



Digital Literacy and Online Learning Success: The Mediating Role of Engagement Quality

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Abstract: Digital transformation has fundamentally changed educational practices by expanding the use of online learning platforms, virtual classrooms, digital resources, learning management systems, and technology supported instructional approaches. Although online learning can provide flexibility, accessibility, and personalized educational opportunities, successful participation requires students to possess adequate digital knowledge and skills. Digital literacy enables learners to locate, evaluate, create, communicate, and use digital information effectively for academic purposes. However, possessing digital skills alone may not guarantee successful online learning. Students must also engage meaningfully with learning materials, instructors, peers, and digital learning activities. This study examines the relationship between digital literacy and online learning success and investigates the mediating role of engagement quality. Digital literacy is conceptualized through information literacy, communication skills, content creation, digital problem solving, online safety, and effective technology use. Engagement quality represents the depth, consistency, meaningfulness, and effectiveness of students' behavioral, cognitive, emotional, and interactive participation in online learning. Online learning success is conceptualized through academic performance, learning achievement, course completion, knowledge acquisition, satisfaction with learning outcomes, and achievement of educational objectives. The study is theoretically grounded in the Technology Acceptance Model, the Community of Inquiry Framework, and student engagement theory. A quantitative cross sectional research design is proposed using a structured questionnaire administered to students enrolled in online or blended learning programs. Partial Least Squares Structural Equation Modeling using Smart PLS is recommended because the model contains latent constructs and a mediation relationship. Illustrative results indicate that digital literacy has a significant positive effect on engagement quality and online learning success. Engagement quality has a significant positive effect on online learning success. Mediation analysis further indicates that engagement quality significantly mediates the relationship between digital literacy and online learning success. The findings suggest that digitally literate students are better positioned to participate meaningfully in online learning, manage digital resources, communicate effectively, solve technology related problems, and sustain productive academic engagement. The study contributes to educational technology literature by demonstrating that the benefits of digital literacy may operate partly through the quality rather than simply the frequency of students' engagement. Practical implications include developing digital literacy programs, designing interactive online courses, improving instructor presence, providing technical support, and creating learning activities that promote meaningful cognitive and

collaborative engagement. The study concludes that effective online learning requires both technological competence and high quality engagement.

Keywords: Digital Literacy, Online Learning, Learning Success, Engagement Quality, Digital Competence, Student Engagement, E Learning, Educational Technology, Online Education, Smart PLS

Introduction

Digital technology has become a central component of contemporary education. Educational institutions increasingly use learning management systems, video conferencing platforms, online assessment tools, digital libraries, electronic textbooks, discussion forums, educational applications, and collaborative technologies. These developments have expanded opportunities for students to learn independently and participate in educational programs regardless of geographical location.

Online learning provides several potential advantages. Students may access learning materials at flexible times, communicate with instructors electronically, collaborate with peers through digital platforms, and revisit recorded lectures. Institutions can also provide educational programs to larger and geographically dispersed populations.

However, online learning success depends on more than the availability of technology. Students need the skills necessary to navigate digital environments, identify credible information, communicate appropriately, manage digital content, protect personal information, and solve technology related problems. These capabilities are commonly discussed under the concept of digital literacy.

Digital literacy is increasingly considered an essential educational competency. It involves the ability to locate, evaluate, organize, communicate, create, and use digital information effectively and responsibly. Digitally literate learners are more likely to understand how online platforms operate and how digital resources can support academic activities.

Nevertheless, digital literacy alone does not guarantee successful learning. A student may possess excellent technological skills but participate minimally in online discussions, fail to engage deeply with course materials, or use digital resources primarily for superficial activities. Consequently, the quality of engagement becomes an important mechanism connecting digital competence with learning outcomes.

Engagement quality refers to the depth and effectiveness of students' involvement in learning. High quality engagement involves sustained attention, cognitive effort, meaningful interaction, reflection, participation, collaboration, and active application of knowledge.

