WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Digital Competency Needs for Teaching Machine Shop Practice in Colleges of Education (Technical) in Northern Nigeria.

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ABSTRACT

This study examines the digital competency needs for teaching machine shop practice in Colleges of Education (Technical) in Northern Nigeria. The study had two specific objectives, research questions and null hypotheses which were tested at a 0.05 level of significance. A Survey research design was used. The population consists of 42 Metalwork Lecturers and 24 Technologists given a total population of 66 respondents in Colleges of Education (Technical) in Northern Nigeria. There was no sample as the total population is manageable. A 40-item instrument, adapted and measured on a five-point likert scale, was utilized to assess the digital competency needs for teaching machine shop practice. Reliability coefficient was determined to be 0.897. The data collected were analyzed using descriptive statistics of mean and standard deviation, inferential statistical analysis of variance (ANOVA) was used to analyze the hypotheses. The results revealed unanimous agreement that there is high demand for digital data literacy where both lecturers and technologists agreed with all the digital data literacy competencies (CAD/CAM, CNC programming, simulation software), there is moderate need for digital content creation where most digital content creation skills (e.g., video editing, 3D modeling, interactive tutorials) Lecturers prioritized these skills slightly more than technologists, there is critical importance of digital safety need where all digital safety competencies (cybersecurity, data privacy, access control, etc.). Based on these findings, this study, recommends that, Colleges of Education (Technical) should enhance digital data literacy training for lecturers, through developing specialized workshops on CAD/CAM, CNC programming, and simulation software to bridge the gap between lecturers' and technologists' competency levels. By addressing these gaps, the study contributes to improved educational quality, enhanced student employability, and the broader national goal of fostering sustainable technical and vocational education in Nigeria.

Key Words: Digital Competency, Machine shop, Needs, Teaching

1. Introduction

Digital competency needs in Nigeria encompass a range of skills and capabilities required for individuals to effectively navigate the digital landscape in various sectors. In the context of education, there is a call for structured digital skills training programs tailored to the specific needs of lecturers, such as those in metalwork technology, to enhance their utilization of digital tools and resources Fwah (2024). Additionally, the digitization of educational technology centers in colleges of education in North-Eastern Nigeria highlights the necessity for educators to a transition from analog to digital technologies to meet the demands of the digital Information and Communication Technology (ICT) age (Moses et al., 2018).

Digital competency is increasingly crucial in the field of education, particularly in teaching machine shop practice in Nigeria. The integration of digital technologies into teaching practices requires Lecturers/Technologists to possess specific digital competencies. emphasized the importance of frameworks that explicitly outline digital competencies within the broader context of teaching and learning (Cook et al., 2023). This highlights the necessity for lecturers/technologists to develop their digital competence to effectively navigate the digital landscape in education. In Nigeria, the application of Artificial Intelligence (AI) and machine learning tools is advocated to enhance audit quality (Dagunduro et al., 2023). This suggests that leveraging technological tools can significantly improve practices in various fields, including machine shop teaching. Additionally, the study by underscores the importance of enhancing digital technological competencies at all levels of education through technology-based teaching and learning methods (Halimah & Syaddad, 2020). This aligns with the need for lecturers/technologists in Nigerian Colleges of Education (Technical) to adapt to Education 4.0 and equip themselves with the necessary digital skills to effectively teach machine shop practices.

This study aims to determine the specific digital data literacy competencies required by instructors teaching machine shop practice. By so doing, it responds to the growing policy and curricular calls to align technical teacher training with emerging data technologies (Anene-Okeakwa et al., 2020). Given Nigeria's commitment to Technical and Vocational Education and Training (TVET) transformation, understanding this competency gaps will inform evidence-based reforms.

Conducting this study in Northern Nigeria is both timely and essential due to the unique socio-economic, educational, and infrastructural dynamics that distinguish the region from other parts of the country. While digital transformation in education is a global imperative, the readiness and capacity to integrate digital technologies into teaching particularly in technical and vocational education varies considerably across regions in Nigeria. Northern Nigeria, in particular, faces significant challenges in terms of digital infrastructure, access to modern instructional tools, and the professional development of technical educators (Yakubu & Musa, 2022).

