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The Role of Technology in Enhancing Students' Digital Literacy

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Abstract: The Role of Technology in Enhancing Students' Digital Literacy. Objective: To ascertain the function of technology integration in augmenting digital literacy proficiency and to explore the mediating influence of heutagogy in elucidating the correlation between technology integration and digital literacy. **Methods:** A quantitative method was utilized to examine data from student responders in the "Islamic Religious Education" curriculum at five campuses in Yogyakarta. Data was gathered using internet surveys. The PLS-SEM model was employed to examine direct and mediated effects, as well as multigroup analysis to investigate any discrepancies in test outcomes. **Findings:** The inclusion of technology does not immediately influence students' digital literacy. Heutagogy effectively facilitates the impact of technology integration on enhancing digital literacy. The incorporation of technology intended to improve digital literacy among final-year students exhibits a detrimental effect, which can be mitigated through heutagogical intervention. **Conclusion:** The findings corroborate prior research emphasizing the significance of policy context, culture, and student demographics as determinants affecting the efficacy of technology integration in enhancing digital literacy.

Keywords: digital literacy, heutagogy, higher education, learning, islamic religious education, technology integration.

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INTRODUCTION

Digital literacy among students is a multifaceted problem that includes a variety of skills and challenges. There is a fundamental difference between digital literacy as a set of technical skills and social competence (Weber et al., 2018; Weninger, 2022). Technology integration revolutionizes the learning environment by promoting the urgency of active participation of learners, which has been proven to improve learning outcomes (Yassin, 2024). Technology integration has been proven to influence students' desire to learn by creating meaningful experiences contextual to daily life in the digital society environment (Husin et al., 2020).

The popular practice of technology integration in Islamic Religious Education includes a blended learning method (Al-Sindi et al., 2023; Yassin, 2024); reverse class models (Yassin, 2024); use of online learning platforms (Stojkoviæ, 2019; Unnikrishnan, 2023); and the use of augmented reality and virtual reality media (Kissane, 2020; Koumiti et al., 2024).

In Indonesia, the development of technology integration is applied to various sectors, such as agriculture (Connor et al., 2021; Tseng et al., n.d.); health (Patel et al., 2019), and waste management (Kurniawan et al., 2023). Education, including sectors that are intensely developing technology integration, for example;

through the cultivation of a positive attitude with technology among educators in rural areas (Muhaimin et al., 2020), the development of lecturers' professional competencies using the TPACK approach (Ansyari, 2015), and the implementation of computer-based national examinations to reduce cheating and improve the quality of education (Berkhout et al., 2024).

Several previous studies have proven that technology integration plays an essential role in improving digital literacy competencies, such as improving the preparation of educators' instructional practices (Arya et al., 2024); Bridging the technology gap across generations (Park et al., 2022); as well as assisting in the design of the use of technology for literacy and language learning (Eutsler & Mitchell, 2023; Hutchison & Woodward, 2014). Previous research on technology integration stated that the effectiveness of technology integration in increasing digital literacy mastery can be influenced by cultural background (Hadad et al., 2023) and the ability of individuals to balance traditional literacy with digital literacy (Lea & Jones, 2011). Alakrash (2021) Finding technological skills can be improved by literacy, but the mastery of literacy will vary according to the field of learning.

Hadad Studies (2023) revealed the difference between perceived digital literacy and mastered digital literacy, where students who obtained high scores with the use of technology actually showed low performance in assignments that contained digital literacy competencies. This condition proves that integrating technology is not enough to improve digital literacy without considering the cultural context and the needs of the education system. Nikou Studies (Nikou & Aavakare, 2021) said that technology integration affects an individual's intention to use technology if mediated by performance expectations, so consideration of other contextual factors is needed to be able to understand the role of technology integration.

Heutagogi (Blaschke, 2012), or self-defined learning models, have been shown to significantly influence digital literacy by fostering autonomy, critical thinking, and the ability to navigate and effectively utilize digital tools for learners (Lynch et al., 2021). The conception of heutagogy aligns with an educational landscape that emphasizes the

urgency of digital literacy to achieve academic and professional success. The integration of heutagogy principles in the education system has the potential to increase students' digital literacy by promoting independent learning activities in digital practice through real contexts in daily life (Akyildiz, 2019; Ashton & Newman, 2006).

This research aims to fill the gap in insight about technology integration as a predictor to improve students' digital literacy in Islamic Religious Education, and also to understand the role of heutagogy in mediating these relationships. The results of this research can be used by stakeholders in higher education to develop a form of technology integration that is relevant to Islamic Religious Education learning that can escalate the mastery of digital literacy.

Technology Integration Model in Education

Various frameworks are proposed by experts to guide technology integration through unique perspectives and methodologies, such as SAMR, RAT, and TPACK models. The SAMR model is a four-level taxonomy that describes how technology affects the design, implementation, and evaluation of learners' learning experiences in the classroom (Arantes, 2022). The SAMR model categorizes the development of technology integration into four levels; substitution, augmentation, modification, and redefinition (Puentedura, n.d.), to help educators assess how technology is changing the learning experience of students starting from the basic substitution of using technology tools to redefining tasks that were previously unimaginable without technology.

Replacement, Amplification, Transforma tion (RAT) is a technology integration framework and evaluation tool to consider the benefits of technology integration (Hughes et al., 2006) with three objectives; replacing non-digital practices, strengthening existing practices, transforming learning, and developing goals with digital practices (Hughes, 2000). TPACK model (Koehler & Mishra, 2009) conceptualizes knowledge by integrating Information and Communication Technology (TIK) through Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK) (Mosley & Pennachio, 2005).

