiness for Technology Integration

The perception, attitude, and motivation of teachers with regard to ICT largely determine their willingness to skilfully use technology in teaching (Ishfaq et al., 2022; Zamir & Thomas, 2019). The attitude of university teachers towards technology and their beliefs about the educational value of the technology are the key factors of whether the teachers will use ICT in their classroom teaching, irrespective of the institutional technology infrastructure.

The studies show that the positive attitudes of teachers to technology and their understanding of the capabilities of technologies to improve student achievement make them much more likely to purposefully use ICT in their work (Muoz et al., 2019). On the other hand, educators with a negative attitude toward technology as an educational resource or with anxiety about their own technical ability, can use the technology available poorly or use it in a manner that limits instead of facilitating any meaningful learning.

These findings have significant consequences on professional practice: helping teachers become more digitally literate, increasing their self-confidence in the use of technology, and developing a positive attitude towards educational technology is the prerequisite work before expecting significant improvements in the results of technology-mediated learning (Zamir and Thomas, 2019).

5.3 TPACK Framework and Integrated Teacher Preparation

The Technological Pedagogical Content Knowledge (TPACK) model provides useful information to appreciate how educators can aptly embrace the use of technology to improve learning. TPACK acknowledges that effective technology-based teaching involves combination of three areas of knowledge: subject content knowledge, pedagogical knowledge, and technological knowledge, and the most effective becomes possible with the deliberate combination of three domains (Tejada & Thayer, 2019).

TPack-centred pre-service teacher education programs have been shown to be effective in assisting aspiring teachers in becoming technologically competent as well as more knowledgeable about how to incorporate technology at the pedagogical level (Tejada & Thayer, 2019). Notably, these programs underline the fact that the integration of technology is not about technology itself, but rather a careful choice of the technological tools that can be used to meet certain pedagogical goals in the subject areas.

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6. Digital Literacy and Specific Student Populations

6.1 English Language Learners and Academic Purposes

Digital literacy competencies are relevant to the higher education of English language learners (ELLs) to a large extent. A study of undergraduate EAL learners in Australian universities revealed that students who had undergone an English for Academic Purposes (EAP) course with direct emphasis on digital literacy practices also reported greater integrity in institutional policy awareness, less frustration accessing course materials and showed greater academic integration (Roche, 2017).

These results point out that in cases of students involved in a linguistically challenging academic environment, digital literacy skills, especially the ability to access and analyse information, have a direct positive impact on academic performance. Incorporation of digital literacy training as a part of language preparation seems to increase the transfer of these peripheral skills into further educational curriculum subjects.

6.2 STEM Education and Emerging Technologies

The emerging digital literacy and computational thinking skills of students in science, technology, engineering and mathematics (STEM) learning environments are becoming more and more important in learning outcomes. The studies on the concept of computational thinking, which highlights problem decomposition, algorithm construction, and systematic problem-solving as the essential components of the teaching approach, have shown that the integration of the concept of computational thinking into the elementary education contributes to the growth of students in terms of critical thinking, teamwork, and the ability to find solutions to the problems (Brackmann et al., 2016).

Nevertheless, the mere availability of technological equipment in the classroom does not mean that the learning is going to be better (Brackmann et al., 2016). Computational thinking on the other hand is a method of teaching by use of technology as the medium through which students seek alternative answers to complex problems. The application of computational thinking to build the necessary twenty-first-century skills not only in computer science but also in other STEM fields is well supported and will foster learning in the discipline.

6.3 Supporting Novice Technology Users

The studies of familiarity with technology among first-year students in tertiary education prove that there is a lot of heterogeneity in the previous exposure to digital technologies, and the patterns of access, ownership, and usage are highly diverse (Byungura et al., 2018). Although smartphones are the most frequently accessed and owned digital technologies in a large number of student groups, learners do not use them in educational practice, which implies that the availability of a device does not necessarily result in the use of educational technology.

