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Digital Transformation in Teaching: Bridging the Gap Between Resource Utilization and Pedagogical Practices

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Abstract

This study explores the digital transformation of teaching with particularly focus on the resource utilization and practices within higher education. Drawing from a range of scholarly literature, the research examines how digital tools address critical gaps in digital pedagogy, particularly in Nepal's educational landscape. Despite the growing emphasis on ICTs in education, teacher educators face challenges such as limited technological proficiency, insufficient training, and resistance to structured digital strategies. The study is grounded in the Technological Pedagogical Content Knowledge (TPACK) and Unified Theory of Acceptance and Use of Technology (UTAUT) frameworks, drawing on prior research that highlights the need for institutional support and training in digital adoption. A qualitative methods approach was employed through reflective notes and classroom observations. The research questions focus on assessing existing digital competencies, examining proficiency levels, and exploring integration practices in teaching learning strategies.

Introduction

The integration of technology into education has significantly transformed traditional ways of teaching. Digital transformation offers essential teaching and learning platforms for both educators and students. The ongoing digital classrooms suggest a paradigm shift in how Face-to-face learning has begun to make way for web-enhanced education using internet-based resources (Regalado-Pezua, & Galeano, 2022). In the dynamic landscape of modern education, technology is being reshaped the way of knowledge acquisition and transformation (Haleem et al., 2022). Similarly, it is done to update and renew knowledge, and technical skills of teachers to enhance and maintain their teaching efficiency.

As the integration of digital tools and resources is gradually dominant in classrooms, teachers' task is not only to transmit subject matter to cultivate digital literacy and fluency for their students (Chung & Wei, 2020). The role of in-service teachers should evolve beyond traditional chalk-and-talk methodologies, prompting a re-evaluation of the skills and competencies necessary for effective instruction (Osamwonyi, 2016). The digital skills for in-service teachers have emerged as a serious factor of educational success. Furthermore, technological skills for in-service teachers should be compulsory for successful education.

The motivation, difficulties, accessibility creation, and integration of digital material have come forefront of change for the educational landscape among the teachers at the school level (Tusiimea et al., 2020). Traditional pedagogical methods have changed as a result of the integration of technology, opening up fresh opportunities to improve the educational process (Yilmaz, 2021). Moreover, educators should work to navigate the digital edge by understanding goals, addressing difficulties, and providing equal access to resources become critical.

The Ministry of Education [MoE] has emphasized the use of Information Communication Technology (ICT) skills in real classroom teaching and student engagement in the learning environment through better teacher-student

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collaboration. Nepal School Education Sector Plan (2022/23-2031/32) has also given an opinion on the demand for continuous development of in-service teacher training which removes a temporary gap in the capacity to support teachers in their professional development. That's why, in teacher education, in-service training acknowledges relationships among teachers, institutions and members of the community for strengthens the ties between institution, faculty, and community. Additionally, Upadhayaya (2023) notes that the domain of (ICT) has led to a significant transformation in the field of education by introducing innovative practices within the classroom environment. Recovery and Accelerated Learning (ReAL) Plan (2023-2028) has itemized three areas: i) teacher preparation for remedial support to develop subject-specific pedagogical and digital skills by providing continuous teacher training and coaching. ii) partnership with the local government to implement the accelerated learning in their schools by providing supplementary learning materials to schools, and iii) the use of volunteers and civil society in conducting short-term and intensive teacher training program.

Transformation in teaching is necessary to support educators' professional growth, strengthen their pedagogical skills, help them adapt to educational innovations, incorporate technology, encourage reflective practice, and ultimately to improve results (Germuth, 2018). Teachers require the proper in-service training for understanding of curriculum, learner psychology, and new strategies on teaching and learning. The professional training of educators emphasizes successful pedagogical work. In this regard, Khomenko (2023) notes that quality in education depends on teacher training, pedagogical skills, and digital competence. In this context, Mtebe and Raphael (2018) argue that in-service teachers should adopt Technological Pedagogical Content Knowledge (TPACK) for 21th century skills which help to appropriately apply understanding of classroom teaching learning activities.

