JACoIT
Journal of Applied Computer and Information Technology

Article

A loop or stagnation? Lecturers' meta-literacy gaps and the 5th Industrial Revolution

Mubaraq Ibrahim Abdulsalam [1], Mutiu Babatunde Ibrahim [1], Fatimoh Danmaigoro [1,*] and Ahmed Fahdilat Talatu [1]

[1]Science Education, Al-Hikmah University, Ilorin, Nigeria; abdulsalammubaraq66@gmail.com; ibrahimmutiu007@gmail.com; danmaigorofatimoh2018@gmail.com; ftahmed@al-hikmah.edu.ng

[*]Corresponding Author: danmaigorofatimoh2018@gmail.com

Received: 10 March 2026
Revised: 11 July 2026
Accepted: 26 July 2026
Published: 4 August 2026

Abstract

The Fifth Industrial Revolution (5IR) has transformed higher education by emphasizing human–technology collaboration, ethical reasoning, and sustainable innovation, creating new demands for lecturers' meta-literacy skills. However, a gap remains between institutional expectations and lecturers' preparedness, as many educators experience technological anxiety, resistance, or stagnation amid rapid digital transformation. This study investigated lecturers' autonomy in integrating emerging technologies, meta-literacy competence, and professional relatedness in sustaining technology-enhanced teaching at universities in Kwara State, Nigeria. Grounded in Self-Determination Theory (SDT), the study explains how the satisfaction of autonomy, competence, and relatedness influences lecturers' professional growth or stagnation. A descriptive correlational design was employed using a standardized questionnaire administered to 100 university lecturers selected through convenience sampling. Data were analyzed using descriptive statistics and Pearson Product-Moment Correlation. The results showed high levels of autonomy in technology integration ($\bar{x}$ = 3.05), meta-literacy competence ($\bar{x}$ = 3.05), and moderately high professional relatedness ($\bar{x}$ = 2.93). However, shortcomings were identified in access to institutional resources, advanced AI-driven educational technologies, and structured professional learning communities. Correlation analysis revealed significant positive relationships among lecturers' autonomy, meta-literacy competence, and professional relatedness ($p < 0.05$), indicating that these factors collectively support sustainable technology-enhanced teaching. Although lecturers demonstrated strong motivation and capability to adopt emerging technologies in the 5IR era, inadequate institutional support may hinder sustained innovation. Strengthening autonomy, competence, and professional relatedness is therefore essential to prevent pedagogical stagnation and foster continuous innovation in higher education.

Keywords: meta-literacy; Industry 5.0; self-determination theory; lecturers' autonomy; professional relatedness

1. Introduction

In the ever-changing world of higher education, professors are at the core of a never-ending cycle of technological development. The question arises whether they are in a loop of ongoing learning, adaptation, and innovation or in stagnation, struggling to keep up with the rising rate of digital revolution in teaching and learning. The combination of AI, XR, learning analytics, and automation tools has changed the way teachers teach, making them take on new roles as facilitators, designers, and reflective practitioners of technology-driven pedagogy [1]. Some lecturers are eager to learn new things and use new technology, but others are resistant, unsure, or tired, which keeps them from moving forward [2]. This gap shows not only variations in digital skills but also underlying motivational and institutional variables that affect how engaged professors are with new ideas [3]. It is important to understand these elements to figure out if teachers are growing in a positive feedback loop or just going along with the flow in a digital ecosystem that is changing quickly.

The term stagnation, in the context of the Fifth Industrial Revolution (5IR), goes beyond simply being a lack of technical skills; it is a pedagogical deadlock in which teachers remain stuck in the automation-based methods of Industry 4.0. In this state, lecturers use digital tools because they are obligated to do so or they do so out of habit, but don't advance towards the paradigm shift that 5IR requires, namely one of human-AI synergy, ethical considerations and sustainable innovation [44]. Stagnation is characterized by reliance on old, shallow technology use and "moderate to poor" self-rated digital proficiency and frequently involves disaffection with the changing digital landscape. The "loop", on the other hand, is an active cycle of reflection and adaptation of the lecturers' digital engagement in order to enhance student experience through continuous learning and adaptation.

The present study is grounded in Self-Determination Theory (SDT) developed by Ryan and Deci [4], which emphasises that human motivation is driven by the satisfaction of three innate psychological needs: autonomy, competence, and relatedness. When these needs are fulfilled, individuals demonstrate intrinsic motivation, persistence, and creativity; when frustrated, they exhibit disengagement and stagnation. In this study, autonomy refers to lecturers' freedom and perceived control in selecting and integrating emerging technologies within their teaching practices. When autonomy is supported, lecturers are more likely to explore and innovate with technology rather than use it out of obligation. Competence involves lecturers' confidence in their ability to effectively use and apply technology to enhance teaching and learning outcomes. This closely aligns with meta-literacy skills, which include the ability to evaluate, create, share, and ethically use digital information [5]. Finally, relatedness refers to lecturers' sense of connection and support from colleagues, administrators, and institutional structures that encourage technology-enhanced teaching. When lecturers feel part of a supportive professional community, they are more motivated to learn and innovate [6].

By applying SDT, this study aims to determine the level of lecturers' autonomy, assess their perceived competence, and describe their relatedness in integrating emerging technologies, providing a motivational lens to explain whether lecturers are experiencing a dynamic loop of professional growth or stagnation in the digital era. The Fifth Industrial Revolution (5IR) represents a paradigm shift in technology integration, one that prioritises human-centred collaboration

between people and intelligent machines. Unlike Industry 4.0, which focused on automation and digitisation, the 5IR emphasises ethics, empathy, and sustainability through human–AI cooperation [7].

In education, this transformation means lecturers are expected not just to use digital tools but to co-create learning experiences that balance technological efficiency with human creativity and ethical reasoning [8]. The European Commission (2021) highlights that Industry 5.0 seeks to empower workers rather than replace them a principle that directly applies to lecturers as mediators of intelligent learning systems. However, global evidence suggests a gap between institutional aspirations and lecturers' preparedness. The OECD [9] reports that while digital learning environments are expanding rapidly, fewer than half of lecturers feel competent in integrating AI-based tools into teaching. Similarly, UNESCO [10] found that limited training and lack of professional support remain major barriers to effective technology adoption in higher education. This context underscores the importance of examining lecturers' autonomy in integrating technologies, their competence in using them effectively, and their relatedness in receiving institutional support. These constructs collectively shape whether lecturers engage in a productive loop of technological adaptation or fall into stagnation due to motivational and institutional deficits.

The use of a 5IR technology-driven environment in the classroom is a gap in the teaching profession worldwide, but Kwara State, Nigeria, is a specific and pertinent location to explore. It is crucial to assess the adaptation of local trainers to the transition from traditional teaching to human-centered technological cooperation in order to meet the "Education 5.0" mandate [41]. There is growing interest among faculty members in using digital tools, but few observations of the actual metacognitive competencies, namely the capacity to critically engage with and respectfully participate in the co-production with AI, exist at the state level [42]. This study's grounding in Kwara State can be used to determine if local institutional challenges, including access to high-end AI resources and institutionalized professional learning communities, are similar to those of other parts of the world or if they are a unique challenge to the region [43].

The concept of meta-literacy, developed by Mackey and Jacobson [11], extends traditional digital literacy to include the ability to critically evaluate, create, and ethically use digital content while collaborating and reflecting on one's own learning. Meta-literacy is foundational for lecturers who must guide students in navigating AI-generated information, online collaboration, and participatory digital platforms. Research indicates that lecturers perceived competence in meta-literacy remains inconsistent. For instance, Mardiana [12] found that although lecturers acknowledge the value of digital skills, fewer than half feel confident in mentoring students in responsible and critical technology use. This indicates a potential competence gap that affects teaching quality and innovation in technology-rich classrooms.