This acknowledgment underscores the necessity of the explicit instructional guidance that helps the students to direct the general knowledge about digital devices into meaningful use of technology in academic settings. The institutions should offer strategic assistance to give confidence among the students in utilizing academic technology tools and competencies that will help them to learn effectively in the technology-mediated classrooms.

7. The Myth of Digital Natives and Heterogeneous Digital Competence

7.1 Challenging the Digital Native Assumption

One important discovery in modern research studies of educational technology is the revelation that young people, owing to their upbringing with digital technologies, have been automatically assumed to have advanced digital literacy. Recent studies have completely challenged the concept of digital native and largely invalidated it (Reid et al., 2023).

Research shows that digital literacy development does not correspond to exposure to digital technologies. Although numerous youths spend more time on social media and entertainment using technologies, they often lack the background knowledge in information assessment, cybersecurity, responsible digital citizenship, and critical thinking on how to assess and analyse digital information (Reid et al., 2023). This disparity between the general technology familiarity and the actual digital literacy has some catastrophic implications on educational policy and practice.

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7.2 Actual Versus Perceived Digital Competence

A comparison of self-assessed and actual digital competence shows significant differences. In a study of future teaching staff in Poland, a majority of the respondents (more than half) rated their general digital competence as high or very high, but on competency tests based on the European Computer Skills Certificate (ECDL) standard, less than 20 percent scored above the required threshold in most areas of the knowledge (Tomczyk, 2021).

It is important to note that there was no predictive validity between self-evaluation of digital skills, attitudes towards new media, and prior learning experience with ICT and actual test performance in ECDL, implying that self-perception of competence and actual ability to demonstrate it differ significantly (Tomczyk, 2021). This observation underscores the significance of objective and subjective self-assessment of competency in terms of educational planning.

7.3 Implications for Curriculum Design and Support

The realization that digital literacy is not something to presuppose makes the curriculum designers have to explicitly design and measure digital competence as a learning outcome. Instead of assuming that students come into the institution with the required digital skills, institutions should strategically plan the instruction to provide the underpinning competencies, that allow advancement to higher skills and facilitate the transfer of skills in different settings.

8. Digital Literacy and Online Learning Readiness

8.1 Emotional Intelligence and Online Learning Success

With the growing integration of online learning and blended learning practices in educational systems, the digital literacy is coming in as one of the factors among others that determine the success of online learning. Studies on readiness of online learning demonstrate that emotional intelligence, which entails self-awareness, self-control, social awareness and relationship management, displays a substantial correlation with readiness to online learning as well as technical digital literacy (Alenezi, 2020).

This observation implies that effective online learning requires both technical competences to traverse digital learning environments and psychological and emotional aspects that permit the student to be self-managed in learning, sustained through motivation and productively interact in technology mediation in a learning setup. The readiness of online learning among female students is always higher than among male peers, and emotional intelligence is a significantly differentiating factor (Alenezi, 2020).

8.2 Digital Platform Acceptance and Academic Performance

The level of acceptance and increase use of digital learning platforms by students determines whether technology-enhanced learning has better outcomes. A study that compared the perception of both teachers and students with regard to technology as a learning tool revealed that there is a high degree of access to technology but a wide gap in the perceived usefulness and actual application of the same in academic activities (Muoz et al., 2019).

Notably, positive relationships were found between perceived ease-of-use and perceived utility of the learning management systems (including Moodle) and student attitudes to the blended learning (Muoz et al., 2019). It indicates that not just technical characteristics affect technology acceptance, but also on subjective perceptions of usability by students, and that user interface design and customization features are worth paying a specific attention to when selecting and implementing a platform.

9. Digital Literacy Competencies for Contemporary Learning Needs

9.1 Twenty-First Century Skills and Digital Competence

Modern educational models begin to pay more attention to the idea that digital literacy should include not only technical skills but also more sophisticated problem-solving, creativity, teamwork, communication, and critical thinking when used in a digital environment (Muhali, 2019). These skills are interpreted to be the keys to the success of students in work and social settings that evolve quickly.