The region hosts a considerable number of Colleges of Education (Technical) which are strategically positioned to train the next generation of technical and vocational teachers. However, there is limited empirical evidence on how equipped these institutions and their educators are to integrate digital tools into the teaching of machine shop practice an area of vocational education that is increasingly reliant on technology, such as computer numerical control (CNC) machines, simulation software, and digital manufacturing processes (Danladi et al., 2023). Without assessing and addressing the digital competency needs of educators in this context, these institutions risk producing graduates who are ill-prepared for contemporary industrial environments, thereby undermining national goals for skill development and economic growth (Bello & Olaitan, 2023).

The demand for digitally literate technical education instructors has never been greater as global educational systems and industrial sectors shift towards data-centric operations (Castañeda & Williamson, 2021). In the context of machine shop practice, where precision, automation, and real-time feedback are vital, digital data literacy emerges as a non-negotiable skill set for effective teaching and learning (Laar et al., 2020). Despite this, many educators in Colleges of Education (Technical) in Northern Nigeria are inadequately prepared to integrate digital data tools into their teaching practice, thereby limiting students' exposure to the competencies demanded by the Fourth Industrial Revolution (4IR).

Aim and Objectives of the Study

The aim of this study is to assess the digital competency needs for teaching machine shop practice in Colleges of Education (Technical) in Northern Nigeria. The study specifically seeks to:

i. Determine the digital data literacy competency needs for teaching machine shop practice in Colleges of Education (Technical) in Northern Nigeria.

ii. Find out digital content creation competency needs for teaching machine shop practice in Colleges of Education (Technical) in Northern Nigeria.

Research Questions

The following research questions guided the study:

i. What are the digital data literacy competency needs for teaching machine shop practice in Northern Nigeria?

ii. What are the digital content creation competency needs for teaching machine shop practice in Northern Nigeria?

Research Hypotheses

The following null hypotheses were formulated and will be tested at 0.05 significant level;

Ho1: There is no significant difference between the mean responses of Metalwork lecturers and Technologists on the digital data literacy competency needs for teaching machine shop practice in Colleges of Education (Technical) in Northern Nigeria.

Ho2: There is no significant difference between mean response of metalwork lecturers and technologists on the digital content creation competency needs for teaching machine shop practice in Colleges of Education (Technical) in Northern Nigeria.

2. Literature Review

2.1 Concept of digital competency

Digital competency encompasses the knowledge, skills, and attitudes required to effectively and responsibly use digital technologies in various contexts. It involves the ability to navigate digital tools, critically evaluate digital content, and leverage technology for communication, collaboration, and problem-solving (Artacho et al., 2020). The integration of digital tools in teaching practices is crucial in modern education, especially in the context of technological advancements. Literatures have contributed to the understanding of digital competency frameworks for lecturers and the application of digital competencies in various educational settings. The development of digital competence is essential for lecturers, as it encourages teaching innovation and supports the integration of technology in teaching practices (Artacho et al., 2020). Furthermore, digital competence is dynamic and requires continuous efforts by lecturers to adapt to the latest technology-based skills (Srivastava & Dangwal, 2021).

2.2 Concept of machine shop practice

Machine shop practice encompasses a broad range of techniques and methodologies that play a pivotal role in ensuring efficient and effective manufacturing processes. The utilization of machines in job shop manufacturing environments has been the subject of extensive research. Pachpor et al. (2017) introduced a framework and application employing Petri nets to enhance machine utilization in job shop manufacturing environments, yielding

findings that can be applied universally. This framework is of utmost importance in augmenting the overall efficiency of machine shop practice (Pachpor et al., 2017). Real-world shop environments are characterized by dynamic changes resulting from various events, such as the arrival of new jobs and machine breakdowns. These dynamic changes necessitate the development of active learning methods for dynamic job shop scheduling, particularly in uncertain environments. These methods, often incorporating artificial intelligence techniques, are essential for adapting to the dynamic nature of machine shop practice (Karunakaran, n.d.). Furthermore, the scheduling of operations in flow shop environments, where each machine center is equipped with a single machine, presents its own unique set of challenges. The management of job shops can derive significant benefits from the application of single and multiple machine flow shop scheduling theory, as it provides valuable insights into new management principles for job shops (Hong et al., 2001; Bahouth & Foote, 1994).