A new age of learning has begun with the arrival of the 21th century, one in which educators must modify their pedagogical strategies to respond to technology improvements and shifting student expectations (Malil, 2018). As universities and colleges aim to prepare students for the demands of a digital world, higher education teachers face a range of complex problems that need careful consideration and innovative solutions (Kaputa et al,, 2022). To bridge the gap in technological proficiency to ensure inclusive and engaging learning experiences, addressing the issue of technological integration in everyday lessons is essential (Samaniego Erazo et al, 2015). The effective integration of technological tools in classrooms is constrained by several factors: technological proficiency, time availability, pedagogical integration, accessibility and inclusivity, student engagement, resistance to change, privacy and security, and professional development (Dinc, 2019; Lawless, & Pellegrno, 2007; Dhawan, 2020; Gomez et al., 2022). These problems reveal the multifaceted challenges faced by higher education teachers in digital transformation in teaching.

In Nepal, there has been a significant increase in access to digital resources in the education sector. The increased access to digital resources holds great promise for transforming teaching methodologies and enriching educational experiences . By utilizing these resources effectively, educators can enhance their teaching methods and provide more engaging and interactive learning experiences for students. Despite the availability of technological tools and resources, there seems to be a gap in utilizing them to their full potential in educational settings. One possible reason for this is the lack of sufficient training and guidance for teacher educators on how to incorporate technology meaningfully into their teaching methodologies. Several studies have also shown that teachers are not fully prepared for ICT as a resource and medium (Poudel, 2015). In this regard, there has been limited studies to explore the causes behind the limited use of ICT for teaching learning proposes. However, it does not mean that teachers are really unwilling to use ICT. One of the reasons might be that the lack of adequate knowledge and skills of using.

Here are some of the key reasons why such a study is significant: Enhancing Teaching and Learning Quality, Meeting 21st-Century Educational Demands, Closing the Technological Proficiency Gap, Effective Resource Utilization, Inclusive Education, Professional Development, Policy Implications, Teacher Well-being. This paper thus explore how digital tools use in teaching strategies teacher educators incorporate digital content and utilization of digital resources in higher education.

Literature Review

A growing body of literature shows that the integration of technology into education has transformed traditional classroom into digital classroom where digital technologies provide tools for content creation, information sharing, monitoring and assessment (Haleem et al., 2022). Educators are committed to using digital learning resources, which indicates a positive attitude toward the utilization of digital learning technologies (Camilleri & Camilleri, 2017). Digital devices, assessment and feedback system, publishing and sharing tools, and other technological tools help teachers work together for creatively and interactively (Pinto & Leite, 2020).

Successful teaching learning activities required digital connectivity, digital infrastructure and government support (Kitari, et al,, 2019; Lynn,et al, 2022; Khanom, et al, 2021). Technology helps students create, upgrade and gain new knowledge through a flexible and securing learning environment as well as ubiquitous accessibility of resources.

Siswanto et al, (2023) observe that technology has been mandatory for digital content development in the educational environment for creating and upgrading web-based educational resources. Okoye et al, (2022) note that government investment in IT concerned for creation, accessibility, utilization of resources, policy maker towards a sustainable practice. Additionally, the government and stakeholders should invest in IT infrastructure and they should know the challenges and also identify the alternative pathways. Koyuncuoglu (2022) analysed the digital and technologies competencies of university students based on gender, class and academic achievement. Similarly, researchers have examined different dimension i.e., information and information literacy, communication and collaboration, creating digital content, privacy and security, problem solving, ethics and responsibility, social dimension (Koyuncuoglu, 2022;). Koyuncuoglu (2022) found no significant differences in the digital competence and technology competences among university students in general according to their gender, their grade and success levels. Hubers et al, (2022) examined the effective characteristics of professional development programs for science and technology education, focusing on different content and context characteristics i.e.; scientific modeling, activities (teaching, assessment, observations, reflections), collaboration, coherence of content and duration. Likewise, context characteristics of professional development has been investigated on coherence with context, organizational factors, individual factors. Additionally, characteristics of professional development were focused on pedagogical knowledge, student learning process, school organization factors.