Twenty-first century learning paradigm is a conceptual shift in the meaning of literacy beyond the limited definition of reading, writing, and mathematics to the broader definitions that include the concept of data literacy, technological literacy, and human skills such as critical thinking, problem-solving, creativity, innovation, collaboration, and communication (Muhali, 2019). Digital literacy becomes the platform which

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facilitates formulation and implementation of these complex competencies.

9.2 Computational Thinking as Digital Literacy

Computational thinking is a significant aspect of modern digital literacy that involves systematized problem-solving, algorithm creation, and general logical thinking that can be used in a variety of areas (Ladi and Martini, 2021). But studies make a distinction between narrow technical skill in computer science as computational thinking and more general views including scientific and critical thinking substratum.

The difference is important: the concept of computational thinking when properly interpreted is not only computer science, but at the same time an educational framework that can be applied in various fields, to equip the mind with the tools of cognition about more and more phenomena that are becoming increasingly digital (Ladi and Martini, 2021). Nevertheless, most of the assertions that computational thinking is naturally transferred to general twenty-first-century capabilities are not substantiated and thus the significance of explicit instructional design that bridges computational thinking to implementation across areas is highlighted.

9.3 Digital Literacy for Intercultural Communication

Within a more globalized world, digital literacy includes the skills of intercultural communicative competence the ability to communicate proficiently and properly across cultural situations, which are more and more mediated by digital means. Digital technologies also allow connecting learners with speakers of other cultures in ways that allow genuine language and cultural interaction that cannot otherwise be associated with traditional classroom environments (Elboubekri, 2017).

Nevertheless, these affordances need deliberate pedagogical design in order to be actualized. Combined strategies featuring a mix of the conventional classroom-based teaching and the cooperative and collaborative online learning allow students to acquire intercultural competence and enjoy the advantage of the direct teacher instructions and peer communication (Elboubekri, 2017).

10. Digital Literacy Development Through Innovative Pedagogical Approaches

10.1 Project-Based Learning and Technology Integration

Technology integration project-based learning (PBL) strategies have shown to be successful in the construction of both digital and subject-matter literacy. Digital competencies are built in meaningful contexts as students undertake real-life projects that need the use of technology, collaborative work, and creative problem-solving, as opposed to being taught or trained in isolated skill-building drills.

As an example, pre-service music teachers who participated in the project-based learning with the music technology created did not only enhance their technical skills but also trusted themselves, were willing to use ICTs in new teaching situations, and knew how technology could facilitate musical learning (Tejada and Thayer, 2019). Use of authentic projects facilitated the reality of the purpose behind the use of technology, which is better suited in competency development as compared to decontextualized technology training.

10.2 Maker Cultures and Hands-On Digital Competencies

The idea of maker culture and its focus on learning through doing, design thinking, and creating digital and physical objects with the usage of technology tools has proved to provide the potential to develop not only technical skills but also the desire to study (Silva et al., 2020). Maker culture-related programs that involved students in construction, alteration, and design with technology have shown higher student motivation, links between classroom knowledge and real-life practice, and improved knowledge of linkages between technical skills and legitimate use.

The latter methods are especially characterized by the possibilities of extending the traditional classroom by virtual learning and remote experimentation laboratories that provide access to advanced technologies and live data that are usually not available to numerous schools (Silva et al., 2020).

10.3 Blended Learning and Hybrid Modalities

Online learning with face-to-face instruction has proven to be effective in attaining digital literacy with the added advantage of direct teacher-student engagement and peer-to-peer learning. Blended learning offers the possibility of differentiated instructions, where online materials can be paced differently, but the overall experience of working in a whole class can be preserved.

The studies on the effectiveness of technology-enhanced learning are gradually gaining more and more information in favour of blended learning techniques as providing advantages that are better than those of the

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face-to-face learning approach or fully online education (Muoz et al., 2019). Nevertheless, blended learning can only be successful when it is designed with care, clear learning goals and modality coherence, implying that design quality is important rather than modality.