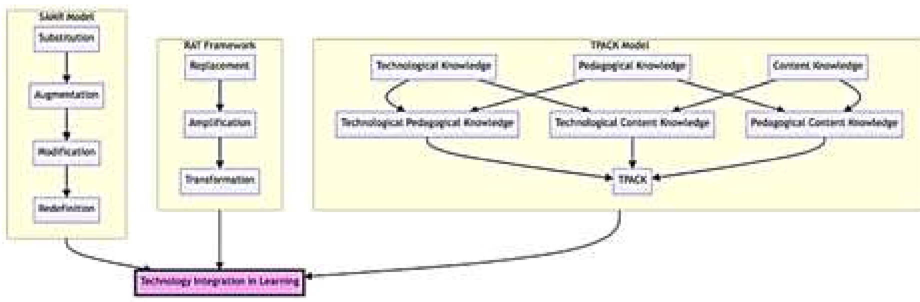

Figure 1. Hypothetical structural model of integration technology

Clarification of the structural framework: (1) SAMR Model. Demonstrates a four-level hierarchy of technological integration. Progression from the foundational level (substitution) to the apex level (redefinition). Exhibits the increasing impact of technology on educational experiences. (2) RAT Framework. Demonstrates three levels of technological integration. Shifts from Substitution to Metamorphosis. Exhibits the progression of technological benefits in educational practices. TPACK Framework. Exhibits the interaction of three essential elements (TK, PK, CK). Exhibits understanding of the intersections that result in Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), and Pedagogical Content Knowledge (PCK). Concludes that TPACK represents the best integration of all three components. Relationships substantially improve the incorporation of technology in education. Each framework presents a unique perspective on technology integration. Technology integration emerges from several frameworks. Figure 1 illustrates the synergistic relationship among the three frameworks in providing a comprehensive understanding of technology integration in education. Each framework has a unique focus and contribution: SAMR prioritizes levels of learning transformation, RAT accentuates the goals and impacts of technology use, and TPACK stresses the knowledge required for effective technology integration. The structural model demonstrates the theoretical relationships among these frameworks and their collective impact on technology integration in educational settings. It demonstrates how varied strategies for technology integration can collectively improve the understanding of effective technology deployment in educational environments.

H1: Does technology integration (IT) directly influence digital literacy (LD)?

Digital Literacy in Education

Digital literacy is a developing competency, not a threshold. Each element of digital literacy does not stand alone and can be adapted to the needs and context of an individual or group. Digital literacy competencies are recognized as essential skills that individuals need to thrive in a networked society, including the user's ability to navigate, evaluate, and create information with digital technologies. The European Union recognizes the importance of digital literacy, where citizens are urged to be digitally competent, both personally and professionally (Cohen, 2012).

Digital literacy is categorized as the context of broader technological competence in the education system, where critical thinking and media awareness are very important (Stergioulas & Drenoyianni, 2011). In this context, digital literacy was developed to form students' awareness when interacting directly with technology. Every educational institution has a responsibility to ensure that its students not only act as information consumers but also as responsible creators and communicators in the digital world (Stergioulas & Drenoyianni, 2011).

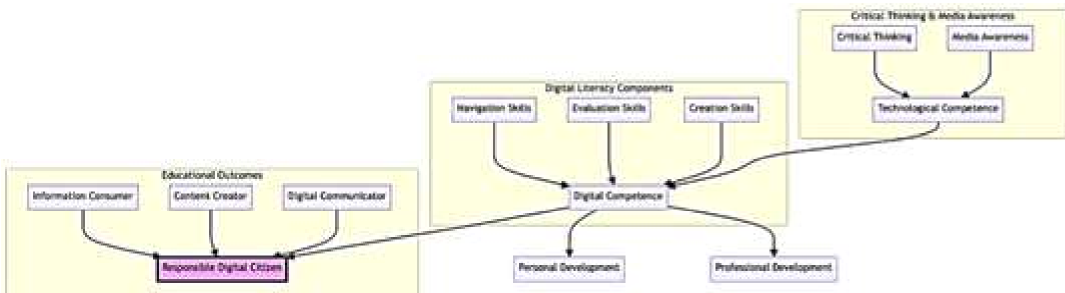

Figure 2. Hypothetical structural model of digital literacy

Figure 2 illustrates the Digital Literacy Component, which encompasses three fundamental competencies: navigation skills, assessment skills, and creativity abilities. These elements coalesce to constitute digital competence, embodying the essential skills required in a networked society. Critical Skills delineates the interconnection among critical thinking, media literacy, and technological proficiency, demonstrating how these competencies enhance overall digital literacy. Educational outcomes illustrate the evolution from Information Consumer to Content Creator and Digital Communicator, culminating in the construction of a Responsible Digital Citizen. growth Pathways illustrates the correlation between digital competence and both personal and professional growth, highlighting the multiple advantages of digital literacy. Interconnected relationships indicate that Digital Competence influences the evolution of Digital Citizenship, whereas Technological Competence underpins Digital Competence. All elements contribute to the cultivation of comprehensive digital literacy. This structural model underscores that digital literacy is a developmental process rather than a static condition, that its components are interrelated and context-dependent, and that educational institutions are pivotal in cultivating these competencies. The primary objective is to cultivate responsible digital citizens capable of adeptly navigating, assessing, and producing content in the digital realm. Digital literacy yields significant benefits for both personal and professional development. The model illustrates the literature's focus on digital literacy as a crucial array of competences requisite for success in contemporary society, emphasizing both the educational process and the anticipated outcomes. H2: Does technology integration (IT) directly influence heutagogy (H)?

Technology Integration and Digital Literacy in Islamic Religious Education

Technology integration and digital literacy from the perspective of Islamic Religious Education is a learning process that improves the experience of students who practice cultural and religious sensitivity. Technology integration involves the use of digital tools and platforms to improve quality, accessibility, digital competence, and ensure the alignment of educational content with Islamic values in the learning process. In this context, digital learning platforms such as online courses, mobile apps, and e- learning resources are important in spreading Islamic teachings and values by facilitating interactive and engaging learning activities, allowing for broader reach and personalization (Amrullah et al., 2024; Choirin et al., 2024).

In the context of Islamic Religious Education, the process of technology integration requires strategic management that increases relevance and effectiveness by involving innovative learning and evaluation methods through the support of adequate technological infrastructure and training for educators and learners (Neliwati et al., 2024). The urgency of digital literacy and technology integration aligns with the conception of lifelong learning in the normative curriculum of Islamic Religious Education (Abubakari & Kalinaki, 2024).