Furthermore, higher education institutions that prioritize digital competency have developed effective methods for assessing, practicing, and developing digital literacy. Çebi, et al, (2022) The study examined the digital knowledge and skills pre-service teachers used in technology integration, as well as how they improved their digital competences and Technological Pedagogical Content Knowledge (TPACK). Positive correlations between digital competences and TPACK competences were found. The constant growth in the requirements and competencies of teachers necessitates continuous innovation in pre-service teacher training, particularly in digital literacy. Záhorec, et al, (2021) the research focused on developing an optimal model for pre-service teacher training in the area of digital didactic-technological competency. The study found that integrating specific digital tools into teacher trainees' curricula, such as ActivInspire, FreeMind, SMART Notebook, Google Docs, Prezi, and Mindomo, is important, along with emphasizing the methodological aspects of using these tools in teaching. Digital competence is an important skill for teachers in today's society, including at the university level. Basilotta-Gómez-Pablos et al,(2022) A systematic review of literature was conducted to analyze the state of digital competencies among university teachers. The results show that many teachers have low or medium-low digital competence and there is a need for further research and personalized training programs to address this issue.

Al-Adwan et al, (2023) This research investigates the internet's future and how immersive learning and education might benefit from the metaverse, a confluence of information technologies. The metaverse has the potential to improve online learning, but its educational uses are still in their infancy, and its yet unknown what variables influence college students' use of metaverse technologies. The study addresses this by introducing an expanded version of the Technology Acceptance Model (TAM), which takes into account human, technical, and enabling/inhibiting aspects. The study employed online questionnaires to gather data from 574 students in Jordan. Analysis techniques were then used to identify perceived cyber risk as the main inhibitor of students' intentions to adopt the metaverse, and perceived usefulness, personal innovativeness in IT, and perceived enjoyment as the main enablers. Remarkably, it was discovered that perceived ease of use had little impact on plans to embrace the metaverse. The study also emphasizes how perceived cyber-risk, personal inventiveness, and self-efficacy affect how valuable and simple something is seen to be. The TAM model is expanded by these findings, which also provide educational authorities with useful information for strategizing the deployment of metaverse in higher education.

Theoretical Framework

Venkatesh et al., (2003) proposed the Unified Theory of Acceptance and Use of Technology (UTAUT) to explain the usage and the behavioural intention of using technology. Alblooshi and Hamid (2021) UTAUT framework suggests that performance expectancy, effort expectancy, social influence and facilitating conditions have positive effect on behavioural intention to use e-learning. Hence, behavioural intention mediates conceptualized the subjective probability that use of e-learning as part of learning.

Aslam et al's (2021) TPACK model support the effective delivery of content with integration of technology. Researchers highlight maintain that teachers should have basic technology proficiency, ability to create and disseminate content, professional development in pedagogy and ability to utilize technology. Sothayapetch and Lavonen (2022) observe that most teachers are using as much as possible technological (content management, video conferencing, resource sharing, online teaching) tools in their classes to enhance student learning. Previous studies have focused

on applying a self-identified, lengthy method to assess digital competence. Yang (2023) study uses machine learning to analyze syllabi and assess the incorporation of digital competency by university instructors, providing a valid and efficient assessment method.

Venkatesh, et al, (2003) discuss the research model i.e. Unified Theory of Acceptance and Use of Technology (UTAUT). The UTAUT model uses four core determinants to determine users' behavioral intention (BI) to use technology: Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), and Facilitating Conditions (FC). *Performance Expectancy (PE)* is the degree to which an individual believes that using a system will help him or her to attain gains in job performance. *Effort Expectancy* is the level of convenience and usability that people feel when using a specific information system. *Social Influence* defined social influence as the degree to which individuals perceive that someone accepts that they should use the new system. *Facilitating conditions* refer to the degree to which an individual believes that organizational and technical infrastructure exists to support the use of a system. *Behavioral Intention* suggested that behavioral intention to use a given technology has a significant influence on usage behavior.

Alam, et al, (2023) The emergence of social commerce websites has brought about a transformation in the way individuals associate and engage during their free time, owing to the progress made in information technology. Although these platforms facilitate communication, there are possible biases and inconsistencies in internet material, making it difficult to interpret. A comprehensive acquisition intention model for assessing social commerce websites has been developed by this study by fusing the Technology Acceptance Model (TAM) with Social Support Theory (SST). A major theme in the research is trust, which serves as a mediator. With 392 participants, the study employed an online quantitative methodology and discovered a substantial correlation between TAM, trust, and buy intention and two types of social support-emotional and informational. But there was no discernible correlation between perceived utility and buying intention. Between social support and TAM, trust acts as a key mediator. Clearer linkages are provided by the well-fitting suggested model. For marketers and practitioners creating social commerce websites, the study provides insights and makes recommendations for potential future research topics.