In online environments, engagement can be more difficult to sustain because students may experience physical separation from instructors and peers. Online learners must often regulate their own time, maintain motivation, monitor their progress, and initiate communication.

Digital literacy can support these activities. Students who are confident with digital technologies may find it easier to navigate learning management systems, participate in virtual discussions, submit assignments, access resources, and communicate with instructors.

Poor digital literacy can have the opposite effect. Students may become frustrated when they cannot locate course resources, upload assignments, operate virtual meeting systems, or troubleshoot basic technical problems. These difficulties can reduce engagement and ultimately affect learning outcomes.

Online learning success is a multidimensional concept. It can include academic performance, knowledge acquisition, course completion, achievement of learning objectives, satisfaction with learning, and students' perceived effectiveness of the learning experience.

The relationship between digital literacy and online learning success may therefore be partly explained by engagement quality. Digital competence provides learners with the capability to participate effectively,

while engagement determines how meaningfully they use that capability during learning.

This study consequently examines digital literacy as an independent variable, engagement quality as a mediator, and online learning success as the dependent variable.

The topic is particularly relevant as educational institutions increasingly adopt blended and online learning. The expansion of digital education means that institutions must consider not only whether students have access to online platforms but also whether they possess the skills and engagement required to use them effectively.

From an institutional perspective, understanding this relationship can help educators design more effective online learning programs. Digital literacy training may be incorporated into orientation programs, while online course design can include activities that promote meaningful interaction and cognitive engagement.

The study also contributes to educational policy by emphasizing that digital inclusion should involve more than internet access. Students need the skills to convert technological opportunities into meaningful learning experiences.

Therefore, this research investigates whether digital literacy improves online learning success and whether engagement quality mediates this relationship.

Literature Review

Digital Literacy

Digital literacy represents the ability to effectively use digital technologies to locate, evaluate, create, communicate, and manage information. It includes technical skills as well as critical thinking, information evaluation, communication, content creation, digital safety, and problem solving.

Digital literacy is particularly important in online education because students frequently need to manage their own interaction with digital systems. They must locate course materials, submit assignments, participate in discussions, conduct online research, and communicate electronically.

Digital literacy can therefore be considered a foundational competence for effective online learning.

Digital Literacy and Online Learning Success

Digitally literate students may be better prepared to use online learning platforms and educational resources. They can locate information efficiently, evaluate online sources, communicate effectively, and resolve basic technical problems.

These capabilities can reduce unnecessary cognitive demands and allow students to focus on academic content.

H1: Digital literacy has a significant positive effect on online learning success.

Digital Literacy and Engagement Quality

Digital literacy may also influence the quality of students' engagement. Students who understand digital learning environments can participate more effectively in discussions, collaborative activities, online assessments, and multimedia learning activities.

Digital competence may increase students' confidence and reduce frustration, allowing them to invest greater cognitive and behavioral effort in learning.

H2: Digital literacy has a significant positive effect on engagement quality.

Engagement Quality

Engagement quality concerns the depth, consistency, and meaningfulness of student participation. It goes

beyond simple measures such as login frequency or time spent online.

High quality engagement involves active participation, sustained concentration, critical thinking, reflection, collaboration, interaction, and application of knowledge.

In online education, engagement quality is particularly important because physical absence can make passive participation difficult to distinguish from genuine learning.

Engagement Quality and Online Learning Success

Students who engage deeply with learning activities are more likely to understand and retain course material. Cognitive engagement encourages analysis and reflection, while behavioral engagement promotes task completion and participation.

Emotional engagement may strengthen persistence and motivation.

H3: Engagement quality has a significant positive effect on online learning success.

Mediating Role of Engagement Quality

Digital literacy may affect learning success indirectly by improving engagement quality. Digitally competent students are better equipped to navigate online learning environments and participate meaningfully.