11. Barriers, Limitations, and Technology-Related Challenges

11.1 Digital Divide and Equity Concerns

Although technology has the potential to enhance the learning outcomes, there is still a significant difference in digital access, which generates and possibly exacerbates educational inequities. Learners with low income, in rural communities and developing nations have extremely low access to technology and struggles to develop digital literacy (Kim, 2018).

Moreover, the global studies prove that the most productive educational systems in displaying positive ICT impacts are the ones that are the most competitiveness and educational selectivity oriented (Valverde-Berrocoso et al., 2022). This trend is of concern because technology-enhanced learning might favour advantaged students, and the achievement gap might widen, unless interventions are specifically designed to promote equity.

11.2 Cognitive Load and Technology Fatigue

The new studies point to the unfortunate side effects of the widespread application of technology in education. Due to the emergence of emergency remote learning and prolonged video conferencing as well as intensive screen-based learning, especially during the COVID-19 pandemic, there was a high level of cognitive fatigue and psychological strain (Wiederhold, 2020). According to reports of students and teachers, technology-mediated instruction becomes too intensive without any strategic breaks and different modalities, which ultimately leads to a decrease in engagement, anxiety, and effectiveness of learning.

This insight underscores the fact that increased technology and increased screen time may not necessarily lead to more learning, but instead a balanced approach with regard to cognitive and emotional well-being seems to be more sustainable (Wiederhold, 2020).

11.3 Implementation Challenges and the "Black Box" Problem

The obstacles to the effectiveness of technology are implementation barriers that schools often face. The lack of proper preparation of teachers and their supporting technical infrastructure, the lack of institutional willingness to alter pedagogical approaches, and the mismatch between the technological investment and the learning purpose also provide conditions in which technological investments in education do not translate into the expected learning outcomes (Gu et al., 2019).

Also, the more sophisticated educational technology becomes, with the introduction of artificial intelligence and the use of algorithms to make decisions, the more urgent the transparency, interpretability, and ethical application issues are. Unclear systems based on algorithms that provide educational advice or evaluation without giving a clear rationale pose the system as a risk of being unfair and lack educator autonomy (Shum and Luckin, 2019).

12. Digital Literacy and Student Diversity

12.1 Gender Differences in Digital Competence and Online Learning

Studies determine the gender differences in the development of digital competences and the success of online learning, although patterns depend on the context. Women students are often more emotionally intelligent and ready to study online than men (Alenezi, 2020), but gender differences in the technical skills and familiarity with particular technologies are more diverse.

Gender relations in digital literacy development require attention in educational intervention because both technical and affective aspects of competence can be experienced and gender disparities can be attributed to dissimilar encouragement or opportunity instead of capability difference.

12.2 Cultural Contexts and Digital Literacy Development

The development of digital literacy takes place in the cultural contexts that influence the technologies that are accessible as well as the desired competencies. Although digital literacy frameworks that associate critical thinking and autonomy to specific cultural values that emphasize individualism and access to information, there are cultural contexts that emphasize other aspects of digital competence.

The studies regarding digital literacy in the cultural context indicate that the most effective educational

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practices necessitate cultural responsiveness that would acknowledge the variety of values and learning needs instead of establishing universal competence patterns (Tomczyk, 2021).

13. Synthesis: When Does Digital Literacy Improve Learning Outcomes?

Summarizing the available research findings, a number of circumstances can be classified to facilitate effective digital literacy ensuring that it can have a positive impact on the student learning outcomes:

Pedagogically Sound Integration: Technology should be incorporated to facilitate particular pedagogical goals instead of using it to be innovative or convenient to the administration. To use technologies effectively, one needs to state learning objectives and effectively choose the tools to be used with a purpose of achieving those objectives.

Teacher Preparation and Support: Teachers need to be digitally competent and learn more about the pedagogy of effective integration of technology. The continuous growth in technical and pedagogical skills needs professional development.