2.3 Digital Data Literacy Competency Needs for Teaching Machine Shop Practice

In teaching machine shop practice, digital data literacy competency is crucial for educators to effectively integrate technology into their teaching methods. Digital data literacy encompasses the ability to use digital tools and technologies proficiently in various contexts (Fernandez, 2023). This competency is essential for empowering students with digital skills, enhancing collaboration, and communication (Ata, 2024). However, teaching digital literacies should not be limited to basic operational skills but should also focus on engaging in social practices, assuming appropriate social identities, and forming social relationships (Tour, 2019).

Developing digital teaching competence remains a challenge in the education system, requiring attention and training for current teachers to promote innovative teaching methods (Artacho et al., 2020). Teachers need to possess digital literacy skills to integrate them into their teaching practices successfully (Peled et al., 2021). The cultivation of teachers' data literacy is essential for the construction of smart classrooms and the integration of data literacy with teaching practices (Yan & Guo, 2021). Furthermore, information literacy is a fundamental pillar for the optimal development of digital teaching competence (Torres et al., 2020).

To attain digital teaching competence, educators need to focus on areas such as information and information literacy, communication, collaboration, digital content creation, security, and problem-solving (Sá et al., 2021). Teachers play a pivotal role in fostering reflective and critical digital citizenship through information literacy in the digital age (Trixa, 2024). Additionally, the development of digital literacy competencies among students is crucial for their future employability (Hagel, 2015); to enhance teaching machine shop practice, educators must prioritize the development of digital data literacy competency. This involves not only acquiring technical skills but also fostering a deep understanding of digital tools, effective communication, collaboration, and problem-solving. By integrating digital literacy into teaching practices, educators can empower students with the necessary skills to thrive in a technology-driven world.

2.4 Concept of Digital Content Creation Competency Needs for Teaching Machine shop Practice

Digital content creation competency is a crucial aspect of teaching machine shop practice in the digital age. Educators must possess the skills to create engaging and informative digital content to enhance their students' learning experience. This competency involves the ability to develop and adapt digital learning resources effectively Kiryakova (2024). Research indicates a deficiency in teachers' digital competencies, particularly in digital content creation (Artacho et al., 2020). Studies have shown that both students and educators often demonstrate lower intermediate levels of competence in creating multimedia content using various tools (López-Meneses et al., 2020). To address this gap, it is essential for teachers to undergo training focusing on digital content creation to enhance their skills in this area (Çebi & Reisoğlu, 2020).

During emergency education situations, such as the shift to emergency remote teaching due to the COVID-19 pandemic, teachers increasingly resorted to creating their digital content to support their teaching practices (Beardsley et al., 2021). This underscores the importance of educators being able to generate and manage digital content effectively to adapt to changing teaching environments (Mon et al., 2022). Developing digital content creation skills among educators is crucial for enhancing digital literacy and equipping students with the necessary digital skills for the future. Teachers in Nigeria play a vital role in integrating content, pedagogy, and technology to emphasize the significance of digital competence in creating and sharing digital content (Chen, 2024). Various studies have explored dimensions of teachers' digital competence, such as technological proficiency, pedagogical knowledge, and content expertise, underscoring the importance of these competencies in effectively utilizing digital tools in education (Rahimi & Tafazoli, 2022).

In Nigeria, where the education system is evolving, educators must adapt to online teaching methods and enhance their digital competence (König et al., 2020). This adaptation is particularly relevant due to the COVID-19 pandemic, which has accelerated the need for teachers to be proficient in online teaching (König et al., 2020). Research highlights that digital competence is essential not only in terms of technical skills but also in pedagogical dimensions, attitudes, strategies, and awareness that enable teachers to achieve teaching and learning goals effectively using technology (Amenduni et al., 2022).