Moreover, meta-literacy development is deeply influenced by autonomy and relatedness. Lecturers who feel empowered to experiment with technology (autonomy) and supported by peers or institutions (relatedness) are more likely to develop strong meta-literacy competencies. Conversely, restricted autonomy or limited collegial support can lead to stagnation, where lecturers depend on outdated or surface-level technological practices [6]. The 5IR calls for

educators who possess meta-literacy skills that integrate technological, ethical, and collaborative dimensions. Lecturers must be capable of critically engaging with AI systems, designing inclusive digital experiences, and fostering human–machine collaboration that upholds educational values [13].

As higher education becomes more reliant on intelligent systems, lecturers' meta-literacy competence becomes a decisive factor in maintaining academic integrity, fostering creativity, and ensuring equitable access to technology-enhanced learning [9]-[10]. Thus, lecturers must not only understand technology but also reflect on how it shapes learning ethics, inclusivity, and student agency. These objectives will generate quantitative insights into the motivational and skill-based factors that influence whether lecturers are in a continuous "loop" of adaptation or experiencing "stagnation" amid the transformations of the Fifth Industrial Revolution.

1.1. Purpose of the Study

The main purpose of this study is to describe and analyse the relationships between lecturers' autonomy, competence, and professional relatedness of meta-skills in the Fifth Industrial Revolution.

1. Determine the level of lecturers' autonomy in integrating emerging technologies within teaching practices.
2. Assess the level of lecturers' competence in applying meta-literacy skills for teaching practices through emerging technologies.
3. Examine lecturers' levels of professional relatedness for sustaining technology-enhanced teaching practices.
4. Determine the relationship among lecturers' autonomy in integrating emerging technologies, competence in applying meta-literacy skills, and professional relatedness in sustaining technology-enhanced teaching practice.

1.2. Research Questions

The following questions were answered during the curse of the study

1. What is the level of lecturers' autonomy in integrating emerging technologies within their teaching practices?
2. What is the level of lecturers' competence in applying meta-literacy skills for teaching practices through emerging technologies?
3. What is the level of lecturers' professional relatedness in sustaining technology-enhanced teaching practices?

1.3. Research Hypothesis

The hypothesis below is tested at the 0.05 level of significance

H01: There is no significant relationship among lecturers' autonomy in integrating emerging technologies, competence in applying meta-literacy skills, and professional relatedness in sustaining technology-enhanced teaching practices.

2. Literature Review

2.1. The Concept of Meta-Literacy

Meta-literacy is a developing and comprehensive concept in modern educational discussions, amalgamating several literacies necessary for navigating intricate digital and information environments. Mackey and Jacobson [11] defined meta-literacy as a comprehensive, self-referential framework encompassing various literacies (including information, digital, media, and visual) and highlighting learners' dual roles as critical consumers and active producers of information. Meta-literacy surpasses traditional definitions of information literacy by encompassing a wide array of literacies, such as digital, media, and critical literacies, highlighting the importance of not only information consumption but also production, ethical considerations, and collaborative creativity. This comprehensive approach recognises the complex and evolving characteristics of information in a progressively participatory and technology-driven society [14].

Meta-literacy emphasises four interconnected dimensions: cognitive (critical assessment), metacognitive (self-reflection and regulation), productive (production and authorship), and social (collaborative engagement and community standards). The multi-dimensional nature of Meta-Literacy renders it particularly appropriate as a pedagogical framework in higher education, where learning objectives encompass not only memory but also content production, ethical engagement, and adaptive reasoning within intricate information ecosystems [14]. Meta-literacy fundamentally acknowledges the necessity for individuals to engage actively in digital contexts, where they critically assess information sources, identify reliability and biases, and ethically utilise and generate knowledge [14]. In contrast to narrower literacies, meta-literacy enhances metacognition and reflexivity, cultivating learners' awareness and regulation of their information behaviours and cognitive processes. Consequently, it immediately facilitates the cultivation of self-directed learning skills considered essential in higher education and professional fields [15].

In higher education, lecturers play a pivotal role in the implementation of meta-literacy, as they are required to possess these abilities and to create and deliver curriculum that foster such literacies in students [16]. The incorporation of meta-literacy among educators requires expertise in emerging technologies and the ability to adjust teaching methods accordingly. Lecturers must critically interact with digital platforms, AI-enhanced tools, and data analytics, while upholding ethical responsibility in knowledge transmission and utilisation [17]. Meta-literacy includes the capacity to interact efficiently within digital communities, highlighting the building of shared knowledge and distributed cognition [14]. This dimension embodies modern educational paradigms rooted in constructivist and connectivist theories, perceiving learning as a socially mediated process that involves various information networks [18]. Thus, meta-literacy enables educators to cultivate environments that promote co-creation, critical discourse, and reflective practice, skills essential for innovation in pedagogy and learning.

Modern proponents of Meta-literacy, including [19], contend that AI complicates the producer/consumer dichotomy; learners and educators must now assess machine-generated outputs, cultivate "prompt literacy," and contemplate the epistemic limitations of algorithmic artefacts [20]. The metacognitive and ethical focusses of Meta-

Literacy are crucial for developing curriculum that foster scepticism towards automated outputs while utilising AI for creative and educational purposes [20]. Consequently, meta-literacy signifies a transformative educational ability that transcends mere technical digital abilities, encompassing critical thinking, ethical reasoning, collaborative involvement, and metacognitive awareness. This extensive literacy corresponds with the expectations imposed on educators within transforming higher education environments, particularly as they address the pedagogical requirements and obstacles of the 5th Industrial Revolution.

2.2. The Fifth Industrial Revolution (5IR) in Education

The concept of the "Fifth Industrial Revolution" (often synonymous with Industry 5.0) signifies a shift in industrial and societal paradigms, from the extensive automation and connectivity of Industry 4.0 to a future where human creativity, purpose, sustainability, and collaboration with machines are paramount. As stated by Alves et al. [21], industry 5.0 prioritises the human element in production and underscores the integration of digital technology with human competencies, values, creativity, and well-being. The blog post by Stephenie [22], characterises the Fifth Industrial Revolution as a transition towards "technology with a human heart," emphasising that future educational frameworks must integrate digital proficiency with social accountability.

This progression is referred to as Education 5.0, a transformative paradigm that prioritises learner-centred, collaborative, and ethically informed education, facilitated by emerging technology. Characterised Education 5.0 as the educational adaptation to Industry 5.0, propelled by artificial intelligence (AI), the Internet of Things (IoT), extended reality (XR), and big data analytics [23]. Consequently, 5IR signifies a paradigm in which technological progress must harmonise with humanistic educational ideals. Education is essential to the trajectory of the Fifth Industrial Revolution, requiring significant transformations in learning ecosystems to equip both educators and students for intricate, evolving futures. The revolution necessitates a transition from conventional STEM (Science, Technology, Engineering, and Mathematics) paradigms to STEAM, incorporating the arts to enhance creativity, ethical reasoning, and comprehensive problem-solving [22]. AI-driven personalised learning paths, along with empathetic and values-oriented pedagogy, are essential for cultivating learners who are both technologically adept and critically conscious, with a strong ethical foundation in their use of technology [16].