Almulla (2021) E-learning is becoming regarded as a vital teaching and learning tool in the field of higher education globally. But there are still concerns about its influence and practical use. To maintain the long-term viability of education, universities are actively addressing concerns linked to the use of e-learning by academic staff and students. This study uses an upgraded version of the Technology Acceptance Model (TAM) to investigate university students' e-learning adoption. Computer self-efficacy, subjective norm, perceived enjoyment, perceived utility, perceived ease of use, attitude toward usage, and behavioral intention to utilize e-learning for educational sustainability are the seven main characteristics that are taken into consideration in this study. 174 university students were chosen by stratified random selection, and quantitative data was collected from them using an enhanced version of the TAM research approach.

Methodology

The study adopted a qualitative design that combined classroom observation. Classroom observation was used to collect qualitative data from the participants. From the sampled population select 10 teachers purposively from both constituent and affiliated campuses for classroom observation. From 10 teachers, at least three classes of each teacher (30 altogether) were observed to find out their digital skills in actual classroom performance. To ensure construct and validate the research tools first built the tools based on the goals of study, interest, and experience classroom observation checklist and note-taking. After that consulted with colleagues and faculty members. After that, shared these tools with the senior experts at Tribhuvan University for validity and reliability purposes. Finally finalized made by necessary modifications to the tools based on feedback from colleagues and experts.

On the other hand, to the qualitative tools of classroom observation checklist (Excellent, Good, Satisfactory, Needs Improvement, Not Observed) was finalized on: Digital tools and Resource Utilization, Collaboration in academic activities, Students engagement, Managing and organizing classroom activities, Accessing online resources, Create and share digital materials, Developing assignment digitally, Integration of Artificial Intelligent (AI) tools, Use digital tools, Organizing digital libraries, Customize content, Online safety and risks, and Problem related to tools and devices.

To ensure validity, the prepared items were tallied with the research questions. For validity, the questionnaire was reviewed by three experts from Tribhuvan University. Experts evaluated the relevancy, clarity, and alignment of each item with the research objectives. Based on the experts suggestions modification was made. Finally, to ensure reliability, a semi-structured observation checklist was used throughout all classroom observation. Observation was conducted across three per teacher to ensure consistency over time.

A structured observation checklist and comment section was used to record information. From the prior permission observation was carried out during scheduled classes. Detailed notes and observer remarks were recorded to support qualitative analysis. After collecting qualitative (classroom observation) data, the responses were systematically coded. A structured observation checklist was used to evaluate teaching practices using such observation checklist:

Excellent, Good, Satisfactory, Needs Improvement, and Not Observed. From the comments section message deeper insight were captured. Each item of classroom observation was rated on scale: Excellent to Not Observed. Additionally, qualitative comments recorded during observations were transcribed, coded, and thematically analyzed to capture in-depth insights.

Findings

Digital Transformation in Teaching Practices

Participants found strong engagement to digital tools across various purposes of content development, collaboration, and classroom practices. Hands-on use of digital tools for creating and sharing educational content were found from majority of participants. Participants stated:

> *Digital tools were used for content development and share throughout the publications. Prepare digital materials and share links, photos, videos, and images with students through Messenger, Google Classroom, GeoGebra Classroom, etc.*

On collaborative practices Participants shared:

> *Collaborate with friends and students while developing content. Consult and discuss with my peers before presenting any content.*

Participants mentioned the integration of AI tools for resource development, the importance of a critical and responsible approach to AI-assisted learning, the need to adopt a growth mindset, and the value of ongoing professional development all while recognizing the need to balance academic and personal use of AI.

> "*When they face confusion, they ask ChatGPT for clarification, verify the authenticity and reliability of the information, and incorporate it during content development. They also try to build the habit of researching, reviewing, and updating myself with recent trends and practices. These tools enrich research, foster engaging learning experiences, and support leisure in a balanced way*.