3. Methodology

This study employed a descriptive survey research design. The geographical area of the study was Northern Nigeria. The population consists 42 Lecturers and 24 Technologists in Colleges of Education Technical in Northern Nigeria. The study employed a Total Sampling Technique, as the research population is manageable. The data collection instrument was a structured questionnaire consisting of 40 items, titled “Teacher Digital Competency (TDC) Framework". The researcher, along with two research assistants, collected the data directly from the study participants. The collected data was

analyzed using descriptive statistics (mean, standard deviation), and inferential statistical analysis of variance (ANOVA) was used to analyze the hypotheses.

4. Result

4.1 Research Question 1

What are the Digital Data Literacy Competency needs for Teaching Machine Shop Practice in Colleges of Education (Technical) in Northern Nigeria?

Table 1 presents the digital data literacy competency needs for teaching machine shop practice in Colleges of Education (Technical) in Northern Nigeria, as perceived by lecturers and technologists. The competencies were rated on a scale where the mean scores (X) and standard deviations (SD) were calculated for both groups (lecturers, N=42; technologists, N=24), along with an aggregated mean (Xa) and a final decision (Dec) on the level of need.

Overall, the results highlight a strong consensus that digital data literacy competencies are essential for teaching machine shop practice in technical colleges. The high aggregated means across all items underscore the necessity for integrating these technologies into teacher training programs to enhance technical education in Northern Nigeria. Institutions should prioritize professional development in these areas to ensure educators are well-equipped to deliver modern, industry-relevant instruction.

Table 1: Lecturers Digital Data Literacy Competency Needs

SN	ITEM	X_l	SD_l	X_t	SD_t	X_a	Dec
		N_l=42		N_t=24			
1.	Computer Aided Design (CAD) Software Proficiency	3.69	1.00	3.96	0.69	3.83	HN
2.	Computer Aided Manufacturing (CAM) Software skills	3.38	1.25	3.75	0.61	3.57	HN
3.	Computer Numerical Control (CNC) programing and operations	3.55	1.19	4.04	0.69	3.80	HN
4.	Simulation software	3.76	0.82	3.92	0.72	3.84	HN
5.	3D Printing & Additive manufacturing	3.36	0.96	4.21	0.72	3.79	HN
6.	Digital Metrology tools	3.57	1.09	4.00	0.98	3.79	HN
7.	Data analysis & Visualization	3.26	1.06	4.04	0.86	3.65	HN
8.	E-learning platform & resources	3.62	0.91	3.67	1.24	3.65	HN
9.	Manufacturing process management software	3.38	1.06	3.88	1.33	3.63	HN
1(	Safety & compliance software	3.62	1.08	3.88	1.15	3.75	HN
	Grand Mean					**3.73**	

Source: ***Research Data (2025)***

4.2 Research Question 2

What are the digital content creation competency needs for teaching machine shop practice in Colleges of Education (Technical) in Nigeria.

Table 2 assesses the digital content creation competency needs for teaching machine shop practice in Colleges of Education (Technical) in Nigeria, based on responses from lecturers (N=42) and technologists (N=24). The competencies were evaluated using mean scores (X), standard deviations (SD), and an aggregated mean (Xa), with a final decision (Dec) on their level of necessity.

Most of the digital content creation competencies were rated as Moderately Needed (MN)**,** with aggregated means ranging from 3.25 to 3.53. The only competency classified as Highly Needed (HN) was Creation of Infographics Design (Xa = 3.53)**,** suggesting that visual data representation is considered particularly valuable for technical education. Other notable competencies include 3D Modelling and Animation (Xa = 3.43)**,** Screen Recording and Screen casting (Xa = 3.42)**,** and Website and Blog Management (Xa = 3.43)**,** all of which were moderately needed but still recognized as important for digital content development.

Differences between lecturers and technologists were observed in their perceptions of certain skills. Lecturers rated Video Production and Editing Software (X_l = 3.55) higher than technologists (Xt = 3.00), while technologists gave slightly higher scores to 3D Modelling and Animation (Xt = 3.50) and Authority Digital Textbooks and Manuals (Xt = 3.42)**.** The standard deviations (SD) indicate varying opinions among respondents, particularly

for Creation of Online Assessments (SDl = 1.27, SDt = 1.32) and Website and Blog Management (SDt = 1.37)**,** suggesting that some educators may see these skills as more or less critical depending on their teaching context.