Furthermore, the integration of the Arts (the "A" in STEAM) is fundamental to the 5IR because it provides the philosophical and critical framework necessary for the ethical reasoning dimension of meta-literacy. While traditional STEM paradigms focus on technical proficiency and algorithmic efficiency, the humanities instill the empathy, creativity, and values-oriented pedagogy required to navigate a human-centered technological landscape. In this context, meta-literacy becomes more than a technical skill; it is a humanistic practice where educators use the critical inquiry skills inherited from the arts to question the biases of AI, assess the social impact of digital content, and ensure that technology serves human well-being and social accountability. This design philosophy focused on using digital innovation and AI

to serve people first ("technology with a human heart"). This approach ensures that the productive and social dimensions of meta-literacy are grounded in a strong ethical foundation [45].

5IR fundamentally redefines literacy and competency based on the principles of learning, unlearning, and relearning, highlighting the necessity of adaptation to swift technology advancements. The capacity to discard obsolete knowledge and acquire new skills is fundamental for educational relevance and personal development in this era [24]. Therefore, educators, especially lecturers, must cultivate advanced meta-literacy abilities and cognitive agility to assist learners in efficiently navigating this dynamic environment. Furthermore, 5IR emphasises leadership approaches that value empathy, collaboration, and social impact over mere economic benefits. This necessitates educational settings that foster these values, empowering educators to embrace innovative technologies while still guiding ethically and sustainably within their institutions [22]. Educational institutions must realign curricula, professional development, and institutional culture to facilitate these human-centric technological advancements.

Furthermore, 5IR emphasises leadership styles that value empathy, teamwork, and social impact in addition to economic benefits. This necessitates educational settings that foster these values, empowering educators to embrace innovative technologies while also guiding their institutions ethically and sustainably [22]. Educational institutions must realign curricula, professional development, and institutional culture to facilitate these human-centric technological advancements. The ramifications for pedagogy and education are significant. Educators must evolve from simple knowledge transmitters to facilitators of learning experiences that utilise intelligent technologies while promoting critical and ethical participation. This requires ongoing professional development centred on human-technology collaboration, ethical AI utilisation, and sustainability principles [19]. In the absence of such reform, institutions face the peril of stasis amidst rapid technological upheaval.

2.3. Competence and Meta-Literacy Skill Acquisition among Lecturers

In the realm of professional teaching practice, competency encompasses the knowledge, abilities, attitudes, and self-efficacy that empower lecturers to execute their jobs effectively [15]. According to Self Determination Theory (SDT), perceived competence is one of the three fundamental psychological demands essential for intrinsic motivation and ongoing involvement in intricate professional tasks. In higher education, competence encompasses not just disciplinary expertise but also the capacity to integrate pedagogical technologies, design learning experiences, assess outcomes, and engage in reflective practice [25]. When educators perceive themselves as proficient in implementing educational innovations, their drive for ongoing professional development rises, so fostering a dynamic cycle of adaptation rather than stagnation. In contrast, diminished perceived ability may result in the evasion of innovation, cursory tool utilisation, and dependence on conventional instructional methods.

A study by Ajani and Oladokun [24] highlights that the acquisition of meta-literacy abilities in higher education is a complicated, iterative process requiring ongoing professional development and practical learning opportunities. Lecturers develop competency by actively engaging with innovative educational technologies like artificial intelligence

(AI), which radically transform instructional methods. Faculty must go beyond instrumental usage to acquire "meta-AI" skills, which are characterised by the capacity to critically oversee and regulate AI's ethical implementation, dependability, and educational significance [26]. This necessitates continuous reflexivity and a willingness to explore within certain subject situations. Furthermore, proficiency in meta-literacy includes the capacity to incorporate AI and other sophisticated tools to improve efficiency and student learning. Examples encompass utilising AI for prompt assignment feedback, replicating real-world events for immersive learning, and facilitating dynamic online class discussions through AI-driven avatars. These applications necessitate that lecturers maintain metacognitive knowledge of both pedagogical effects and technology limitations, so enabling informed instructional choices [27]. The acquisition process is further hampered by generational disparities in technological proficiency. Although students are sometimes considered "digital natives," instructors exhibit considerable variability in their digital fluency and comfort, needing customised professional development that encompasses affective elements such as motivation and confidence in addition to technical instruction [28]. Institutional support systems and collaborative learning communities are crucial for maintaining competence development and addressing resistance or stagnation [14].

Recent meta-analyses and empirical research indicate a continuous trend: whereas numerous lecturers acknowledge the significance of digital and meta-literacy competencies, their self-assessed levels of competence remain moderate to poor. Liesa-Orus et al. [29] conducted a meta-analysis involving 7,470 lecturers from Europe and Latin America, revealing an average effect size of $r = -0.21$ for self-perceived digital competence, which encompasses meta-literacy dimensions. This indicates a "moderate negative" perception of competence, despite favourable attitudes towards ICTs. The disparity between perception and real competence indicates an urgent requirement for institutional reforms. A comprehensive study conducted by Dang et al. [30] involving 626 higher education lecturers indicated that various dimensions of the DigCompEdu (European Framework for the Digital Competence of Educators), such as digital resources, teaching and learning, assessment, and learner empowerment, exhibited a positive correlation with student learning value ($B = 0.266$ for digital resources competence) (Digital competence of lecturers and its impact on student learning value in higher education, 2024). These data underscore that lecturer proficiency in areas related to meta-literacy has direct pedagogical implications. Consequently, the acquisition of competency and meta-literacy skills among lecturers is essential for resilient and adaptable teaching that fulfils the requirements of the 5th Industrial Revolution. This necessitates the integration of reflective practice, ethical leadership, and ongoing professional development centred on developing technology. By cultivating these competencies, lecturers boost their teaching efficacy and exemplify essential digital citizenship for students, ultimately promoting transformative educational results.

Although extensive research globally has established that digital competence gaps exist, there is a lack of empirical research that focuses specifically on the level of digital competence in the field of meta-literacy in the Nigerian higher education sector. Meta-literacy competency among lecturers in Kwara State is still scarce data, although some local scholarship has already started to call for a move towards an intelligent library and overall implementation of 5IR technologies in Nigeria. The study explicitly tackles this gap in the research and thus made the choice of Kwara State as

a critical area for the investigation [46]. The study seeks to set a local benchmark and establish if the 'moderate to poor' academic competence judgements noted internationally are reflected in the North-Central Nigeria academic environment so that a local structure for institutional reform can be established.

2.4. Relatedness and Professional Support Systems for Sustainable Technology Use

In the context of Self-Determination Theory (SDT), relatedness denotes the essential psychological requirement to experience connection with others, get support within one's professional group, and be esteemed as a part of that community [31]. In higher education, relatedness encompasses more than simple collegial connection; it entails significant engagement with peers, mentorship, leadership support, and institutional frameworks that foster a sense of belonging and professional identity [6]. When lecturers experience isolation, lack of support, or disconnection from collaborative frameworks, their willingness to adopt new professional practices, such as incorporating emerging technologies, may wane, leading to stasis instead of progress. Professional support systems typically consist of both official and informal structures, including peer networks, mentoring programs, professional learning communities (PLCs), technical support teams, instructional designers, leadership encouragement, and policy norms that promote innovation. Research demonstrates that in technology-enhanced educational environments, such support systems are crucial for the enduring integration of novel pedagogical tools and literacies.