Active Student Engagement: Learning outcomes become better when technological means facilitates active and constructive engagement between the student and technology as opposed to passive use of technology. The interactive applications, simulations, modelling tools and collaboration platforms are more effective than the tool applications mainly in information delivery.

Fit with Subject Domain: Technology is effective in subject areas to a wide degree. Applications that have the greatest impacts are generally those that are domain specific (e.g. dynamic geometry to mathematics) as opposed to generic technology tools.

Equal Opportunity and Provision: It is most reliable and equitable when every student can access technology with strength and is instructed to develop the required competencies. Equity will not be paid attention to, and without doing this, technology integration will even increase and not reduce achievement gaps.

Controllable Cognitive Workload: Successful learning involves a balance between the use of technologies and other forms, and it is important to avoid mental exhaustion and preserve a healthy state of mind in addition to studying.

Organizational Readiness: Long-term improvement relies on the organizational support, such as the commitment of the leadership, allocation of resources, technical infrastructure, and the organizational culture that cherishes continuous improvement.

14. Future Research Directions and Outstanding Questions

Although a lot of work has been done concerning digital literacy and learning outcomes, there is still a lot of unexplored questions. Future studies need to fill in:

Causal Mechanisms: Although there are reports of the correlations between digital literacy and better outcomes, the particular processes by which certain competencies affect learning in particular areas are not fully understood. Future studies with an explicit focus on the influence of individual digital competencies on the learning process in specific subject areas would enhance the instructional design guidance.

Long-Term Effects: In the majority of studies, short-term learning outcomes are studied. The longitudinal research on whether the growth of digital literacy would facilitate the retrospective gains and transfer to the new environment would be clear on the actual impact of technology.

Equity and Access: Studies on how to promote the development of digital literacy among all students, especially those who represent underserved populations, are still needed. The knowledge of the ways to overcome digital divides and make technology-benefits fairly is the issue that should be prioritized.

Artificial Intelligence and Emerging Technologies: With the growing presence of AI, augmented reality, and other emerging technologies in the educational setting, the studies analyzing their effects on learning outcomes and the development of digital literacy become a necessary element.

Interdisciplinary Integration: Digital literacy studies need to be more integrated, with more perspectives on cognitive psychology, pedagogy, instructional design, equity studies, and ethics, beyond technology centric approach.

15. Implications for Policy and Practice

15.1 Institutional Recommendations

Schools have to invest in full-scale digital literacy development courses to every student and clearly tackle the competences instead of making assumptions. Digital literacy should be taught through the standard subjects instead of just in computer science, as it is acknowledged that applications in subject areas are more transferable than general computer skills programs.

The institutions should also allocate large sums in teacher professional development, which includes taking care of the educators in becoming digitally literate, as well as pedagogical knowledge of integration of technology. The principles of TPACK frame should be integrated into teacher education programs that would assist future educators in building combined technical-pedagogical-content knowledge.

15.2 Technology Implementation Guidance

Instead of adopting technology due to its own advantage, education systems need to undertake scrupulous needs analysis ascertaining certain learning barriers technology could help to solve. The use of technology must not come before clear pedagogical goals.

The implementation must be mindful of the user experience since the adoption of technology is affected by technology acceptance. Plug-and-play user-friendly, intuitiveness, with high levels of technical support and customization enable stronger adoption compared to complicated systems that need a lot of troubleshooting.

15.3 Equity Considerations

The policy should be clear about digital divides, as all students should be able to access technology resources and teaching. The implementation process should be done fairly, and specific consideration should be given to low-income students, rural students, and students who belong to underrepresented groups, and resources should be allocated with the aim of making them accessible and supported.

16. Conclusion

Digital literacy has a great impact on student learning outcomes, and the correlation is not always direct and positive. Instead, the effect of digital literacy on learning relies on various contextual influences such as the quality of pedagogical implementation, teacher preparation and facilitation, organizational preparation, equal access and conformity between technology tools and learning goals.