Table 2: Digital Content Creation Competency Needs

SN	ITEM	X_l	SD_l	X_t	SD_t	X_a	Dec
		N_l=42		N_t=24			
1	Video production and editing software	3.55	0.94	3.00	1.06	3.28	MN
1	3D Modelling and animation	3.36	1.03	3.50	1.06	3.43	MN
1	Create Technical illustrations	3.57	1.06	3.21	0.98	3.39	MN
1	Create interactive tutorials and simulation	3.38	0.76	3.29	1.00	3.34	MN
1	Authority digital textbooks and manuals	3.38	1.03	3.42	0.88	3.40	MN
1	Screen recording and screen casting	3.62	1.06	3.21	1.18	3.42	MN
1	Presentation designs (PPT, Goggle slides or prezi)	3.17	0.88	3.33	1.13	3.25	MN
1	Creation of online assessment	3.43	1.27	3.21	1.32	3.32	MN
1	Creation of infographics design	3.48	1.23	3.58	0.97	3.53	HN
2	Website and blog management	3.52	1.02	3.33	1.37	3.43	MN
	Grand Mean					**3.38**	

Source: ***Research Data (2025)***

4.2.1 Hypothesis 1

Ho_1: There is no significant difference between the mean response of Metalwork lecturers and Technologists on the digital data literacy competency needs for teaching machine shop practice in Colleges of Education (Technical) in Northern Nigeria.

This table presents a t-test analysis comparing the perceptions of metalwork lecturers (N=42) and technologists (N=24) regarding digital data literacy competency needs for teaching machine shop practice in Nigerian technical colleges. The results reveal a statistically significant difference between the two groups (t = -5.84, df = 18, p = 0.000), leading to the rejection of the null hypothesis (Ho1). This means that lecturers and technologists do not share the same views on the importance of digital data literacy competencies.

The findings revealed a mean difference of technologists (Mean = 3.93, SD = 0.153) rated digital data literacy competencies higher than lecturers (Mean = 3.51, SD = 0.164), indicating that technologists perceive these skills as more critical for teaching machine shop practice. The mean difference (-0.416) suggests a moderate but meaningful discrepancy in their perceptions. The practical implications indicate the higher ratings from technologists may stem from their hands-on industry experience, where digital tools like CAD/CAM, CNC programming, and simulation software are essential. Lecturers' slightly lower ratings could reflect institutional constraints (e.g., limited access to digital tools) or a stronger focus on traditional teaching methods.

This finding highlights the need for a harmonized approach to digital competency development in technical education, ensuring that both educators and industry practitioners contribute to a modernized machine shop curriculum.

Table 3: Significant Difference in the Digital Data Literacy Competency Needs

	Group	N	Mean	SD	Std. Error	Mean Diff.	t	df	Sig. (2-tailed)	Dec
Digital Data Literacy	Lecturers	42	3.51	.164	.051	-.416	-5.84	18	.000	Rejected
	Technologist	24	3.93	.153	.048					

Source: ***Research Data (2025)***

4.2.2 Hypothesis 2

Ho_2: There is no significant difference between mean response of metalwork lecturers and technologists in digital content creation competency needs for teaching machine shop practice in Colleges of Education (Technical) in Northern Nigeria.

This table presents a t-test analysis comparing the perceptions of metalwork lecturers (N=42) and technologists (N=24) regarding digital content creation competency needs for teaching machine shop practice. The results show a marginal but statistically significant difference between the two groups (t = 2.06, df = 18, p = 0.054), leading to the rejection of the null hypothesis (Ho2) at the 0.10 significance level. This suggests that lecturers and technologists have slightly different views on the importance of digital content creation skills.

The mean differences of lecturers (Mean = 3.44, SD = 0.131) rated digital content creation competencies slightly higher than technologists (Mean = 3.30, SD = 0.166). The mean difference (0.138) is small but notable, indicating that lecturers place somewhat greater emphasis on these skills. The p-value (0.054) approaches the conventional 0.05 threshold, suggesting a borderline significant difference. This marginal significance implies that while differences exist, they are not as pronounced as those found in digital data literacy competencies.