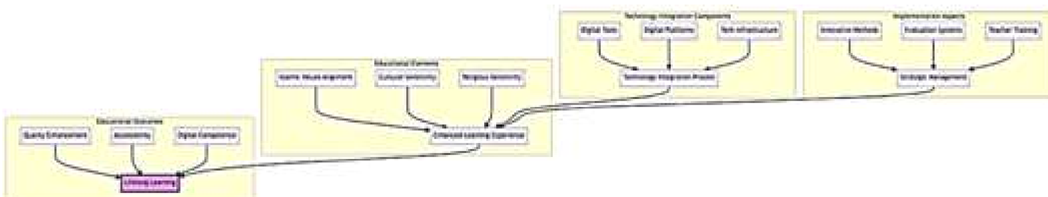

Figure 3. Hypothetical structural of technology and literacy in islamic education

A structural model diagram illustrating the interactions among variables pertinent to technology integration and digital literacy in Islamic religious education, as derived from the literature review presented. Integration of Technology Components include digital tools, digital platforms, and technological infrastructure. These components amalgamate to constitute the Technology Integration Process and signify the technological basis requisite for implementation. Educational Elements demonstrates three primary sensitivities: alignment with Islamic values, cultural sensitivity, and religious sensitivity—these characteristics enhance the learning experience and ensure educational content adheres to Islamic standards. Implementation factors encompass creative methodologies, evaluation systems, and teacher training, integrated within strategic management. Concentrates on pragmatic implementation tactics. Educational outcomes illustrate essential results: quality improvement, accessibility, digital proficiency, and the promotion of lifelong learning, while also reflecting long-term educational objectives. Principal Connections The incorporation of technology impacts the learning experience, strategic management molds the learning experience, an enriched learning experience fosters lifelong learning, and all elements contribute to a holistic Islamic education. This structural model underscores the amalgamation of technology with the preservation of Islamic beliefs. The significance of cultural and religious sensitivity, the function of strategic management in execution, the objective of lifelong learning in Islamic education, and the relationship between technical and educational dimensions. The model illustrates the manner in which technology integration facilitates Islamic religious instruction. Digital literacy improves the accessibility and quality of education. Strategic management guarantees efficient execution. Cultural and religious sensitivity are upheld consistently. The primary objective is to promote lifelong learning in accordance with Islamic teachings. This framework illustrates the intricate interaction of technology integration, instructional methodologies, and Islamic principles in contemporary religious education.

H3: Does heutagogy (H) directly influence digital literacy (LD)?

Heutagogy Practice in Higher Education

In the last century and a half, the educational model has undergone a significant shift; from the broadcast transmission model (pedagogy) of the 19th century (Cajori, 1890), (Herbart, 1895) to a learner-centered or androgynous educational model (Knowles, 1970) which was originally developed by John Dewey in the 1930s. The model was further elaborated in the 1960s by Joseph Schwab (1966) and Jerome Bruner (2009) which become a new model influenced by the World Wide Web called heutagogy, which focuses more on the learning motives of individual learners (2009).

Heutagogy is a transformative education that prioritizes autonomy and the ability to direct the self-learning process for students. Heutagogy is relevant to the complex and rapidly evolving educational landscape, where traditional pedagogical methods are judged to have failed to the various needs of learners (Arantes, 2022).

Heutagogy emphasizes educational control and the ability to make choices about what and how to learn that align with learners' individual needs (Jia & Yin, 2011). At the heart of the heutagogy is the concept of student autonomy, which allows students to make decisions about the educational path to be taken during their studies (Tholin, 2008).

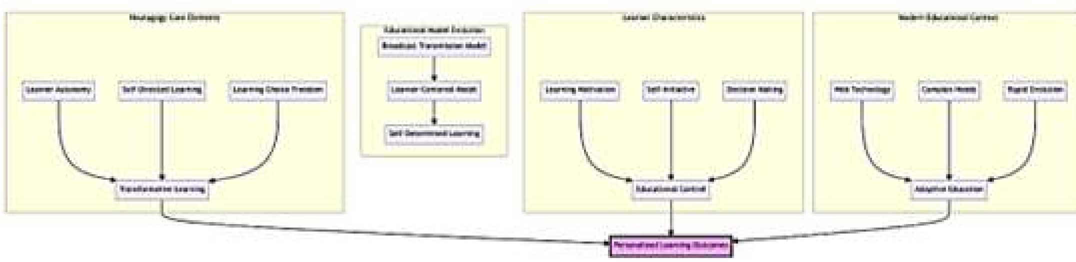

Figure 4. Hypothetical structural model of heutagogy practice

A structural model diagram illustrating the progression and interrelations among factors pertinent to educational models, with a special emphasis on heutagogy as derived from the literature review presented. Clarification of the structural model: The historical evolution illustrates the advancement from the Broadcast Transmission Model (Pedagogy) to the Learner-Centered Model (Andragogy) and ultimately to Self-Determined Learning (Heutagogy), reflecting the history of educational methodologies. Heutagogy's core elements include learner autonomy, self-directed learning, and the flexibility of learning choice. These components facilitate transformative learning and underscore a student-centered methodology. Learner Characteristics: exhibits essential features such as learning motivation, self-initiative, and decision-making, resulting in educational autonomy and highlighting the proactive role of learners. The modern context encompasses contemporary elements such as web technology, intricate needs, and quick evolution, resulting in adaptable education that mirrors the current educational scene. Principal Associations Transformative learning impacts customized learning, educational governance determines learning outcomes, adaptive education facilitates personalization, and all elements contribute to personalized learning results. This structural model highlights the transition from conventional to contemporary educational methodologies. The pivotal significance of learner autonomy and self-direction, The significance of personal autonomy and agency, The impact of technology and evolving requirements, The objective of individualized learning outcomes. The model illustrates the evolution of educational methodologies, with heutagogy catering to contemporary learning requirements, learner autonomy being pivotal for effective education, technology facilitating personalized learning, individual choice and control as fundamental components, and the primary objective being the attainment of personalized learning outcomes that satisfy individual needs. This model illustrates the shift from conventional educational methods to a more adaptable, learner-centered approach that defines heutagogy, emphasizing the significant role of technology and individual autonomy in contemporary education. H4: Does heutagogy learning (H) mediate the effect of technology integration (IT) on digital literacy (LD)?