Collaborative professional environments allow lecturers to share expertise, exchange experiences, and co-develop strategies for technology integration, thereby alleviating feelings of isolation and technological anxiety. These networks serve as "potent instruments for professional development," wherein ongoing discourse and reciprocal support foster collective efficacy in technology utilisation. Empirical research underscores the advantages of collegial support in augmenting lecturers' readiness and competence to engage with and maintain technology-enhanced pedagogies, hence cultivating a culture of innovation and resilience inside institutions [24]. In a study of university educators, Landa et al. [32] found that lecturers who actively participated in professional networks demonstrated greater self-efficacy in using digital technologies and were more likely to continuously refine their teaching practices. Similarly, Kim et al. [33] reported that peer mentoring and access to instructional design support significantly predicted the sustained use of educational technologies beyond their initial implementation. Furthermore, Dogan et al. [34] found that leadership support, including encouragement from academic leaders, the provision of institutional resources, and a supportive environment for innovation, was positively associated with the integration of innovative teaching and learning technologies. The authors further argued that leadership support mediates the relationship between lecturers' technological competence and technology integration, highlighting the critical role of professional relatedness and institutional support networks in bridging competence gaps.

A deficiency in professional assistance and peer collaboration leads to technical stagnation, since lecturers often express discontent due to poor infrastructure, insufficient training, and minimal social reinforcement [35]. The logistical and psychological obstacles encountered in the absence of sufficient relatedness mechanisms hinder the sustained adoption of technology, leading to shallow or fragmented usage that does not significantly enhance teaching and learning [36]. This study indicates that the dimension of relatedness pertains directly to the third objective: to delineate the extent of lecturers' relatedness about professional support for maintaining technology-enhanced teaching methods. Assessing relatedness entails evaluating the degree to which lecturers perceive the presence of mentoring, peer collaboration, technical support, leadership encouragement, and participation in a community of practice. Consequently, interconnectedness and professional support structures are essential for the successful incorporation of developing technologies in educational settings. They fulfil fundamental psychological needs according to Self-Determination Theory while also implementing institutional commitments to promote adaptable, innovative, and resilient teaching practices in accordance with the requirements of the 5th Industrial Revolution.

2.5. Lecturers' Autonomy in Integrating Emerging Technologies

The autonomy of lecturers in incorporating developing technologies is a crucial determinant of the quality and durability of technology-enhanced teaching methods. Autonomy denotes the extent of professional authority educators possess in choosing, modifying, and applying technology tools to align with their instructional objectives and student requirements [37]. The literature indicates that increased autonomy among lecturers enhances their intrinsic motivation to innovate, persevere, and dedicate effort to effective technology integration, leading to more student-centered and engaging learning environments [4]. Conversely, top-down requirements lacking professional discretion often result in superficial adoption; technology is utilised out of obligation rather than pedagogical necessity, leading to stagnation instead of a fruitful learning cycle.

Autonomy in technology integration does not suggest a lack of accountability. The autonomy of lecturers to innovate must be reconciled with quality assurance, accessibility norms, and the integrity of assessments. The swift rise of generative AI and sophisticated analytics technologies introduces new facets to autonomy. AI tools can enhance lecturer autonomy by automating routine tasks such as grading and feedback, facilitating personalisation, and offering decision support. Conversely, the institutional implementation of prescriptive AI systems may limit lecturers' choices and diminish professional judgement if they are compelled to follow AI-driven workflows without the opportunity for design discretion. Consequently, autonomy in the fifth industrial revolution hinges on whether institutions regard AI as a tool governed by professionals or as a prescribed operational framework that constrains educational choices [38].

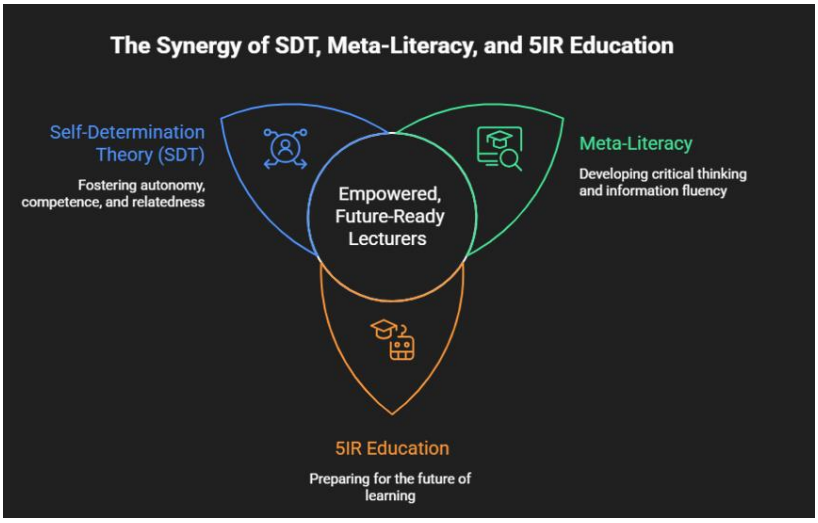

Figure 1. Conceptual relationship among Self-Determination Theory, meta-literacy, and 5IR education

Recent faculty surveys and research influenced by Self-Determination Theory conducted by Legrain et al. [39] demonstrate a strong correlation between perceived autonomy and the extent of technological integration. Extensive faculty reports indicate that lecturers who have greater autonomy and congruence between technology implementation and educational objectives are more inclined to persist in innovation and report favourable student engagement results [40]. SDT-based analyses reveal that autonomy interacts with perceived competence: autonomy lacking competence may lead to frustration, whereas competence devoid of autonomy may result in underutilised potential. Consequently, autonomy should be regarded as essential yet insufficient; optimal outcomes arise when autonomy, competence (meta-literacy), and relatedness are concurrently fostered [26]. Consequently, lecturers' autonomy in incorporating developing technology is essential for cultivating intrinsic motivation, professional agency, and innovative instructional practices in accordance with the objectives of the 5th Industrial Revolution. Educational systems must prioritise autonomy-supportive environments that balance freedom with guidance to harness technology's transformative potential in teaching and learning.

3. Materials and Methods

This study employed a descriptive correlational research design to examine the relationships between lecturers' autonomy in integrating emerging technologies, competence in applying meta-literacy skills, and professional relatedness for maintaining technology-enhanced teaching practices in Kwara State. The design was deemed suitable as it allows the researcher to delineate current conditions and ascertain the strength and direction of correlations among variables without manipulation. The target population consisted of university lecturers in Kwara State. A convenience sampling method was utilised to pick 100 instructors in three universities (1-Federal; 1-State; and 1-Private), based on their accessibility, availability, and willingness to engage in the study. This sampling approach guaranteed that participants were educators

actively involved in teaching and knowledgeable about technology-driven instructional practices. A sample size of 100 respondents is considered appropriate and sufficient for this study due to Statistical Robustness for Correlation, Suitability for a Local Benchmark and Descriptive Depth.

The data-gathering instrument was a structured questionnaire segmented into four pieces. Section A documented the demographic data of the respondents, encompassing gender and educational qualifications. Section B had 10 items assessing lecturers' autonomy in using emerging technology in their pedagogical methods. Section C contained ten items evaluating lecturers' proficiency in using meta-literacy abilities for instructional practices via emerging technologies, whereas Section D consisted of ten items assessing lecturers' professional engagement in maintaining technology-enhanced teaching methodologies. All items were evaluated using a four-point Likert scale, from Strongly Disagree (1) to Strongly Agree (4). The instrument was validated by three specialists in the Department of Educational Technology and Measurement and Evaluation at Al-Hikmah University. Content and construct validity were assessed to measure the clarity, accuracy, and relevance of the instrument. A pilot study with twenty lecturers was conducted, and the instrument's internal consistency was assessed using the Cronbach's alpha method, resulting in a reliability coefficient of 0.71, signifying satisfactory reliability for the study. The Cronbach's Alpha value of 0.71 obtained in this study demonstrates that the instrument is sufficiently reliable because it exceeds the widely accepted threshold of 0.70 for internal consistency in social science and educational research.