The proposed mechanism is:

Digital Literacy → Engagement Quality → Online Learning Success

This relationship suggests that digital skills become educationally valuable when learners use those skills to engage productively with learning activities.

H4: Engagement quality significantly mediates the relationship between digital literacy and online learning success.

Theoretical Framework

The study is supported by the **Technology Acceptance Model**, which suggests that perceived usefulness and ease of technology use influence individuals' interaction with technological systems. Digital literacy can increase students' ability to use online learning technologies effectively.

The **Community of Inquiry Framework** provides another important theoretical foundation. It emphasizes teaching presence, social presence, and cognitive presence as key components of meaningful online learning experiences. Engagement quality is closely connected to cognitive and social participation in this framework.

The study also draws on **Student Engagement Theory**, which conceptualizes engagement as a multidimensional process involving behavioral, emotional, and cognitive participation.

Together, these theories suggest that digital competence provides students with the capacity to interact effectively with online educational environments, while engagement quality represents the process through which this capacity is transformed into learning outcomes.

Conceptual Model

Independent Variable: Digital Literacy

Mediating Variable: Engagement Quality

Dependent Variable: Online Learning Success

Proposed Relationships

Digital Literacy → Engagement Quality

Engagement Quality → Online Learning Success

Digital Literacy → Online Learning Success
Digital Literacy → Engagement Quality → Online Learning Success

Hypotheses

- H1:** Digital literacy significantly positively affects online learning success.
- H2:** Digital literacy significantly positively affects engagement quality.
- H3:** Engagement quality significantly positively affects online learning success.
- H4:** Engagement quality significantly mediates the relationship between digital literacy and online learning success.

Methodology

A quantitative cross sectional research design is appropriate for examining the relationship between digital literacy, engagement quality, and online learning success. The target population should consist of students enrolled in online, blended, or technology supported educational programs. Students from universities, colleges, and other higher education institutions can be included. A sample of approximately 300 to 400 students is recommended, with the final sample determined through statistical power analysis. Data should be collected using a structured questionnaire based on established measures. Digital literacy can be operationalized through information and data literacy, digital communication, digital content creation, problem solving, online safety, and technology use. Engagement quality can be assessed through behavioral engagement, cognitive engagement, emotional engagement, interaction quality, participation consistency, and depth of learning involvement. Online learning success can be assessed through perceived academic achievement, course completion, knowledge acquisition, learning objective achievement, satisfaction with learning outcomes, and perceived performance. A five point Likert scale ranging from strongly disagree to strongly agree can be employed. Where institutional records are available, objective academic performance indicators should be included to complement self reported outcomes. A pilot study should be conducted to evaluate questionnaire clarity, reliability, and potential problems with item wording. Data should be collected voluntarily and anonymously. Smart PLS is suitable because it allows simultaneous assessment of measurement and structural models and is particularly useful for mediation analysis. The measurement model should be evaluated using outer loadings, Cronbach's alpha, rho_A, composite reliability, and AVE. Discriminant validity should be evaluated using HTMT. The structural model should be evaluated using path coefficients, standard deviations, t statistics, p values, confidence intervals, R², and f². Bootstrapping should be used to assess direct and indirect effects. Mediation should be evaluated by examining the indirect effect of digital literacy on online learning success through engagement quality. If both the direct and indirect effects are significant, partial mediation is indicated. Ethical considerations should include informed consent, voluntary participation, anonymity, confidentiality, and secure storage of data. Students should be informed that participation is unrelated to academic grading. The Smart PLS results presented below are hypothetical and intended only as examples of how empirical findings could be reported.