■ METHOD

Research Design and Procedures

This study employs a cross-sectional design and a quantitative approach. Data is collected at a certain point in time (one-time cross-sectional), as noted by Ray (2015). The research will be conducted over a duration of 10 months, from September 2023 to June 2024, comprising the subsequent stages:

Preparation Period (September - October 2023)

Literature Review: An analysis of literature concerning technology integration, heutagogy, and digital literacy; identification of research gaps; and development of a theoretical framework. Adaptation of instruments; translation of instruments (forward-backward translation), modification for cultural and linguistic contexts, and collaboration with language experts. Validation by a panel including three education specialists and two technology specialists, followed by adjustments informed by their feedback and the finalization of the instrument.

Data Collection Interval (November 2023 - February 2024)

Instrument Evaluation: Execute a pilot study with 30 students, do preliminary validity and reliability assessments, and refine the final instrument. Primary Data Collection; Partnership with institutions, dissemination of online surveys, and monitoring and follow-up of participants.

Analytical Phase (March - June 2024)

Data analysis includes screening and cleansing, descriptive analysis, and SEM-PLS. Reporting; analysis of outcomes; compilation of reports evaluation and conclusion.

Population and Sampling Technique

Students from five Islamic universities in Yogyakarta are included in the research population. These universities are Universitas

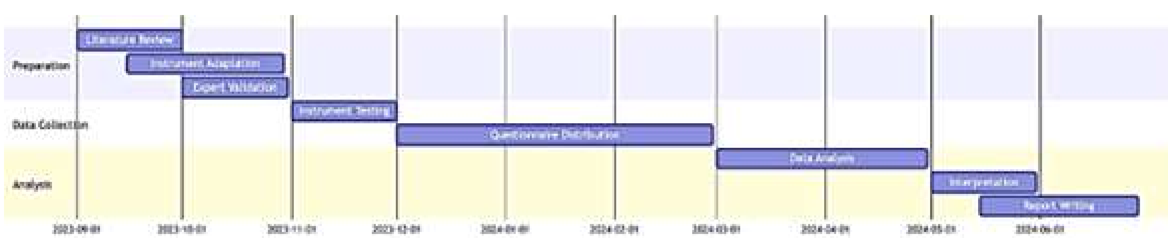

Figure 5. Research *time*line

Characteristic	Category	Frequency	Percentage
University	Universitas Ahmad Dahlan	165	37.41%
	UIN Sunan Kalijaga	92	20.86%
	Universitas Islam Indonesia	76	17.23%
	Universitas 'Aisyiyah	54	12.24%
	Universitas Muhammadiyah Yogyakarta	54	12.24%
Study Period	Early Years (Semester 1-4)	411	93.2%
	Final Years (Semester 5-8)	30	6.8%
Total		441	100%

Figure 6. Respondent Demographic

Ahmad Dahlan, UIN Sunan Kalijaga, Universitas Islam Indonesia, Universitas 'Aisyiyah, and Universitas Muhammadiyah Yogyakarta. Utilizing a non-probability-based sampling method with the subsequent characteristics:

Analysis Procedure

Furnish data, frequencies, and percentages categorized by demographic categories. Calculating both the mean and standard deviation of a variable is essential. An evaluation We are utilizing SEM-PLS (Second Order) to extract conclusions from the research results. This comprises the software: The SmartPLS analysis comprises the following components: The initial phase entails performing a comprehensive assessment of the measurement methodology. The researcher examines mediation effects through the assessment of structural models. The researcher performed an analysis among several groups. Criteria for Evaluating Models and Their Application The composite reliability must exceed 0.70. When the Average Variance Extracted (AVE) surpasses 0.50. The Fornell-Larcker criterion and the HTMT ratio are two methods used to determine discriminant validity. The calculation of the coefficient of determination underscores the importance of route coefficients. A link exists between the impact sizes (f2) and the predictive relevance (Q2).

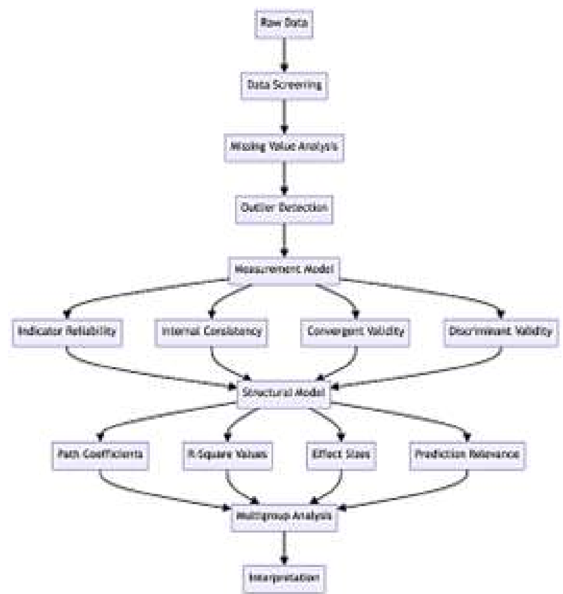

Figure 7. Data analysis procedure

Instruments

The research uses non-test instruments in the form of questionnaires with 144 items comprising three main variables: Technology Integration (70 items), adaptation sources from Downie et al. (2021), Francis (2017), Javeri & Persichitte (2007), Kolb (2020), Mitchell (2021), Ortega-Sánchez et al. (2020), Rodríguez et al. (2021). Indicators: (1) Technology Utilization (15 items), for examples "I use digital technology in daily learning" and "I utilize various online learning applications." (2) Technical Capability (20 items), for examples "I can solve basic technical problems on digital devices" and "I can use various online learning platforms." (3) Pedagogical Integration (20 items), for examples "I integrate technology according to learning objectives" and "I select digital tools appropriate to the material." (4) Usage Evaluation (15 items), for examples "I evaluate the effectiveness of technology use" and "I reflect on technology usage."

Heutagogy (40 items), adaptation sources from Bakare (2018), Kamrozzaman et al. (2020), Qassrawi (2023). Indicators: (1) Self-Determined Learning (10 items), for examples "I set my own learning goals" and "I choose learning strategies that suit my needs." (2) Capability Development (10 items), for examples "I develop new capabilities independently" and "I seek opportunities to enhance competencies." (3) Learning Process Engagement (10 items), for examples "I actively engage in the learning process" and "I collaborate with peers in learning" (4) Double-Loop Learning (10 items), for examples "I reflect on my learning process" and "I evaluate the effectiveness of learning strategies."