Data collection was conducted via the distribution of printed questionnaires. A formal letter of introduction was acquired from the researcher's department and submitted to the school authorities to secure approval for data collecting. The questionnaires were delivered directly to the participants, and the researcher remained on-site to collect them immediately upon completion to guarantee a high response rate. The gathered data were examined utilising both descriptive and inferential statistics. Descriptive statistics, including frequency counts, percentages, and mean scores, were employed to encapsulate demographic information and address study questions one to three. A mean judgement scale of 1.0-2.0 was classified as "low," and 2.1-4.0 denoted "high." Pearson Product Moment Correlation (PPMC) was utilised to evaluate the association between lecturers' autonomy, competency in using meta-literacy skills, and professional relatedness in maintaining technology-enhanced teaching methods.

4. Results

The respondents' demographic characteristics were first examined to provide an overview of the participants involved in this study. These characteristics provide important contextual information for understanding lecturers' experiences, perceptions, and readiness in responding to the evolving demands of digital transformation and the 5th Industrial Revolution. Table 1 presents the gender distribution of the respondents.

Table 1. Gender distribution of respondents

Gender	Frequency	Percentage (%)
Male	62	62%
Female	38	38%
Total	**100**	**100%**

Table 1 presents the gender distribution of the respondents. The results indicate that 62% of the lecturers who participated in the study were male, while 38% were female. This shows that male lecturers constituted the majority of the sample, suggesting a gender imbalance in the academic workforce within the study area, with men being more represented in technology-integrated teaching roles than their female counterparts.

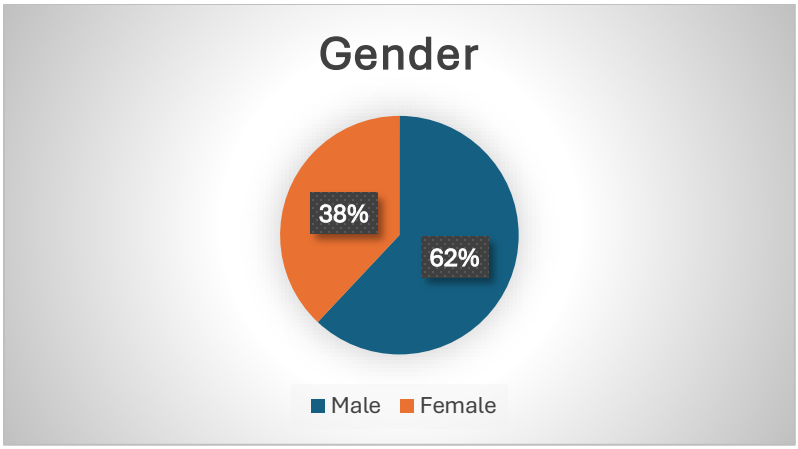

Figure 2. Gender distribution of respondents

RQ1: What is the level of lecturers' autonomy in integrating emerging technologies within their teaching practices?

Table 2. Lecturers' Autonomy in Integrating Emerging Technologies

S/N	Items	SA (4)	A (3)	D (2)	SD (1)	Mean
1	I have the freedom to choose the digital tools I use in my teaching.	45	38	12	5	3.23
2	My institution encourages me to experiment with emerging technologies in my courses.	30	44	18	8	2.96
3	I independently decide when and how to integrate technology into my lessons.	52	35	10	3	3.36
4	I feel empowered to modify my teaching strategies using new technologies.	40	42	14	4	3.18
5	I am allowed to design digital learning activities that suit my teaching style.	37	45	13	5	3.14
6	My department supports lecturers' personal initiatives in technology integration.	28	40	22	10	2.86
7	I can adapt institutional digital policies to meet my teaching needs.	25	38	27	10	2.78
8	I have access to necessary resources to implement my preferred technologies.	20	35	30	15	2.60
9	I can decide the extent to which I use AI or digital tools in teaching.	42	36	16	6	3.14
10	I feel autonomous in exploring new digital methods without strict supervision.	48	33	12	7	3.22
	Grand Mean					**3.05**

Table 2 presents the findings on lecturers' autonomy in incorporating developing technologies into their teaching methodologies. The results indicate a mean score of 3.05, categorising it inside the "high" range on the decision scale. This indicates that lecturers typically exhibit a significant degree of autonomy in selecting, implementing, and testing digital tools in their teaching methodologies. The highest mean score (3.36) was observed for the statement "I independently decide when and how to integrate technology into my lessons," indicating that lecturers had considerable autonomy in deciding the timing and method of technology integration. Correspondingly, elevated mean values were recorded for statements such as "I have the freedom to choose the digital tools I use in my teaching" (3.23) and "I feel autonomous in exploring new digital methods without strict supervision" (3.22), suggesting that numerous lecturers regard themselves as self-directed in their utilisation of technology. Nonetheless, comparatively lower mean scores on items such as "I have access to necessary resources to implement my preferred technologies" (2.60) and "I can adapt institutional digital policies to meet my teaching needs" (2.78) indicate that institutional support and resource availability continue to pose moderate challenges. The findings indicate that professors have significant professional autonomy in incorporating emerging technologies; nevertheless, infrastructural and policy constraints may hinder comprehensive implementation in Nigerian higher education institutions.

RQ2: What is the level of lecturers' competence in applying meta-literacy skills for teaching practices through emerging technologies?

Table 3. Lecturers' Competence in Applying Meta-Literacy Skills

S/N	Items	SA (4)	A (3)	D (2)	SD (1)	Mean
1	I can effectively evaluate the credibility of digital information sources.	38	42	15	5	3.13
2	I can create and share digital content that supports student learning.	34	45	16	5	3.08
3	I integrate ethical use of digital information in my teaching activities.	40	40	15	5	3.15
4	I guide students to think critically about information found online.	36	43	14	7	3.08
5	I use online collaboration tools to enhance students' participation.	30	46	17	7	2.99
6	I am confident in using AI-based tools for instructional design.	25	38	27	10	2.78
7	I can adapt my teaching methods to suit different digital platforms.	33	45	17	5	3.06
8	I continuously reflect on how I use technology to improve my teaching.	42	39	13	6	3.17
9	I teach students how to create and share digital content responsibly.	35	44	16	5	3.09
10	I can combine multiple digital tools to support learning objectives.	30	41	20	9	2.92
	Grand Mean					**3.05**

Table 3 indicates a grand mean score of 3.05, signifying that lecturers exhibit a high degree of proficiency in using meta-literacy skills for instructional activities via new technologies. This indicates that the majority of lecturers have the requisite knowledge and abilities to assess, develop, and ethically utilise digital resources in educational settings. The highest mean score (3.17) was seen for the statement "I continuously reflect on how I use technology to improve my teaching," suggesting that lecturers are reflective practitioners who critically evaluate their digital engagement for pedagogical enhancement. Correspondingly, elevated mean scores for statements such as "I integrate ethical use of digital

information in my teaching activities" (3.15) and "I can effectively evaluate the credibility of digital information sources" (3.13) highlight their capacity to engage responsibly and critically with online content. Nonetheless, the comparatively lower mean scores for items such as "I am confident in using AI-based tools for instructional design" (2.78) and "I can combine multiple digital tools to support learning objectives" (2.92) indicate that lecturers may still encounter difficulties with advanced technological applications and the integration of complex digital tools. The findings suggest that although lecturers in Nigerian universities exhibit a high degree of meta-literacy competency, there is a necessity for focused professional development in emerging and AI-driven instructional technologies to improve pedagogical innovation.

RQ3: What is the level of lecturers' professional relatedness in sustaining technology-enhanced teaching practices?