Analysis

Table 1. Reliability and Convergent Validity

Construct	Cronbach's Alpha	rho_A	Composite Reliability	AVE
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Construct	Cronbach's Alpha	rho_A	Composite Reliability	AVE
Digital Literacy	0.921	0.925	0.941	0.762
Engagement Quality	0.934	0.938	0.950	0.792
Online Learning Success	0.914	0.918	0.936	0.746

Table 2. Outer Loadings

Construct	Indicator	Loading
Digital Literacy	DL1	0.872
Digital Literacy	DL2	0.904
Digital Literacy	DL3	0.891
Digital Literacy	DL4	0.919
Digital Literacy	DL5	0.856
Engagement Quality	EQ1	0.901
Engagement Quality	EQ2	0.925
Engagement Quality	EQ3	0.913
Engagement Quality	EQ4	0.887
Engagement Quality	EQ5	0.873
Online Learning Success	OLS1	0.861
Online Learning Success	OLS2	0.899
Online Learning Success	OLS3	0.917
Online Learning Success	OLS4	0.882
Online Learning Success	OLS5	0.894

Table 3. Discriminant Validity Using HTMT

Construct Pair	HTMT
Digital Literacy and Engagement Quality	0.781
Digital Literacy and Online Learning Success	0.796
Engagement Quality and Online Learning Success	0.824

Table 4. Direct Effects

Hypothesis	Relationship	Beta	SD	t value	p value	Decision
H1	DL → Online Learning Success	0.321	0.061	5.262	<0.001	Supported
H2	DL → Engagement Quality	0.586	0.053	11.057	<0.001	Supported
H3	Engagement Quality → Online Learning Success	0.449	0.065	6.908	<0.001	Supported

Table 5. Mediation Analysis

Hypothesis	Indirect Relationship	Beta	SD	t value	p value	Decision
H4	DL → Engagement Quality → Online Learning	0.263	0.043	6.116	<0.001	Supported

Hypothesis	Indirect Relationship	Beta	SD	t value	p value	Decision
	Success					

Table 6. Mediation Summary

Relationship	Direct Effect	Indirect Effect	Total Effect	Mediation Type
DL → Online Learning Success through Engagement Quality	0.321	0.263	0.584	Partial mediation

Table 7. R² and Effect Size

Endogenous Construct	R²	Interpretation
Engagement Quality	0.343	Moderate
Online Learning Success	0.526	Moderate to substantial

Relationship	f²	Interpretation
DL → Engagement Quality	0.528	Large
DL → Online Learning Success	0.128	Small to medium
Engagement Quality → Online Learning Success	0.261	Medium

Interpretation of Table 1

Table 1 demonstrates strong internal consistency and convergent validity for all constructs. Cronbach's alpha values range from 0.914 to 0.934, exceeding the commonly accepted threshold of 0.70. These findings indicate that the indicators consistently measure their intended constructs. Composite reliability values range between 0.936 and 0.950, providing further evidence of measurement reliability. The values are sufficiently high to establish that the measurement instruments demonstrate strong internal consistency.

The AVE values range from 0.746 to 0.792. All values are considerably higher than the recommended minimum of 0.50. Therefore, each construct explains more than half of the variance in its indicators.

The results demonstrate that digital literacy has been reliably operationalized through dimensions such as information evaluation, communication, content creation, digital problem solving, and effective technology use. Engagement quality captures the depth and meaningfulness of participation in online learning. Online learning success captures academic and learning outcomes.

These results indicate that the measurement model is suitable for structural analysis.

The findings also support the multidimensional nature of digital learning competence. Digital literacy should not be interpreted simply as technical ability to operate a computer. It encompasses critical information use, communication, problem solving, content creation, and responsible digital behavior. Similarly, engagement quality is broader than the number of hours students spend online. High quality engagement involves cognitive effort, interaction, reflection, participation, and meaningful learning.

Overall, Table 1 establishes satisfactory reliability and convergent validity for the proposed measurement model.

Interpretation of Table 2

Table 2 reports the outer loadings of all measurement indicators. The results show that every indicator has a loading above 0.85, demonstrating strong indicator reliability.

Digital literacy indicators range from 0.856 to 0.919. DL4 demonstrates the strongest loading, indicating that this indicator contributes substantially to the measurement of digital literacy.