Digital Literacy (34 items), adaptation source from Ganapathy & Kaur (2015). Indicators: (1) Information Literacy (8 items), for examples "I can effectively search for digital information" and "I can evaluate online source credibility." (2) Visual Literacy (8 items), for examples "I can interpret visual information" and "I can create effective visual content." (3) Media Literacy (9 items), for examples "I understand various forms of digital media" and "I can critically analyze media messages." (4) Computer/ICT Literacy (9 items), for examples "I am proficient in using digital devices" and "I can manage digital files effectively."

Measurement Scale

Utilize a five-point Likert scale: strongly disagree, disagree, neutral, agree, and strongly agree. The choice of scales aims to diminish respondent discomfort (Sachdev & Verma, 2004), enhance response distinction, and augment response reliability. To attain construct validity, a Content Validity Ratio (CVR) exceeding 0.70 is required, along with at least three expert evaluations for content validation. Face validity is established when factor loading exceeds 0.70 and autocorrelation error (AVE) surpasses 0.50. We are now performing assessments to determine the document's readability and clarity. With a sample size of thirty, we ensured that Cronbach's alpha exceeded 0.70 and that the composite reliability likewise surpassed 0.70. This enabled us to assess the reliability of internal consistency. Over a period of two weeks, we found that the correlation between the two variables exceeded 0.70. A blue square denotes the conceptual model, Technology Integration (TI). Digital Literacy (DL), represented by a blue circle in the upper right corner. The orange circle at the base signifies Heutagogy (H). Lines and hypotheses (H1, H2, H3, H4) depict the correlations among the variables:

H1: Illustrates the correlation between technology integration and digital literacy.
H2: Illustrates the correlation between technology integration and heutagogy.
H3: Demonstrates the relationship between digital literacy and heutagogy.
H4: Demonstrates the indirect association between technology integration and Heutagogy via digital literacy (mediating impact). H4 indicates the mediation effect, where Technology Integration's influence on Heutagogy can occur indirectly through Digital Literacy. The dotted line represents the mediation path (H4). This model is more comprehensive as it considers both direct and indirect effects between variables.

The mediation hypothesis (H4) is important to explain the mechanism of how Technology Integration can influence Heutagogy through the enhancement of Digital Literacy as an intervening variable. This model analyzes the impact of technology integration on digital literacy, the influence of technology integration on heutagogy (self-directed learning), the effect of digital literacy on instructional design, and the role of digital literacy in mediating the interaction between technology integration and heutagogy.

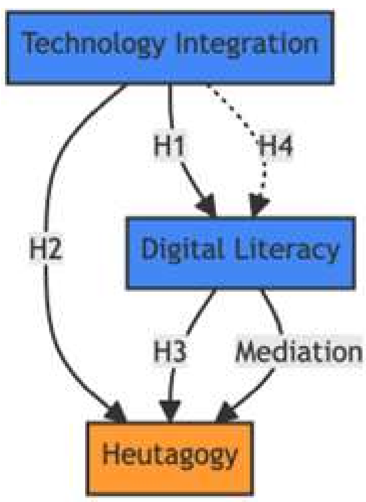

Figure 8. Research design

RESULT AND DISCUSSION

Measurement Model Evaluation

Convergent Validity

Outer Loading: all indicators show loading values > 0.6, indicating good validity in measuring their respective constructs:

1. Technology Integration (IT): 0.891-0.907 '! indicators demonstrate excellent measurement of technology integration.
2. Heutagogy (H): 0.816-0.877 '! indicators validly measure the heutagogical approach.
3. Digital Literacy (LD): 0.873-0.905 '! indicators excellently measure digital literacy

Based on Table 1 and Table 2, it is known that the construct in the outer model in this study is valid. The calculations in Table 3 also show that all the outer model constructs in this study are reliable. So, it can be concluded that the measurement model in this study has shown convergent validity and adequate discrimination validity.

Table 1. Convergent validity test results

Construction	Indicator	Outer Loading	AVE	Test Results
Technology Integration (IT)	IT.1	0.891	0.712	Valid
	IT.2	0.907		
	IT.3	0.891		
Heutagogi (H)	H.1	0.816	0.803	Valid
	H.2	0.877		
	H.3	0.820		
	H.4	0.833		
	H.5	0.871		
Digital Literacy (LD)	LD.1	0.873	0.846	Valid
	LD.2	0.891		
	LD.3	0.873		
	LD.4	0.905		

Table 2. Discrimination validity test results

Construction	H	IT	LD
H			
IT	0.875		
LD	0.786	0.664	

AVE (Average Variance Extracted)

All constructs have AVE > 0.5. Interpretation: Constructs explain more than 50% variance of their indicators, demonstrating excellent convergent validity: (1) Technology Integration: 0.712 (71.2%). (2) Heutagogy: 0.803 (80.3%). (3) Digital Literacy: 0.846 (84.6%)

Relevance of High AVE Values and Construct Validity

Discrimination validity was evaluated with the Heterotrait-Monotrait Ratio of Correlations (HTMT) with a provision between 0.85 (Roemer et al., 2021; Voorhees et al., 2016) up to 0.9 (Roemer et al., 2021). The researcher took the value of < 1 as the threshold for the validity value of discrimination (Franke & Sarstedt, 2019; Roemer et al., 2021). A high Average Variance Extracted (AVE) value indicates that the construct can explain more than 50% of the variance of its indicators.

Although AVE values are not shown in the provided data, the high composite reliability values (>0.9) indicate good internal consistency of the constructs. All HTMT values are below the threshold of 0.9, indicating that the three constructs (Heutagogy, Technology Integration, and Digital Literacy) have good discrimination from each other. Figure 9 illustrates a path diagram using a mermaid to visualize the relationships between variables. HTMT value analysis the discriminant validity table:

1. HTMT between H-IT: 0.875 (< 0.9), shows a strong correlation between Heutagogy and Technology Integration. Value approaches the 0.9 threshold, indicating potential conceptual overlap that needs attention.
2. HTMT between H-LD: 0.786 (< 0.9), indicates a moderate-to-strong correlation between Heutagogy and Digital Literacy. This value still within acceptable limits for discriminant validity.
3. HTMT between IT-LD: 0.664 (< 0.9), this value shows a moderate correlation between Technology Integration and Digital Literacy. Lowest value among the three relationships, demonstrating clear differentiation between these constructs.