Table 4. Lecturers' professional relatedness in sustaining technology-enhanced teaching practices

S/N	Items	SA (4)	A (3)	D (2)	SD (1)	Mean
1	I feel supported by my colleagues in using new educational technologies.	36	40	18	6	3.06
2	My institution provides opportunities for collaborative learning among lecturers.	28	42	20	10	2.88
3	I share ideas and best practices about technology use with peers.	35	43	15	7	3.06
4	I receive guidance from my department on integrating technology effectively.	30	40	20	10	2.90
5	My institution promotes teamwork among lecturers for digital innovation.	27	38	25	10	2.82
6	I can easily seek help from colleagues when facing technological challenges.	40	39	15	6	3.13
7	There is an active community of practice for technology-enhanced teaching in my institution.	25	37	25	13	2.74
8	I feel connected to a professional network that supports technology use in education.	29	40	21	10	2.88
9	My administrators encourage collaboration in developing technology-based lessons.	31	38	22	9	2.91
10	I feel a sense of belonging to a community that values technology-driven innovation.	33	39	20	8	2.97
	Grand Mean					**2.93**

Table 4 reveals a grand mean score of 2.93, signifying that lecturers demonstrate a reasonably high degree of professional relatedness in maintaining technology-enhanced teaching practices. This indicates that although there is evidence of collegial collaboration and support, the degree of professional connectivity and institutional collaboration regarding technology integration is not consistently robust across all situations. The highest mean score (3.13) was seen for the statement "I can easily seek help from colleagues when facing technological challenges," indicating that peer support is essential in lecturers' utilisation of technology. Likewise, statements such as "I feel supported by my colleagues in utilising new educational technologies" (3.06) and "I exchange ideas and best practices regarding technology use with peers" (3.06) reflect a favourable culture of informal collaboration and knowledge dissemination among lecturers. In

contrast, diminished mean scores were recorded for statements such as "There is an active community of practice for technology-enhanced teaching in my institution" (2.74) and "My institution promotes teamwork among lecturers for digital innovation" (2.82), indicating a relative deficiency in organised institutional frameworks to support collaborative digital initiatives. The findings indicate that, although the professional relatedness among lecturers at the individual and peer levels is moderately robust, there is a necessity for enhanced institutional commitment to formal collaboration networks and professional learning communities to effectively maintain technology-enhanced teaching practices in Nigerian higher education.

H01: There is no significant relationship among lecturers' autonomy in integrating emerging technologies, competence in applying meta-literacy skills, and professional relatedness in sustaining technology-enhanced teaching practices.

Table 5. *Pearson Correlation Matrix among Study Variables*

Variables	Lecturers' Autonomy	Meta-Literacy Competence	Professional Relatedness	p-value
Lecturers' Autonomy	1.000	0.641**	0.523**	0.000
Meta-Literacy Competence	0.641**	1.000	0.587**	0.000
Professional Relatedness	0.523**	0.587**	1.000	0.000

Table 5 presents the multiple correlation analysis showing the relationships among lecturers' autonomy in integrating emerging technologies, competence in applying meta-literacy skills, and professional relatedness in sustaining technology-enhanced teaching practices. The results reveal strong positive correlations among the three variables, with correlation coefficients ranging from $r = 0.523$ to $r = 0.641$, all significant at $p < 0.05$. Specifically, lecturers' autonomy shows a high and significant relationship with meta-literacy competence ($r = 0.641$, $p = 0.000$), indicating that lecturers who exercise greater autonomy in technology integration tend to demonstrate higher competence in applying meta-literacy skills. Similarly, autonomy correlates positively with professional relatedness ($r = 0.523$, $p = 0.000$), suggesting that lecturers with higher levels of autonomy are also more likely to experience stronger professional collaboration and support. Furthermore, meta-literacy competence is significantly associated with professional relatedness ($r = 0.587$, $p = 0.000$), implying that lecturers who are more competent in meta-literacy are also more engaged in collaborative professional networks. Since all p-values are less than 0.05, the null hypothesis (H_{01}) stating that there is no significant relationship among the three variables is rejected. This finding indicates a significant and positive interrelationship among lecturers' autonomy, competence, and professional relatedness in sustaining technology-enhanced teaching practices within Nigerian higher education institutions.

5. Discussion

The study established that lecturers in Kwara State possess a high level of autonomy in selecting and integrating emerging technologies. This high degree of self-direction, particularly in deciding the timing and methods of integration,

suggests that educators are not merely complying with external mandates but are acting as autonomous agents of innovation. According to SDT, such autonomy is the primary catalyst for intrinsic motivation and persistence. However, a critical tension exists while individual agency is high, institutional resource availability and the ability to adapt rigid digital policies remain significant hurdles. This suggests that while lecturers have the willingness to innovate, they are often operating within an "autonomy-supportive vacuum" where their personal initiatives lack the necessary structural backing

The finding that lecturers exhibit a high level of meta-literacy competence indicates a strong foundation in critical thinking and ethical reflection. The high scores for evaluating digital source credibility and reflecting on technological use suggest that lecturers have successfully transitioned from basic digital literacy to the self-referential, evaluative framework of meta-literacy. Nevertheless, a "competence gap" persists regarding advanced AI-driven tools. This mirrors the OECD (2024) report, which found that fewer than half of global educators feel prepared to integrate AI into their pedagogy. This lower confidence in AI tools likely stems from limited exposure and a lack of structured training rather than a lack of interest. In the 5IR context, this creates a "hybrid state" where lecturers possess the human-centric ethical reasoning required by Education 5.0 but lack the technical "prompt literacy" needed to effectively collaborate with intelligent machines.

While the study found a high level of professional relatedness, the depth of this connection is largely informal. The ability to seek help from colleagues serves as a vital safety net, mitigating "technological anxiety" through peer networks. However, the lower scores for formal Communities of Practice (CoP) ($\bar{x}$=2.74) and institutional teamwork for digital innovation sreveal a deficiency in organized support. As noted by Landa et al. (2023), leadership support is crucial for closing competence gaps; without formal structures, technological adoption remains surface-level or fragmented. This missing link in relatedness prevents the transition from individual experimentation to a sustainable, institution-wide culture of innovation

The strong positive correlations among autonomy, competence, and relatedness (r=0.523 to 0.641) provide empirical validation for the integrated SDT framework in Nigerian higher education. The high correlation between autonomy and competence (r=0.641) reinforces the idea that when lecturers feel empowered to experiment, they naturally develop stronger meta-literacy skills. These findings suggest that lecturers in Kwara State are currently in a productive "loop" of professional growth, driven by high intrinsic motivation and peer support. However, the identified deficiencies in institutional resources and formal AI training represent potential "stagnation points". To prevent pedagogical stagnation, institutions must move beyond relying on individual lecturer resilience and instead foster autonomy-supportive environments that provide the infrastructure and formal collaborative networks necessary for the human-machine synergy of the 5th Industrial Revolution.

6. Conclusions

The study concludes that lecturers in Kwara State demonstrate significant autonomy, competence, and professional engagement in incorporating emerging technologies into their teaching practices, indicating a robust commitment to technology-enhanced pedagogy within the framework of the Fifth Industrial Revolution. The findings indicate that lecturers are in the loop at assessing, generating, and ethically using digital resources, in addition to collaborating with colleagues to maintain creative pedagogical methods. Nonetheless, the study underscores that although individual motivation and skill are notably elevated, institutional support mechanisms such as organised professional learning communities, access to digital infrastructure, and formalised technological training are insufficient. The notable and affirmative link between autonomy, meta-literacy competency, and professional relatedness suggests that lecturers with enhanced independence and technical proficiency are more inclined to participate in effective professional collaboration.