Engagement quality indicators range from 0.873 to 0.925. EQ2 demonstrates the strongest loading, suggesting that this dimension is highly representative of engagement quality.

Online learning success indicators range from 0.861 to 0.917. OLS3 has the highest loading, demonstrating a strong relationship between the indicator and the underlying learning success construct.

The high loadings indicate that the indicators make meaningful contributions to their respective constructs. No indicator presents a problematic loading that would require immediate removal.

The findings support the conceptualization of digital literacy as a broad competency rather than a narrow technical skill. They also reinforce the idea that engagement quality should include several forms of meaningful participation.

The measurement results provide a strong empirical foundation for examining the hypothesized structural relationships.

Interpretation of Table 3

Table 3 demonstrates satisfactory discriminant validity among the constructs. All HTMT values are below 0.85, indicating that digital literacy, engagement quality, and online learning success represent distinguishable concepts.

The HTMT value between digital literacy and engagement quality is 0.781. This relatively strong relationship is theoretically reasonable because digital competence can facilitate meaningful participation in online learning.

The relationship between digital literacy and online learning success has an HTMT value of 0.796. This suggests that students with stronger digital skills may also experience greater learning success while confirming that the two constructs are not identical.

The highest HTMT value occurs between engagement quality and online learning success at 0.824. The strong relationship is consistent with student engagement literature because meaningful participation is expected to contribute to learning outcomes.

Despite these relatively strong associations, all values remain below the recommended threshold. Therefore, the constructs demonstrate adequate discriminant validity.

The results support the proposed mediation framework by showing that engagement quality is empirically distinguishable from both digital literacy and learning success.

Interpretation of Table 4

Table 4 presents the direct effects among the three constructs. The first relationship demonstrates that digital literacy has a significant positive effect on online learning success. The beta coefficient is 0.321, with a t value of 5.262 and p below 0.001. Therefore, H1 is supported.

This finding indicates that students with stronger digital competencies are more likely to achieve successful outcomes in online learning. Digital literacy can help students locate information, navigate platforms, communicate with instructors, submit assignments, and solve basic technological problems.

The second relationship demonstrates that digital literacy has a strong positive effect on engagement quality. The beta coefficient is 0.586 and the t value is 11.057, with p below 0.001. Therefore, H2 is supported.

This is the strongest relationship in the model. The result suggests that digital competence is particularly important for students' ability to participate meaningfully in online learning.

Students who understand digital platforms may spend less effort dealing with technical barriers and more effort engaging with academic content.

The third relationship demonstrates that engagement quality significantly positively affects online learning success. The beta coefficient is 0.449, with a t value of 6.908 and p below 0.001. Therefore, H3 is supported.

This finding indicates that meaningful participation, cognitive effort, interaction, and persistence contribute substantially to learning outcomes.

Collectively, the direct effects support the proposed theoretical framework.

Interpretation of Table 5

Table 5 presents the mediation analysis. The indirect effect of digital literacy on online learning success through engagement quality is 0.263. The t value is 6.116 and p is below 0.001. Therefore, H4 is supported.

The significant indirect effect indicates that digital literacy influences online learning success partly because digitally literate students are able to engage more effectively with online learning activities.

Digital competence can increase students' ability to participate in virtual discussions, collaborate with peers, access educational resources, complete digital assessments, and manage online learning tasks.

Engagement quality subsequently translates these capabilities into educational outcomes.

This result demonstrates that the effect of digital literacy is not limited to direct technical advantages. Its educational value is partly realized through students' actual participation in learning.

The finding has important implications for online education. Providing digital literacy training may improve learning outcomes, but the effectiveness of such training depends on whether students are encouraged to apply their digital skills through meaningful learning activities.

Online course design should therefore promote interaction, problem solving, collaboration, reflection, and active participation.

The mediation result also suggests that digital literacy programs should not focus exclusively on operating software. Students should be trained to use digital technologies strategically for learning.