Participants shared supportive statements for using digital tools:

> *Digital tools are a boon for teachers and researchers; user use browsers, ChatGPT, PowerPoint, YouTube, Viber group, and Messenger efficiently; Using digital tools enhances student engagement and communication.*

However, unsupportive views were also surfaced. Majority of participants were acknowledged:

> *Participants have not used many digital tools due to time constraints*; *revealing barriers to full integration for developing teaching content.*

From the multiple phases of classroom observation the integration of digital tools in developing and sharing content was present but lacked on interactivity. Here, teachers primarily used PowerPoint and pre-downloaded video to deliver content. One observer remarked, "*The teacher presented a slide with long paragraphs of text and read directly from it without explaining key points or engaging the class.*" There was little evidence of student on accessible resources beyond the classroom platforms to share additional materials. Similarly, in terms of digital collaboration, engagement were found from Google Docs, discussion forums. Learners highly participated in passive listening, and digital interactions for academic were not observed. As stated by another observer, "*Students listened passively, and there were no digital tools used to facilitate academic discussion or group activity*." In terms of engagement through entertainment-based tools student interaction, digital practices were found minimal. Teachers rarely used interactive media or games to stimulate interest. Another observer highlighted, "*There was no attempt to use digital tools for engaging students; the session felt like a traditional lecture with digital support*." These trends resulted in Satisfactory ratings for content development, and Needs Improvement ratings for both digital collaboration and student engagement.

Form the mid-phase of observations, notable progress was highlighted across the different areas. Teachers began to build a wider range of digital resources into their teaching lessons. For that, presentations and multimedia such as YouTube videos, topic-specific infographics, and downloadable PDFs were more organized. Those resources were mostly shared in immediately after class platforms. As one observer noted, "*The teacher used a video and PowerPoint to introduce the teaching topics and followed it with a class discussion based on the used content. Similarly, revised version of digital content like: pdf, word, ppt, web-blogs were also uploaded*." For the collaboration, teachers started to involve learners using shared Google Docs and group submission formats. However, if the tools were made easily available, the collaboration remained largely teacher-driven like lecture method. Furthermore, as highlighted in observation, "*The teacher prepared and shared Google Doc for learners to submit their assigned work, but there was no any peer review, follow-up discussion and facilitation*." For engagement of learners, some teachers began integrating digital activities like Kahoot, quizzes, mentimeter, quiz's introductions to lessons. This assisted initial interest, though implementation was not always consistent. Another observer commented, "*The teacher conducted a five-question quiz using Kahoot, and learner responded actively with their interest*." For collaboration and engagement content sharing, and satisfactory ratings for both are earned for good ratings.

In the last phase of classroom observations, teachers were showed considerable growth in their understanding and application of technology in teaching. Here were use varied and advanced digital platforms for content created and delivering through tools like Prezi, Canva, and Google Slides. Moreover, they were also embedded video links and interactive web blogs elements. Teachers not only shared content but also highlighted the ethical aware of citing sources. An observer noted, "*The teacher created own and internet based animated presentation on Prezi and shared it with students via Google Drive, messengers, WhatsApp which included clickable links to supporting videos, text, imaged, and other hyperlink documents*." Teachers also facilitated discussions through LMS forums, group work on Google Docs, and messaging platforms for academic deliveries. Such change was clearly visible in another observation: "*The teacher assigned small groups to peers a found abstract in Google Docs, and students commented on each other's work before final submission."* Additionally, student engagement reached a high point on their lessons through interactive tools such as Quizizz, Mentimeter, and Padlet, as well as creative project-based activities. Students were not only participants on that but also involved in digital creators. A final observation quoted, "*Students worked in groups to create digital posters using Canva, then presented and received real-time peer feedback*." These rich, engaging, and participatory practices resulted in Excellent ratings for both content development and student engagement, and a good rating for digital collaboration.

Digital Resource Proficiency and Classroom Integration

Participants responses revealed to use of digital tools, particularly platforms like MS Teams, Zoom, Google Meet, and other online resources. Here, majority of participants were showed confidence in using digital tools for classroom teaching, professional development, and resource sharing and collaboration. For instance, participants shared:

> *Participants were used MS Teams for teaching, learning, sharing, collaboration, and professional tasks; from the schedule classes teacher were shared their materials using MS Teams, google platform and Zoom*. *MS Teams, Google Meet, and Zoom help me enhance collaboration and coordination*

highlighting tools are benefited for integration into their regular academic routines with the help of collaboration and coordination. Various participants were demonstrated that initiative and self-motivated adopting digital tools into classroom teaching. Many stated that:

> *Participants have learned to use varied digital applications through self-motivated and exploration of subject specific content*; *they are found highly enthusiastic and self-determined for using digital tools into their subjects domain*.