Recommendations:

1. Institutions should promote lecturers' autonomy by providing flexibility in technology integration and adequate infrastructural support for innovative teaching.
2. Regular professional development programmes should be implemented to strengthen lecturers' meta-literacy competence, especially in emerging digital and AI-based instructional tools.
3. Universities should establish structured professional learning communities and peer collaboration platforms to enhance lecturers' professional relatedness in technology use.
4. Educational administrators should adopt an integrated strategy that fosters autonomy, competence, and collaboration to sustain technology-enhanced teaching practices in the 5th Industrial Revolution era.

Author Contributions: Mutiu Babatunde Ibrahim: Conceptualization, introduction, visual, project administration; **Mubaraq Ibrahim Abdulsalam**: Literature review, formal analysis, SDT visualization; **Fatimoh Danmaigoro**: Writing review and editing, data curation; **Ahmed Fahdilat Talatu**: Supervisor.

Funding: This research received no external funding.

Data Availability Statement: The dataset generated and analyzed during this study is not publicly available due to institutional policies and ethical restrictions governing the use of research data collected from human participants under assurances of confidentiality and ethical approval that do not permit public data sharing. To protect participants' privacy and comply with the terms of informed consent, the data have not been deposited in a public repository. Requests for access to de-identified data may be considered by the corresponding author on reasonable request, subject to institutional ethical approval and applicable data protection requirements.

Acknowledgments: During the preparation of this manuscript/study, the author(s) used [Napkin AI] for [visual generation]. Generative artificial intelligence (GenAI) was used to generate text. The authors have reviewed and edited the output and take full responsibility for the content of this publication.

Conflicts of Interest: The authors declare no conflicts of interest.

References

[1] S. Yadav, "Leveraging AI to enhance teaching and learning in education: The role of artificial intelligence in modernizing classroom practices," in *Optimizing Research Techniques and Learning Strategies With Digital Technologies*, pp. 211–238, 2025, doi: 10.4018/979-8-3693-7863-2.ch008.

[2] A. Uzorka, S. Namara, and A. O. Olaniyan, "Modern technology adoption and professional development of lecturers," *Education and Information Technologies*, vol. 28, no. 11, pp. 14693–14719, 2023, doi: 10.1007/s10639-023-11790-w.

[3] X. Zhou, K. Sun, K. Zhu, L. Feng, Q. Sun, and D. Zhong, "The impact of digital literacy on university students' innovation capability: Evidence from Ningbo, China," *Frontiers in Psychology*, vol. 16, p. 1548817, 2025, doi: 10.3389/fpsyg.2025.1548817.

[4] R. M. Ryan and E. L. Deci, "Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions," *Contemporary Educational Psychology*, vol. 61, p. 101860, 2020, doi: 10.1016/j.cedpsych.2020.101860.

[5] V. Moravec, N. Hynek, M. Skare, B. Gavurova, and M. Kubak, "Human or machine? The perception of artificial intelligence in journalism, its socio-economic conditions, and technological developments toward the digital future," *Technological Forecasting and Social Change*, vol. 200, Art. no. 123162, 2024, doi: 10.1016/j.techfore.2023.123162.

[6] R. M. Ryan and E. L. Deci, *Self-Determination Theory: Basic Psychological Needs in Motivation, Development, and Wellness*. New York, NY, USA: The Guilford Press, 2017, doi: 10.1521/978.14625/28806.

[7] M. T. Islam, K. Sepanloo, S. Woo, S. H. Woo, and Y. Son, "A review of the Industry 4.0 to 5.0 transition: Exploring the intersection, challenges, and opportunities of technology and human–machine collaboration," *Machines*, vol. 13, no. 4, Art. no. 267, 2025, doi: 10.3390/machines13040267.

[8] K. I. B. Qolamani and M. M. Mohammed, "The digital revolution in higher education: Transforming teaching and learning," *QALAMUNA: Jurnal Pendidikan, Sosial, dan Agama*, vol. 15, no. 2, pp. 837–846, 2023, doi: 10.37680/qalamuna.v15i2.3905.

[9] S. Varsik and L. Vosberg, "The potential impact of Artificial Intelligence on equity and inclusion in education," *OECD Artificial Intelligence Papers*, no. 23, OECD Publishing, Paris, France, 2024, doi: 10.1787/15df715b-en.

[10] UNESCO, *Global Education Monitoring Report 2023: Technology in Education: A Tool on Whose Terms?* Paris, France: UNESCO, 2023, doi: 10.54676/UZQV8501.

[11] T. P. Mackey and T. E. Jacobson, "Reframing information literacy as a metaliteracy," *College & Research Libraries*, vol. 72, no. 1, pp. 62–78, 2011, doi: 10.5860/crl-76r1.

[12] H. Mardiana, "Perceived impact of lecturers' digital literacy skills in higher education institutions," *SAGE Open*, vol. 14, no. 3, Art. no. 21582440241256937, 2024, doi: 10.1177/21582440241256937.

[13] L. V. Mulaudzi and J. Hamilton, "Lecturers' perspectives on the role of AI in personalized learning: Benefits, challenges, and ethical considerations in higher education," *Journal of Academic Ethics*, vol. 23, no. 4, pp. 1571–1591, 2025, doi: 10.1007/s10805-024-09566-3.

[14] T. P. Mackey and T. E. Jacobson, *Metaliteracy: Reinventing Information Literacy to Empower Learners*. Chicago, IL, USA: ALA Neal-Schuman, 2014.

[15] J. Strong, "Moving from theory to practice: Applying the four-domain metaliteracy model to the business communication classroom," *EuroAmerican Journal of Applied Linguistics and Languages*, vol. 12, no. 1, pp. 115–143, 2025, doi: 10.21283/2376905X.1.12.1.3335.

[16] G. Bester, "Literacy and 5IR," *LearnYa Skills*, Jun. 16, 2025. [Online]. Available: https://learnyaskills.com/literacy-and-5ir/

[17] M. Pinto, D. Caballero-Mariscal, F.-J. García-Marco, and C. Gómez-Camarero, "A strategic approach to information literacy: Data literacy. A systematic review," *Profesional de la Información*, vol. 32, no. 6, Art. no. e320609, 2023, doi: 10.3145/epi.2023.nov.09.

[18] S. Zhu, H. H. Yang, D. Wu, and F. Chen, "Investigating the relationship between information literacy and social media competence among university students," *Journal of Educational Computing Research*, vol. 59, no. 7, pp. 1425–1449, 2021, doi: 10.1177/0735633121997360.

[19] M.-C. Martínez-Bravo, C. Sádaba-Chalezquer, and J. Serrano-Puche, "Fifty years of digital literacy studies: A meta-research for interdisciplinary and conceptual convergence," *Profesional de la Información*, vol. 29, no. 4, Art. no. e290428, 2020, doi: 10.3145/epi.2020.jul.28.

[20] Metaliteracy.org, "Empowering Learners with Metaliteracy in AI Education," *Metaliteracy.org*, Oct. 9, 2024. [Online]. Available: https://metaliteracy.org/empowering-learners-with-metaliteracy-in-ai-education/

[21] J. Alves, T. M. Lima, and P. D. Gaspar, "Is Industry 5.0 a Human-Centred Approach? A Systematic Review," *Processes*, vol. 11, no. 1, Art. no. 193, 2023, doi: 10.3390/pr11010193.

[22] S. Badenhorst, "The Fifth Industrial Revolution (5IR): Technology with a Human Heart," *SACAP*, May 26, 2025. [Online]. Available: https://www.sacap.edu.za/blog/applied-psychology/fifth-industrial-revolution-5ir/

[23] S. Ahmad, S. Umirzakova, G. Mujtaba, M. S. Amin, and T. Whangbo, "Education 5.0: Requirements, Enabling Technologies, and Future Directions," *arXiv* preprint arXiv:2307.15846, 2023, doi: 10.48550/arXiv.2307.15846.