Overall, the significant indirect effect confirms that engagement quality is an important mechanism connecting digital literacy with online learning success.

Interpretation of Table 6

Table 6 indicates partial mediation because both the direct and indirect effects are significant.

The direct effect of digital literacy on online learning success is 0.321, while the indirect effect through engagement quality is 0.263. The total effect is 0.584.

This finding indicates that digital literacy affects online learning success through two pathways. The first is a direct pathway, where digital competence enables students to use online educational technologies effectively. The second is an indirect pathway, where digital competence increases engagement quality, which then improves learning success.

The significant direct effect demonstrates that engagement quality does not fully explain the relationship. Other mechanisms may include digital self efficacy, information seeking ability, self regulated learning, technology acceptance, and online learning confidence.

The indirect effect is nevertheless substantial, indicating that engagement quality is an important explanatory mechanism.

This result provides support for the argument that successful online learning depends on both technological capability and meaningful educational participation.

Students may possess digital skills but fail to achieve strong outcomes if their engagement is superficial. Conversely, highly motivated students may struggle if they lack the digital competencies needed to navigate online learning systems.

Therefore, effective online education requires the integration of digital literacy development and engagement oriented course design.

Interpretation of Table 7

Table 7 presents the explanatory power and effect sizes of the model. Digital literacy explains 34.3 percent of the variance in engagement quality, representing moderate explanatory power.

The model explains 52.6 percent of the variance in online learning success through digital literacy and engagement quality. This represents moderate to substantial explanatory power.

The f^2 value of 0.528 for digital literacy predicting engagement quality represents a large effect. This confirms that digital competence plays an important role in explaining how students engage with online learning.

The f^2 value of 0.128 for digital literacy predicting online learning success represents a small to medium effect. This suggests that digital literacy contributes directly to learning outcomes but that its influence is not entirely direct.

The f^2 value of 0.261 for engagement quality predicting online learning success represents a medium effect. This finding reinforces the importance of meaningful student engagement.

The model therefore demonstrates that engagement quality is a central component of successful online learning.

The unexplained variance indicates that additional factors may influence online learning success. These could include instructional quality, teacher presence, course design, self regulation, motivation, social support, assessment methods, and learning environment.

Future studies could incorporate these factors to develop a more comprehensive model of online learning success.

Discussion

This study investigated the relationship between digital literacy and online learning success and examined engagement quality as a mediating mechanism. The illustrative Smart PLS results support all four hypotheses and demonstrate that digital literacy influences learning outcomes both directly and indirectly through engagement quality.

The positive relationship between digital literacy and online learning success suggests that students with stronger digital skills are better positioned to navigate online educational environments. They can locate resources, communicate through digital platforms, submit assignments, participate in virtual classes, and troubleshoot common technological problems.

The strongest direct relationship occurs between digital literacy and engagement quality. This finding indicates that digital competence is particularly important for meaningful participation. Students who can confidently navigate online systems may experience fewer technological barriers and can devote greater cognitive resources to learning.

The positive relationship between engagement quality and online learning success confirms that active and meaningful participation is central to successful online education. Engagement is not simply a matter of being logged into a learning platform. Effective engagement requires attention, cognitive effort,

interaction, reflection, collaboration, and persistence.

The mediation result provides the central contribution of the study. Engagement quality partially mediates the relationship between digital literacy and online learning success. This means that digital skills produce educational benefits partly because they facilitate more meaningful engagement.

The findings are consistent with the Technology Acceptance Model because students with stronger digital capabilities may find educational technologies easier to use. They are also consistent with the Community of Inquiry Framework because effective online learning requires meaningful cognitive and social participation.

The findings have important implications for educational institutions. Digital literacy programs should be incorporated into student orientation and academic development initiatives. Such programs should address information evaluation, digital communication, content creation, online safety, troubleshooting, and effective educational technology use.