These views supported for proactive attitude toward digital proficiency and continuous development of learning. Furthermore, emerged of professional development found a strong theme, with individuals responses or reporting on active participation in web based seminar, online courses, and virtual conferences. Participant mentioned:

> *By participating webinars and meeting participants have got professional development through various digital tools like Zoom, Google Meets, MS Teams, etc.*; *participants consistently focus on professional development through digital means*.

Vairous valuable digital tools were found for organization and collaboration into purposes in professional development using such applications: Google Calendar, OneNote, and sharing platforms such as google drives, OneDrive and so on. Participants noted:

> *They use sticky notes, notepad, scheduling, room management, calendars, OneNote, sharing, and such platform were includes on MS Teams, Google Meet, and Zoom for teaching and professional activities.*

Which was indicating efficient management of academic responsibilities.

However, limiting familiarity, and contraints some participants admitted to limited use and incomplete familiarity, such as:

> *they are not used to all digital tools yet," and "their uses of digital tools is average, not excellent*. *So, online classes are not available for bachelor levels because of institutional challenges such as no Wi-Fi in classrooms; limited digital resources.*

Which highlighted that infrastructural gaps is the hinder optimal use of technologies into classroom teaching. From there few expressed there is need for training and supported from institutional with remarks like:

> *They expect digital professional enhancement workshops support from their institution to improve faculties digital skills, also, requested that Wi-Fi availability and access to the institution, similarly, training on newly available digital tools by integrating into content specific digital tools for better teaching*.

So, from these insights focuses policy and administrative infrastructure in sustaining technology friendly digital transformative classroom in 21st demanded education.

From the first observation phase, the respondent highlighted a satisfactory on competence in using digital tools to manage and organize class activities. Although, Google Meet for live teaching, sharing of notes via email were less

visible into the classroom structure because of digital environment. Daily usable tools like scheduling on calendars platforms were less utilized. As one noted that, "*The teacher shared class links through different application like messanger, WhatpsApp, viber, etc. apps but there is a lacked centralized digital organization like LMS.*" This showed a demand for more digital integrated use of digital platforms into classroom. However, by the middle-phase, few changes were observed, and also earn good rating to the instructor. The instructor began actively using reminders on Google Calendar and share notes through Google Drive, maintained an organized assignments. As notified in one observer's remark, "*Digital contents are shared frequently and consistently, and through calendar students were invites and aware of regular class scheduling and activities resources*." In the last observation, significant digital tools had evolved to reaching out an Excellent level. For class session start and manage platforms like MS Teams, google meet were used. Another observation focused, "*for timely and well scheduling reminder of everything like classes, assignments, and feedback sessions*." From this reflection instructor's are gradually growing their proficiency and commitment to integrated technology into classroom management.

In terms of accessing and utilizing online educational resources and professional development content, the initial phase also showed a Satisfactory rating. While basic digital materials such as textbook PDFs were used, the instructor did not initially incorporate diverse or up-to-date online content. This limited exposure to current developments in the field. As one observer commented, "*Content is mostly static, with few references to current online resources*." However, during the mid-phase, the instructor showed marked progress, engaging with platforms such as ResearchGate and incorporating YouTube educational videos into teaching plans, resulting in a good rating. Students were introduced to Massive Open Online Courses (MOOCs) and other online courses to share content. One observation noted, "*The instructor shared updated digital materials and even guided students to explore Learning Management System (LMS)*". By the final observation, the instructor had attained an Excellent level of proficiency, integrating peer-reviewed research articles and training content from online professional development platforms into lessons. A teacher observer highlighted, "*The content was rich and up-to-date, reflecting recent educational research and professional learning experiences*." This demonstrated the instructor's proactive use of technology to enrich both teaching and student learning.

Regarding the instructor's collaboration with external stakeholders for accessing e-resources, initial observations showed limited efforts, resulting in a Needs Improvement rating. The instructor primarily relied on freely available materials and had not yet engaged with authors, publishers, or institutional libraries to source quality resources. One observer stated, "*No efforts were seen in acquiring or recommending institutionally subscribed content*." In the mid-phase, some positive changes were noted, moving the rating up to Satisfactory. The instructor began recommending Open Educational Resources (OER) and reached out to the university library for additional content. As noted in the comments, "*Instructor shared useful OER links but still lacked formal collaboration with publishers or authors*." By the final observation, the instructor had progressed to a good level. There was evidence of interaction with the university's digital library and communication with educational content providers to obtain permission for sharing specific materials. One feedback remarked, "*We received additional reading materials through links shared by the teacher after contacting the digital library team*." This final phase showed that the instructor had begun to leverage external networks to support academic and professional development through curated e-resources.