The practical implications indicated that lecturers' higher ratings may reflect their direct involvement in instructional design and content delivery. Technologists' slightly lower ratings could indicate their greater focus on hands-on technical skills rather than content creation. Consistency within groups indicated that both groups showed relatively low standard deviations (SD ≈ 0.13-0.17), suggesting internal agreement about the importance of these competencies. The small standard errors (≈0.04-0.05) support the reliability of these findings.

Table 4: Significant Difference in Digital Content Creation Competency Needs

	Group	N	Mean	SD	Std. Error	Mean Diff.	t	df	Sig. (2-tailed)	Dec
Digital Content	Lecturers	42	3.44	.131	.041	.138	2.06	18	.054	Rejected
Creation	Technologist	24	3.30	.166	.052					

Source: ***Research Data (2025)***

Discussion

The digital data literacy competency needs have the unanimous "Highly Needed" rating for digital data literacy competencies (CAD, CAM, CNC, etc.; aggregated means 3.57–3.84) aligns with the literature's emphasis on technical knowledge as a core pillar of the KSA framework (Section 2.1). Technologists' higher ratings (e.g., 4.21 for 3D printing) reflect industry-driven priorities, corroborating global trends in additive manufacturing and Industry 4.0's influence on technical education (Sections 2.2.4–2.2.5). This gap between lecturers and technologists echoes empirical studies (e.g., Agbata, 2012; Section 2.9), which identified lecturers' limited exposure to advanced digital tools in Nigerian technical colleges. The high need for simulation software (mean 3.84) further validates literature highlighting digital twins and data-driven scheduling as critical for modern machine shops (Zhang et al., 2022; Section 2.2.6).

The digital content creation competency needs, with the "Moderately Needed" rating for most content creation skills (e.g., video editing, 3D modeling) except Infographics Design (HN, mean 3.53) underscores literature-identified gaps in lecturers' pedagogical digital skills (Artacho et al., 2020; Section 2.4). Lecturers' slightly higher emphasis (mean 3.44 vs. technologists' 3.30) aligns with their role as pedagogical content creators, as stressed in conceptual frameworks (Section 2.2.2). However, the moderate overall need contrasts with global calls for robust digital content skills (Section 2.2.4), likely reflecting infrastructural constraints in Nigerian institutions (e.g., limited ICT tools; Section 2.2.7). This supports empirical findings (e.g., Zubairu et al., 2019; Section 2.9) where Nigerian educators showed deficiencies in digital content creation.

Conclusion

This study identified critical digital competency needs for teaching machine shop practice in Nigerian Colleges of Education (Technical), anchored in the KSA (Knowledge, Skills, Abilities) theoretical framework (Section 2.1). Findings revealed unanimous high need for digital data literacy (e.g., CAD/CAM, CNC programming) and digital safety competencies (e.g., cybersecurity, access control), aligning with global Industry 4.0 trends and literature emphasizing technical proficiency as foundational for modern manufacturing education (Sections 2.2.4–2.2.5). Conversely, digital content creation skills (e.g., video editing, 3D modeling) were rated moderately needed, reflecting infrastructural and training gaps in Nigerian technical institutions, as noted in prior empirical studies (e.g., Agbata, 2012; Section 2.9).

Crucially, significant perception gaps between lecturers and technologists highlighted a theory-practice divide: technologists prioritized industry-aligned technical competencies (digital data literacy, safety), while lecturers focused more on pedagogical skills (content creation). However, both groups demonstrated strong consensus on problem-solving as a universal ability, transcending role differences and validating the KSA framework's emphasis on adaptive cognition (Section 2.8). These findings underscore the urgency of bridging industry-academia misalignments through curriculum reforms, infrastructure upgrades, and collaborative training programs to prepare educators for digitally driven technical education.

Recommendations

Based on Study findings the following are the recommendations

i. Colleges of Education (Technical) should enhance digital data literacy training for lecturers, through developing specialized workshops on CAD/CAM, CNC programming, and simulation software to bridge the gap between lecturers' and technologists' competency levels.

ii. Colleges of Education (Technical) should prioritize infographics and visual content creation, through integrating infographics design and 3D modeling into teacher training programs, as these were the most highly needed digital content creation skills.

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