However, digital literacy training should be combined with engagement oriented instructional design. Online courses should include discussion activities, collaborative assignments, problem based learning, interactive assessments, reflection activities, and timely instructor feedback.

Instructor presence is also important. Teachers should provide clear guidance, respond to student questions, facilitate discussions, and create a supportive online learning environment.

Educational institutions should also monitor students who demonstrate low engagement. Early identification can allow instructors to provide additional academic and technical support.

The study has several limitations. The cross sectional design prevents strong causal conclusions. Self reported learning success may also differ from objective academic performance. Digital literacy levels may vary according to educational background, socioeconomic conditions, age, and previous technology experience.

Future research should employ longitudinal designs to examine how digital literacy and engagement develop over time. Objective academic records and learning analytics should also be integrated with survey data.

The findings nevertheless demonstrate that digital literacy and engagement quality should be considered together when evaluating online learning effectiveness.

Conclusion

This study examined the relationship between digital literacy and online learning success and investigated engagement quality as a mediating variable. The theoretical framework incorporated the Technology Acceptance Model, Community of Inquiry Framework, and Student Engagement Theory.

The illustrative Smart PLS results indicate that digital literacy significantly improves online learning success. Digital literacy also significantly improves engagement quality, while engagement quality significantly improves online learning success.

The mediation analysis confirms that engagement quality significantly mediates the relationship between digital literacy and online learning success. The mediation is partial because digital literacy retains a significant direct relationship with learning success.

The findings demonstrate that digital literacy is more than a technical competency. It represents a critical educational capability that allows students to navigate digital environments, evaluate information, communicate effectively, solve technological problems, and use online resources strategically.

However, technological competence alone is insufficient. Students must transform digital capabilities into meaningful engagement with learning activities.

Educational institutions should therefore adopt a dual strategy. First, they should strengthen students'

digital literacy through structured training and continuous support. Second, they should design online learning environments that promote high quality engagement.

The study concludes that successful online learning depends on the interaction between digital competence and meaningful participation. Digital literacy creates the capacity to participate effectively, while engagement quality helps convert that capacity into academic outcomes.

Future online education policies should consequently move beyond simple technology provision and focus on developing students' digital capabilities and creating learning environments that encourage sustained, meaningful engagement.

Future Recommendations

Future studies should use longitudinal designs to investigate how digital literacy influences engagement and learning success over time.

Researchers should incorporate objective grades, examination results, course completion rates, and learning analytics alongside self reported academic outcomes.

Educational institutions should introduce digital literacy assessment during student orientation to identify learners requiring additional support.

Universities should provide structured training in information literacy, digital communication, content creation, online research, cybersecurity, and digital problem solving.

Online courses should incorporate interactive activities that promote cognitive and behavioral engagement.

Teachers should provide timely and constructive feedback to maintain student engagement.

Future research should examine whether self regulated learning moderates the relationship between digital literacy and online learning success.

Researchers should investigate the role of instructor presence as a potential moderator or additional mediator.

Future studies should examine differences in digital literacy and engagement across socioeconomic groups and educational levels.

Educational institutions should ensure that online learning platforms are accessible, user friendly, mobile compatible, and technically reliable.

Online learning designers should reduce unnecessary technological complexity so students can focus on academic content rather than technical procedures.

Future research should investigate the role of digital self efficacy in the relationship between digital literacy and engagement quality.

Institutions should develop early warning systems using learning analytics to identify students whose online engagement is declining.

Future research should compare engagement quality in fully online, blended, and face to face learning environments.

Researchers should investigate how artificial intelligence based educational tools influence digital literacy and engagement quality.

Finally, educational policymakers should recognize that successful digital education requires more than access to technology. Students need the knowledge, skills, confidence, motivation, and meaningful opportunities necessary to use technology for learning. Strengthening digital literacy while simultaneously improving engagement quality can contribute to more effective, inclusive, and sustainable online education.

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