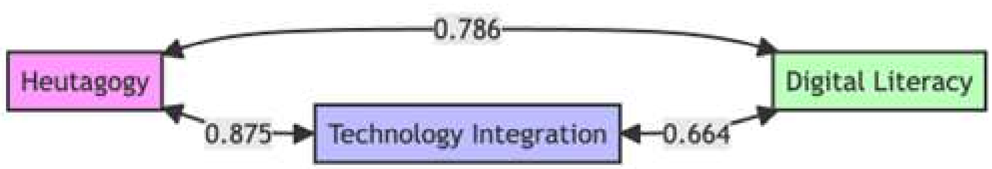

Figure 9. The relationships between variables

All constructs demonstrate good discriminant validity (HTMT < 0.9). Construct reliability is excellent (CR > 0.9). Although there are relatively strong correlations between constructs, they remain within acceptable limits to ensure each construct measures a distinct concept.

Composite Reliability dan Cronbach's Alpha

The provisions of Cronbach's Alpha (CA) and Composite Reliability (CR) > 0.7 and for exploratory studies with the number of 0.6 is still acceptable (Ghozali, 2014; J. F. Hair Jr et al., 2014). The reliability analysis shows excellent internal consistency: (1) Heutagogy (H): CR = 0.925, á = 0.899. (2) Technology Integration (IT): CR = 0.925, á = 0.878. (3) Digital Literacy (LD): CR = 0.936, á = 0.908. These values significantly exceed the minimum threshold of 0.7, indicating strong measurement reliability across all constructs.

Table 3. Reliability test results

Construction	Reliability Criteria		Test Results
	Cronbach's Alpha	Composite Reliability	
H	0.899	0.925	Reliable
IT	0.878	0.925	Reliable
LD	0.908	0.936	Reliable

Inner Model Evaluation

Mediation Effect Analysis

The path analysis in this research measures two direct and indirect relationships (see Fig.10), by evaluating T-statistics, P-values, and original samples (J. Hair Jr et al., 2023). Significance is obtained if T-statistics > 1.96 (Ghozali, 2014) and P-values < 0.05 (Imam, 2014). Original sample value between -1 to 1; Close to 1 means there is a strong and positive relationship, close to -1 means there is a strong and negative relationship.

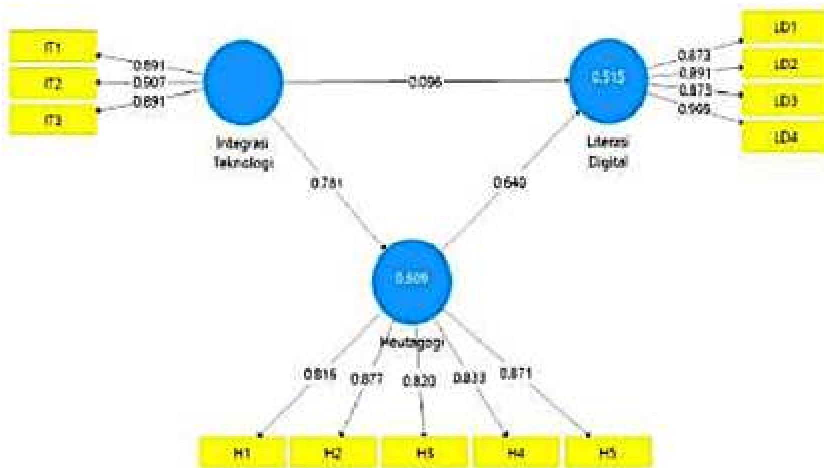

Figure 10. Estimation model

The path analysis results show a perfect mediation effect (Baron, 1986), where (1) indirect effect (IT ’! H ’! LD): (a) T-statistics = 7.844 (>1.96); (b) P-value = 0.000 (<0.05); (c) Original Sample = 0.314 (positive); and (d) Conclusion: significantly positive. (2) Direct Effect (IT ’! LD): (a) T-statistics = 0.464 (<1.96); (b) P-value = 0.643 (>0.05); (c) Original Sample = 0.096 (weak); and (d) Conclusion: not significant.

Heutagogy, as a learner-centered approach (Hase, S., & Kenyon, C. 2013) serves as a perfect mediator because direct effect is not significant, indirect effect is significantly positive, indicates that technology integration’s influence on digital literacy must go through the heutagogical approach, promotes self-determined learning, develops digital capabilities and competencies, encourages reflective and transformative learning.

Why Direct Effect Is Not Significant

The direct effect between technology integration and digital literacy fails to show significance primarily due to persistent infrastructure limitations. The digital divide continues to be a significant global challenge, where access to technology remains unevenly distributed across different regions and socioeconomic groups. This disparity is further complicated by the varying quality of devices and internet connections available to different users, creating inconsistent learning experiences.

Moreover, technical constraints such as limited bandwidth, outdated hardware, and software compatibility issues frequently hamper the optimal utilization of technological resources. These infrastructure-related challenges create substantial barriers that prevent technology integration from directly translating into improved digital literacy outcomes. The combination of these factors - the persistent digital divide, inconsistent access to technology, variable quality of available resources, and technical limitations - creates a complex web of obstacles that effectively blocks the direct pathway between technology integration and digital literacy development (Van Dijk, J. A., 2020).

The insignificant direct effect can also be attributed to critical user readiness factors that impede the immediate impact of technology integration on digital literacy. The prevalent low technology acceptance among users serves as a fundamental barrier, where individuals often struggle to embrace new technological tools and platforms in their learning processes. This challenge is exacerbated by insufficient technology training programs, leaving users without the necessary foundational skills and confidence to effectively utilize digital resources. The generational digital gap presents another substantial obstacle, as different age groups exhibit varying levels of comfort and proficiency with technology, creating disparities in adoption rates and usage patterns. Furthermore, there exists a notable resistance to technological change, where users often demonstrate reluctance to modify their established learning habits and methodologies, preferring traditional approaches over digital alternatives. These interconnected human factors collectively create a significant barrier that prevents technology integration from directly translating into enhanced digital literacy, highlighting the necessity for mediating approaches that can address these psychological and skill-based challenges (Davis, (989).