It is proven that in case digital literacy is built actively with the help of appropriate pedagogy, it provides students with the competencies which help them to achieve higher academic success, improve their engagement, and acquire twenty-first century skills which will allow them to become members of digitally mediated societies. Specific advantages are accrued in certain areas such as mathematics and science, to some groups of students such as language learners, and when technology facilitates active, as opposed to passive learning.

On the other hand, integration of technology, lacked in pedagogical soundness, teacher preparation, and articulate learning objectives, often have poor outcomes. The myth that exposure to digital technologies naturally creates digital literacy competence, so-called digital native, has been repeatedly disproved by studies showing that there is a lot of heterogeneity in the competence and that it must be taught explicitly.

To proceed, future educational systems should not be technology-for-technology but rather purposeful, evidence-based integration to support the development of digital literacy of all students in educational systems. It demands significant investment in the training of teachers, a focus on the design of pedagogy, the belief in equity, as well as continuous monitoring of the real effects of technology in education. Digital literacy is a crucial competency of the twenty-first century, but to reach the potential of improving the outcomes in learning, it is necessary to be implemented with care based on research evidence and pedagogical knowledge and principles of dedication to educational equity.

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The participant in the study gave their informed consent.

Statement of Data Availability

The corresponding author can provide the data used in this study upon request.

Conflict of Interest

The authors declare no conflict of interest.

References

Alenezi, A. M. (2020). The relationship of students' emotional intelligence and the level of their readiness for online education: A contextual study on the example of university training in Saudi Arabia. *Образование и Наука, 22*(4), 89–109. https://doi.org/10.17853/1994-5639-2020-4-89-109

Aurangzeb, D., & Asif, M. (2021). Role of leadership in digital transformation: A case of Pakistani SMEs. In *Fourth International Conference on Emerging Trends in Engineering, Management and Sciences (ICETEMS-2021)(4 (1), 219-229)*.

Aurangzeb, M., Tunio, M., Rehman, Z., & Asif, M. (2021). Influence of administrative expertise on human resources practitioners on the job performance: Mediating role of achievement motivation. *International Journal of Management*, *12*(4), 408-421.

Boudadi, N. A., & Gutiérrez-Colón, M. (2020). Effect of gamification on students' motivation and learning achievement in Second Language Acquisition within higher education: A literature review 2011–2019. *The EuroCALL Review, 28*(1), 57–69. https://doi.org/10.4995/EuroCALL.2020.12872

Brackmann, C. P., Barone, D. C., Casali, A. P., Boucinha, R. H., & Muñoz-Hernandez, S. (2016, September). Computational thinking: Panorama of the Americas. In *2016 International Symposium on Computers in Education (SIIE)* (pp. 1–6). IEEE. https://doi.org/10.1109/SIIE.2016.7751687

Byungura, J. C., Hansson, H., Muparasi, M., & Ruhinda, B. (2018). Familiarity with technology among first-year students in Rwandan tertiary education. *Electronic Journal of e-Learning, 16*(1), 30–45. https://doi.org/10.34190/EJEL.18.1.372

ElElboubekri, A. (2017). The intercultural communicative competence and digital education: The case of Moroccan University students of English in Oujda. *Journal of Educational Technology Systems, 45*(4), 520–545. https://doi.org/10.1177/0047239516656488

Gu, X., Crook, C., & Spector, M. (2019). Facilitating innovation with technology: Key actors in educational ecosystems. *British Journal of Educational Technology, 50*(3), 1141–1155. https://doi.org/10.1111/bjet.12789

Ishfaq, U., Imran, A., Joseph, V., Haqdad, U., Samraameer, & Asif, M. (2022). Mediating role of trust between emotional intelligence and project team performance in telecommunication sector. *Palarch's Journal of Archaeology of Egypt/Egyptology, 19*(4), 988–1005.