[24] Y. A. Ajani and B. D. Oladokun, "Advocacy for Intelligent Libraries in the Era of Fifth Industrial Revolution," *Folia Toruniensia*, vol. 24, pp. 29–51, 2024, doi: 10.12775/FT.2024.002.

[25] J. M. Fernández-Batanero, P. Román-Graván, M. Montenegro-Rueda, E. López-Meneses, and J. Fernández-Cerero, "Digital teaching competence in higher education: A systematic review," *Education Sciences*, vol. 11, no. 11, Art. no. 689, 2021, doi: 10.3390/educsci11110689.

[26] T. K. F. Chiu, C. S. Chai, P. J. Williams, and T.-J. Lin, "Teacher professional development on self-determination theory–based design thinking in STEM education," *Educational Technology & Society*, vol. 24, no. 4, pp. 153–165, 2021.

[27] F. Zarei and S. Adivi, "Beyond information literacy: Why metaliteracy is crucial for modern health education," *BioSocial Health Journal*, vol. 1, no. 3, pp. 113–114, 2024, doi: 10.34172/bshj.33.

[28] K. Ahuna and M. Kiener, "Beyond digital literacy: Cultivating 'Meta AI' skills in students and faculty," *Faculty Focus*, Aug. 6, 2025. [Online]. Available: https://www.facultyfocus.com/articles/teaching-with-technology-articles/beyond-digital-literacy-cultivating-meta-ai-skills-in-students-and-faculty/

[29] M. Liesa-Orus, R. Lozano-Blasco, and L. Arce-Romeral, "Digital competence in university lecturers: A meta-analysis of teaching challenges," *Education Sciences*, vol. 13, no. 5, Art. no. 508, 2023, doi: 10.3390/educsci13050508.

[30] T. D. Dang, T. T. Phan, T. N. Q. Vu, T. D. La, and V. K. Pham, "Digital competence of lecturers and its impact on student learning value in higher education," *Heliyon*, vol. 10, no. 17, Art. no. e37318, 2024, doi: 10.1016/j.heliyon.2024.e37318.

[31] E. L. Deci, A. H. Olafsen, and R. M. Ryan, "Self-determination theory in work organizations: The state of a science," *Annual Review of Organizational Psychology and Organizational Behavior*, vol. 4, pp. 19–43, 2017, doi: 10.1146/annurev-orgpsych-032516-113108.

[32] E. Landa, C. Zhu, J. Sesabo, and H. Machumu, "Leader support and the integration of innovative teaching–learning technologies: The mediating role of technological level of knowledge," *Education and Information Technologies*, vol. 28, no. 12, pp. 15523–15541, 2023, doi: 10.1007/s10639-023-11776-8.

[33] J. Kim, S. Pak, and Y. H. Cho, "The role of teachers' social networks in ICT-based instruction," *The Asia-Pacific Education Researcher*, vol. 31, no. 2, pp. 165–174, 2022, doi: 10.1007/s40299-020-00547-5.

[34] S. Dogan, N. A. Dogan, and I. Celik, "Teachers' skills to integrate technology in education: Two path models explaining instructional and application software use," *Education and Information Technologies*, vol. 26, no. 1, pp. 1311–1332, 2021, doi: 10.1007/s10639-020-10310-4.

[35] J. T. Nagy and I. Dringó-Horváth, "Factors influencing university teachers' technological integration," *Education Sciences*, vol. 14, no. 1, Art. no. 55, 2024, doi: 10.3390/educsci14010055.

[36] G. Azanza, O. Korres, J. Paños-Castro, and J. Petchamé, "Empowering university lecturers in the digital age: Exploring the factors influencing the use of digital technologies in higher education," *Education Sciences*, vol. 14, no. 7, Art. no. 728, 2024, doi: 10.3390/educsci14070728.

[37] Q. Xia, T. K. F. Chiu, M. Lee, I. T. Sanusi, Y. Dai, and C. S. Chai, "A self-determination theory (SDT) design approach for inclusive and diverse artificial intelligence (AI) education," *Computers & Education*, vol. 189, Art. no. 104582, 2022, doi: 10.1016/j.compedu.2022.104582.

[38] H.-P. Lee, A. Sarkar, L. Tankelevitch, I. Drosos, S. Rintel, R. Banks, and N. Wilson, "The impact of generative AI on critical thinking: Self-reported reductions in cognitive effort and confidence effects," in *Proceedings of the CHI Conference on Human Factors in Computing Systems*, 2025, pp. 1–22, doi: 10.1145/3706598.3713778.

[39] P. Legrain, N. Gillet, C. Gernigon, and M.-A. Lafrenière, "Integration of information and communication technology and pupils' motivation in a physical education setting," *Journal of Teaching in Physical Education*, vol. 34, no. 3, pp. 384–401, 2015, doi: 10.1123/jtpe.2014-0013.

[40] N. Muscanell, *2023 Faculty and Technology Report: A First Look at Teaching Preferences since the Pandemic*. Boulder, CO, USA: EDUCAUSE, Aug. 21, 2023. [Online]. Available: https://www.educause.edu/ecar/research-publications/2023/faculty-and-technology-report-a-first-look-at-teaching-preferences-since-the-pandemic

[41] E. C. Onwubiko, "Meta-literacy for librarians and users in an era of metaverse technology: Librarians point of view," *Graduate Journal of Interdisciplinary Research, Reports and Reviews*, vol. 3, no. 1, pp. 32–47, 2025, doi: 10.34256/gjir3.v3i01.36.

[42] E. E. Okon, G. E. Agbor, M. B. Onabe, P. A. Olom, P. E. Oche, C. O. Ereh, P. U. Ushie, E. E. Elogbo, C. O. Umoren, S. S. Bishie-Unung, A. E. Dijeh, M. O. Ingwe, T. A. Ateb, L. A. Ashi, P. A. Nyiam, E. N. Ekong, M. Bekomson, K. O. Effiong, and K. N. C. Nwaiwu, "Influence of academic staff instructional competence on the delivery of business education in public universities," *Discover Education*, vol. 5, no. 1, Art. no. 71, 2026, doi: 10.1007/s44217-026-01288-1.

[43] A. A. Ahmed, A. M. Gazali, S. A. Yunus, and F. S. Isiaka, "Assessment of lecturers' readiness, digital competence and psychological disposition toward artificial intelligence integration in Colleges of Education in Kwara State," *Aminu Kano Academic Scholars Association Multidisciplinary Journal*, vol. 4, no. 3, pp. 95–110, 2026, doi: 10.64726/0tagba81.

[44] B. C. Echezu and E. E. Dimkpa, "Assessing the impact of the Fifth Industrial Revolution on teacher education in Rivers State," *Journal of Education in Developing Areas*, vol. 33, no. 2, pp. 146–160, 2025.

[45] C. G. Della, E. S. Della, and M. E. S. Della, "Stakeholders' productivity through mushroom livelihood projects in Pangasinan (Transforming Lives, Empowering People: A Technology with a Human Heart)," *IAMURE International Journal of Ecology and Conservation*, vol. 38, no. 1, 2022.

[46] G. O. Adigun, Y. A. Ajani, and R. T. Enakrire, "The intelligent libraries: Innovation for a sustainable knowledge system in the Fifth (5th) Industrial Revolution," *Libri*, vol. 74, no. 3, pp. 211–223, 2024, doi: 10.1515/libri-2023-0111.