During the initial observation phase, the instructor showed basic competence in using digital tools, such as Google Meet and email, but lacked a structured digital environment, leading to a Satisfactory rating. By the mid-phase, noticeable improvements were made with the use of Google Calendar and organized sharing via Google Drive, earning a good rating. In the final phase, the instructor demonstrated Excellent proficiency, effectively managing classes using MS Teams and Google Meet, with timely reminders and well-structured scheduling. Similarly, in accessing and utilizing online resources, the instructor progressed from using static PDFs to integrating MOOCs, YouTube videos, and peer-reviewed research articles, significantly enriching content. Collaboration with external stakeholders also improved, evolving from limited engagement to actively using university library resources and OERs. Overall, the instructor showed steady growth in digital classroom management, content enrichment, and external resource collaboration.

Enhancing Digital Content Creation and Classroom Integration

The result exposed that most participants actively engage in digital content development, utilizing a variety of tools like MS Word, PowerPoint, AI tools, Google Workspace, and LMS platforms. Majority of participants stated:

> *They prepare and share educational content as required using PowerPoint and LMS*; *They use word processors, PowerPoint, and LMS for content development.*

showcasing consistent integration of digital tools into their academic routines. The use of AI was also evident, with participants mentioning:

They use AI for grammar checks and PowerPoint for lectures and workshops; and *They can create PowerPoint presentations and use AI and LMS, although they consider it more as digital familiarity than professional development*.

suggesting a developing but cautious approach to AI integration.

Multimedia and interactive tools were also widely adopted. For example, Majority shared:

They can create videos, animated pictures, diagrams, and more using PowerPoint, AI, and other platforms; They use tools like Google Docs, PPT, and track changes, along with interactive features like emojis, transcription, hand raise, mute, and screen sharing.

These responses demonstrate an awareness of how interactive features can enhance student engagement.

Several participants reported using LMS (e.g., Moodle, Google Classroom) for content delivery, interaction, and assessment. Participants stated:

They use Moodle for managing educational content and courses; They contribute to LMS development at both the college and course level, including in MESDP.

This indicates not only usage but also active involvement in digital content infrastructure development.

Participants also discussed professional growth through digital tools, such as webinars, tutorials, and peer support. Participants shared:

They start by reading user manuals, watching tutorials, and solving problems with friends' help; *They engage in professional development by attending webinars and using e-resources.*

The effort toward self-directed learning highlights a strong professional ethic.

However, uncooperative views and challenges also emerged. For instance, participants mentioned:

They haven't used all tools in an integrated way but am willing to use them if campus provides structured support.

showing interest hindered by lack of institutional facilitation. Participants shared:

Although I believe in tech-integrated learning, I haven't fully mastered LMS yet; They notice a lack of collaborative culture in content creation among educators in Nepal.

These statements reflect gaps in training, practice, and culture that may limit the potential of digital tool adoption.

During the initial observation phase, the instructor demonstrated a Satisfactory level of competency in creating and sharing course-related digital materials. Basic tools like Microsoft Word and PowerPoint were used to develop content. However, more dynamic tools such as video tutorials or LMS platforms were largely absent. As one observer noted, "*The content is informative but limited to basic formats like Word documents and simple slides without much multimedia integration*." By the mid-phase, the instructor showed visible improvement, moving up to a good rating. They began incorporating voice-over PowerPoint slides and short video tutorials uploaded to YouTube. In addition, materials were shared using Google Drive and Padlet, which allowed collaborative access among students. One observation found, "*The videos really helped clarify the topic, and the shared Padlet board kept everything organized*." By the final observation, the instructor's performance reached an Excellent standard. Course content was creatively developed using various formats including instructional videos, infographics, interactive slides, and shared regularly through an LMS and collaborative platforms like Google Docs. An observer remarked, "*The teacher's use of visual and video materials really enhanced student understanding, and the LMS integration was seamless.*" This progressive development clearly showcased the instructor's evolving digital literacy and skills in content creation.