Kim, K. M., & Md-Ali, R. (2017). GeoGebra: Towards realizing 21st century learning in mathematics education. *Malaysian Journal of Learning and Instruction, 14*(1), 93–115. https://doi.org/10.32890/mjli2017.14.1.5

Kim, S. (2018). ICT and the UN's sustainable development goal for education: Using ICT to boost the math performance of immigrant youths in the US. *Sustainability, 10*(12), Article 4584. https://doi.org/10.3390/su10124584

Lodi, M., & Martini, S. (2021). Computational thinking, between Papert and Wing. *Science & Education, 30*(4), 883–908. https://doi.org/10.1007/s11191-021-00246-4

Muhali, M. (2019). *Pembelajaran inovatif abad ke-21*. Penerbit Deepublish.

Muñoz, M. L. A., Almenara, J. C., & Zamorano, I. V. (2019). Comparative study between teachers and students on acceptance and use of technologies for educational purposes in the Chilean context. *Revista Electrónica de Investigación Educativa, 21*, 104–119. https://doi.org/10.24320/redie.2019.21.e11.2035

Reid, L., Button, D., & Brommeyer, M. (2023). Challenging the myth of the digital native: A narrative review. *Nursing Reports, 13*(2), 573–600. https://doi.org/10.3390/nursrep13020052

Roche, T. B. (2017). Assessing the role of digital literacy in English for Academic Purposes university pathway programs. *Journal of Academic Language and Learning, 11*(1), A71–A87. https://doi.org/10.18539/JALL2017.11.1.6

Rosa, M. D. L., & Obillos, J. P. (2016). Experiences, perceptions and attitudes on ICT integration: A case study among novice and experienced language teachers in the Philippines. *International Journal of*

Education and Development Using Information and Communication Technology, 12(3), 4–20.

Shum, S. B., & Luckin, R. (2019). Learning analytics and AI: Politics, pedagogy and practices. *British Journal of Educational Technology, 50*(6), 2785–2793. https://doi.org/10.1111/bjet.12861

Shute, V. J., & Rahimi, S. (2017). Review of computer-based assessment for learning in elementary and secondary education. *Journal of Computer Assisted Learning, 33*(1), 1–19. https://doi.org/10.1111/jcal.12170

Silva, J. B., Silva, I. N., & Bilessimo, S. M. S. (2020). Technological structure for technology integration in the classroom, inspired by the maker culture. *Journal of Information Technology Education: Research, 19*, 167–204. https://doi.org/10.28945/4534

Tejada, J. J. A., & Morel, T. T. (2019). Design and validation of a music technology course for initial music teacher education based on the TPACK framework and the project-based learning approach. *Journal of Music, Technology & Education, 12*(3), 225–246. https://doi.org/10.1386/jmte_00015_1

Tomczyk, Ł. (2021). Declared and real level of digital skills of future teaching staff. *Education Sciences, 11*(10), Article 619. https://doi.org/10.3390/educsci11100619

Valverde-Berrocoso, J., Acevedo-Borrega, J., & Cerezo-Pizarro, M. (2022). Educational technology and student performance: A systematic review. *Frontiers in Education, 7*, Article 916502. https://doi.org/10.3389/feduc.2022.916502

Wiederhold, B. K. (2020). Connecting through technology during the coronavirus disease 2019 pandemic: Avoiding "Zoom fatigue." *Cyberpsychology, Behavior, and Social Networking, 23*(7), 437–438. https://doi.org/10.1089/cyber.2020.29188

Yustika, G. P., & Iswati, S. (2020). Digital literacy in formal online education: A short review. *Dinamika Pendidikan, 15*(1), 66–76. https://doi.org/10.15294/dp.v15i1.23052

Zamir, S., & Thomas, M. (2019). Effects of university teachers' perceptions, attitude and motivation on their readiness for the integration of ICT in classroom teaching. *Journal of Education and Educational Development, 6*(2), 308–326. https://doi.org/10.22555/joeed.v6i2.1913