How Heutagogy Addresses Weaknesses

The heutagogical approach effectively addresses technological integration challenges through comprehensive development of self-determined learning capabilities. Through this approach, learners experience enhanced agency in their digital learning journey, developing stronger digital self-efficacy as they navigate various technological platforms and tools. The process naturally builds a robust digital identity, while simultaneously fostering increased intrinsic motivation for technological engagement and exploration. This self-directed approach encourages independent exploration of digital resources, allowing learners to discover and adapt technologies according to their personal learning needs and preferences (Blaschke, L. M., & Hase, S., 2019).

Furthermore, the strengthening of learning capacity through heutagogy manifests in multiple interconnected dimensions. Learners systematically develop comprehensive digital competencies while enhancing their critical digital literacy skills, enabling them to evaluate and utilize digital resources more effectively. The approach inherently promotes reflective practice, encouraging learners to continuously assess and improve their digital learning strategies. This process naturally develops metacognitive abilities as learners become more aware of their learning processes and technological interactions. The overall result is improved critical thinking skills, particularly in the context of digital environments, enabling learners to make more informed decisions about their use of technology for learning and professional development. This holistic enhancement of learning capacity creates a sustainable foundation for ongoing digital literacy development (Hase, S., & Kenyon, C., 2013).

The research findings demonstrate that the heutagogical approach plays a crucial role in bridging the gap between technology integration and digital literacy. Without the heutagogical approach, technology integration alone is insufficient to effectively enhance digital literacy. These findings align with literature emphasizing the importance of self-determined learning in developing digital competencies (Blaschke, 2016).

Table 4. Path analysis test results

Specific Indirect Effect Path Coefficients	*Ts >1.96*	*Pv < .05*	OS	Conclusion of Test Results	
IT → **H** → LD	7.844	.000	.314	Significant (+)	Perfect Mediation
IT → LD	.464	.643	.096	Insignificant	

Table 4 shows that there is a direct insignificant relationship between Technology Integration (IT) and Digital Literacy (LD). Meanwhile, the indirect relationship in the form of mediation from Heutagogy (H) to Technology Integration (IT) with Digital Literacy gave significant positive results. It can be concluded that Heutagogy (H) perfectly mediates the influence of Technology Integration (IT) on Digital Literacy (LD).

Table 5 is the result of a multi-group analysis that shows that the direct influence of Technology Integration (IT) on Digital Literacy (LD) is not significant, both for first- year and final-year students. Final-year students even get a negative result of –.059, which means that every 1 unit increase in the predictor construct will decrease the dependent construct by .059 units. After being mediated by Heutagogy (H), the results became significant with perfect mediation for first-year students, and not significant for final-year students. But in the final-year students, it does not produce negative grades like before.

Table 5. Multigroup test results based on student study period

Relationships Between Constructs	First-Year Students (Pt)				Final-Year Students (Ak)			
	OS	*Ts >1.96*	*Pv < .05*	*Sig.Pt*	*Sig.Ak*	*Pv < .05*	*Ts>1.96*	*OS*
IT → LD	.011	.203	.839	insignificant	insignificant	.779	.280	–.059
IT → **H** → LD	.343	8.434	.000	significant	insignificant	.240	1.177	.191
Test Results	Perfect Mediation				Not Mediated			

Model Fit

The fit model test was carried out by (a) evaluating the determination coefficient or R2 where $R^2 > 0.1$, which means it has an effect, with the qualifications in Table 6 (J. Hair Jr et al., 2023); (b) Goodness of Fit (Wong, 2019), by looking at the Standardized Root Mean Residual (SRMR) value 0.08 means acceptable and > 0.08 means the model is not suitable, Unweighted Least Squares Discrepancy (dULS) < 0.95 means the latent construct already has a difference, while dULS > 0.95 indicates the latent construct has no difference and the ideal Geodesic Discrepancy (dG) < 0.95, meaning the model is suitable; and (3) the Predictive Relevance or Q2 value > 0 (Hair, 2009; J. F. Hair Jr et al., 2017), where the model has good predictive relevance and observation values, and Q2 d" 0 means that the model does not have good predictive relevance and observation values.

Table 6. R-Square value qualification

Coefficient of Determination Value	Level Qualification
R^2 of 0.70	Strong
R^2 of 0.67	Substantial
R^2 of 0.33	*Moderate*
R^2 of 0.19	Weak

Table 7. Determination coefficient test results

Endogenous Variables	R-*Square* (R^2)	Level Qualification
Heutagogy (H)	0.609	*Moderate*
Digital Literacy (LD)	0.515	*Moderate*

Table 8. Fit model test results

Criteria	*Saturated Model*	*Estimated Model*
dULS	0.422	0.438
dG	0.275	0.275
SRMR	0.050	0.051

Table 9. Predictive relevance test results

Endogenous Variables	Q^2 (=1-SSE/SSO)
Heutagogy (H)	0.459
Digital Literacy (LD)	0.425

Table 7 shows that all endogenous variables in this study were successfully influenced by exogenous variables with moderate categories. Table 8 shows that the model in this study is already compatible, has differences between constructs, and already has a good fit. Table 9 shows that each endogenous variable in the model already has good predictive observation and relevance values.

The direct relationship between Technology Integration (IT) to Digital Literacy (LD) is insignificant and becomes significant after being mediated by Heutagogy (H). This finding aligns with Lisa's research (Blaschke et al., 2021) on the role of heutagogy in digital literacy.

Table 10 is the answer to the hypothesis of this study, which shows that of the four hypotheses, one was rejected (IT-LD) while three hypotheses were accepted (IT-H; H- LD; IT-H-LD), so it was concluded that the Heutagogy (H) approach has a perfect mediating role to increase the mastery of Digital Literacy (LD) with the influence support of Technology Integration (IT).

The findings of the multigroup analysis in this study (see Table 5) are in line with Graham's previous research (Walton, 2016) and Julio (Cabero-Almenara et al., 2023) who found a gap in digital literacy mastery due to gender differences. In this research, it was found that the

Table 10. Conclusion of hypothesis test results

Hypothesis	H0	H1
1 (IT-LD)	accepted	rejected
2 (IT-H)	rejected	accepted
3 (H-LD)	rejected	accepted
4 (IT-H-LD)	rejected	accepted

equality of technology integration has no effect on increasing digital literacy, and can even result in negative effects on final-year students. In other words, digital literacy mastery cannot be achieved only by completing technological access as a form of institutional literacy support. The findings of the multigroup in this research prove that digital literacy mastery can be improved by substituting technological activities in Islamic Religious Education learning, such as lecture projects. The results of this study recommend an emphasis on heutagogy learning for first-year and final-year students, as an escalation effort in mastering digital literacy.

The findings of this multigroup research are not in line with the results of Márquez's study (2023) which states that older students at universities have a more developed digital literacy culture due to familiarity with digital technology for academic purposes. The contribution of heutagogy to final-year students is not significant, which may be due to the lack of relevance between learning strategies and the involvement of final-year students who are facing the complexity of real challenges, thus demanding the need for learning contextualization far beyond what students feel in the first year in the university (Baba Rahim, 2022; Puzziferro, 2008).

In the rural context, the heutagogical approach plays a strategic role in digital literacy development (Blaschke & Hase, 2019) suggest that the heutagogical approach, which emphasizes self-directed learning, can be an effective solution in addressing technological infrastructure limitations in rural areas. This is reinforced by Roberts et al. (2018) research identifying the importance of developing students' adaptive capabilities in facing the digital divide in rural regions. Narayan et al. (2019) further affirm that self-determined learning enables students to develop creative solutions in resource-constrained contexts. In the domain of Islamic Education learning, the integration of heutagogical approaches with digital technology demonstrates significant potential. Hamid et al. (2021) underscore the importance of developing digital projects that integrate Islamic concepts with modern technology.

Research by Al-Rahmi et al. (2020) demonstrates the effectiveness of independent exploration in searching and analyzing digital Islamic study resources. Meanwhile, Cabero-Almenara et al. (2023) emphasize the importance of online collaborative learning in facilitating the exchange of perspectives and Islamic understanding in the digital context. Nevertheless, research findings indicate specific challenges for final-year students. Walton (2016) identifies that high cognitive load due to focus on final projects can impede the effectiveness of technology integration. Hase & Kenyon (2013) discuss the gap between technological learning approaches and students' professional needs. Moore & Greenland (2017) further reveal the lack of relevance between digital learning materials and the job market demands faced by final-year students.

To enhance the effectiveness of the heutagogical approach, several strategies can be implemented based on recent research. Blaschke (2021) proposes developing industry-oriented digital projects, while Dick et al. (2020) emphasize the importance of case-based learning that integrates technology with real-world problems. Peters (2019) adds the significance of developing digital portfolios as professional career support instruments. The integration of these strategies can help create more meaningful and contextual learning. The heutagogical approach in digital literacy development not only addresses the digital divide challenges in rural areas but also provides an important foundation in Islamic Education learning and students' professional development. Through proper implementation and consideration of local context, this approach can better prepare learners to face the demands of the digital era. The success of this implementation depends on educational institutions' ability to adapt and integrate various learning elements according to learners' specific needs and their learning context.

Further research is needed to explore the long-term effectiveness of the heutagogical approach in a broader context, including its impact on alumni professional development and its contribution to developing an inclusive digital society. This will provide a more comprehensive understanding of the role of the heutagogical approach in shaping the future of digital education in Indonesia.

The integration of digital literacy development through heutagogy in Islamic Education represents a significant advancement in educational methodology. This approach not only bridges the technological gap but also ensures that religious education remains relevant and engaging in the digital age. The findings suggest that successful implementation requires careful consideration of local resources, cultural context, and technological accessibility, particularly in rural areas where infrastructure may be limited.

Moreover, the research indicates that the effectiveness of heutagogical approaches in digital literacy development varies significantly across different student populations and contexts. This variation necessitates a flexible and adaptive implementation strategy that can be customized to meet specific institutional and regional needs. The challenges identified, particularly among final-year students, highlight the importance of aligning digital literacy initiatives with practical professional requirements and market demands.

These findings contribute to the growing body of knowledge regarding educational technology integration in religious education and rural development contexts. They also provide valuable insights for policymakers and educators working to bridge the digital divide while maintaining the quality and relevance of educational programs. Future research directions should focus on developing more robust evaluation frameworks for measuring the long-term impact of these interventions and identifying best practices for sustainable implementation across diverse educational settings.

■ CONCLUSION

The empirical findings of this research reveal a significant insight: the mere integration of technology does not automatically translate to enhanced digital literacy among Islamic Religious Education students. This challenges the conventional assumption that technology implementation alone is sufficient for digital competency development. The study's results indicate that the relationship between technology integration and digital literacy is more complex and nuanced than previously theorized, suggesting that the pathway to digital literacy mastery requires a more sophisticated pedagogical approach. This finding aligns with recent scholarly discourse, particularly in the context of higher education, where the effectiveness of technology integration has been increasingly scrutinized (Blaschke & Hase, 2019; Roberts et al., 2018).

The research demonstrates that heutagogy, functioning as a mediating factor, plays a crucial role in enhancing digital literacy competencies. This approach, which emphasizes student self-regulation and autonomous learning strategies, emerges as a viable solution for institutions facing technological limitations. The implications are particularly significant for higher education institutions with resource constraints, as it suggests that digital literacy can be effectively developed through well-designed heutagogical interventions, such as critical analysis of Islamic-related information and hoax detection activities. This finding is supported by contemporary research (Al-Rahmi et al., 2020; Hamid et al., 2021) which emphasizes the importance of learner autonomy and self-directed learning in digital literacy development. The study thus provides a practical framework for stakeholders and educators to prioritize heutagogical approaches in their digital literacy initiatives, potentially democratizing access to digital competency development across varying institutional contexts.

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