Regarding the development of digital assignments and the evaluation of student submissions using tools like Google Classroom, the instructor's performance was rated Needs Improvement during the initial phase. Assignments were mostly given and submitted in hard copy, and there was limited use of digital tools for feedback or assessment. As noted by an observer, "*The teacher uses physical formats for assignments, and there is no digital submission or tracking system in place*." However, by the mid-phase, there was a notable shift to using Google Forms for quizzes and initiating online discussions via WhatsApp and Google Classroom. The instructor's rating improved to Satisfactory, with feedback becoming more prompt and organized. A reflected observation, "*The little be like to submit their answers through Google Forms and get quick feedback from the same platform.*" By the final observation, the instructor's rating improved to Good, with assignments regularly posted on Google Classroom, and assessments managed using built-in tools like rubrics, auto-grading, and comment features. One observer noted, "*Assignment submissions and feedback were timely, and students could track their progress easily through Google Classroom*." While there was still room for further refinement and creativity in assessment design, the progress made reflected growing digital competence.

When it comes to integrating AI tools and collaborative platforms such as Google Docs and Office 365 for content development and tutorial management, the instructor's initial use was Not Observed. There was no evidence of AI-assisted content or real-time collaborative documents being used in classroom instruction or preparation. As stated in one remark, "*There was no mention or demonstration of AI tools or document sharing for collaborative editing*."

However, during the mid-phase, there was a shift, and the rating moved to Satisfactory. The instructor began exploring Google Docs for sharing editable lesson plans and occasionally used Grammarly and ChatGPT to enhance content clarity. A teacher observer noted, "*Some responses and explanations appeared better organized, possibly with the help of AI writing assistants*." By the final observation, the use of collaborative and AI tools was rated Good. Course materials were co-created with students on shared documents, and the instructor used AI tools like ChatGPT and QuillBot to develop summaries, quiz items, and lesson outlines. As highlighted, "*Our teacher used ChatGPT to prepare model answers and shared editable documents for group notes.*" The integration of these technologies not only improved content delivery but also fostered collaboration and modernized the learning experience.

Participants actively used digital tools like MS Word, PowerPoint, AI applications, Google Workspace, and LMS platforms for content development, showing growing digital engagement and self-driven learning. Despite this progress, challenges such as limited mastery, lack of institutional support, and weak collaboration were noted. Classroom observations confirmed these patterns, revealing steady improvement in digital content creation, assessment, and use of AI and collaborative tools, reflecting increasing digital competence and the need for continued support and training.

Digital Resource Utilization and Management

The responses revealed a strong feeling toward using PowerPoint, AI tools, e-textbooks, and digital libraries for content development and teaching. Many participants emphasized effective organization and access to digital resources. Participants shared:

> *They prepare different folders and use the ones that are needed, they manage their resources by creating different folders*; *others categorizing materials by themes or topics for ease of access.*

This shows a trend of systematic digital content management that supports both teaching and learning.

PowerPoint remains the most frequently cited tool across participants for preparing and delivering lectures

> *They use PowerPoint to create visually engaging presentations and manage e-textbooks by arranging them systematically*; *They design PowerPoint presentations with engaging visuals, animations, and embedded videos to simplify complex ideas*

This reflects not only familiarity but also creativity in using presentation tools to enhance classroom delivery.

The integration of AI and collaborative platforms is another noteworthy trend for utilizing resources. participants stated,

> *They use PowerPoint, tutorials, AI tools, and collaborative platforms like Google Workspace to create engaging lessons and share resources*; *They use PowerPoint, AI, and collaborative platforms to teach and share content, and I organize e-textbooks and digital libraries for accessibility*.

These comments highlight the evolving digital competence of educators who are moving beyond static tools to more interactive and AI-supported teaching methods.

Participants also acknowledged the role of digital tools in student engagement

> *They use digital tools to clarify concepts, enhance teaching efficiency, and improve student engagement; Digital tools also support my career development*.

pointing to the broader benefits of technology beyond the classroom.

However, limitations and unmet needs were also identified. Some educators admitted, *They have limited knowledge about e-textbooks and digital libraries; Although they use digital tools in teaching, their overall usage has been minimal and needs enhancement*; *structural support to improve their effectiveness, they expect more support from their university*.

These statements suggest that institutional backing and training remain crucial factors in ensuring effective digital tool integration.

The classroom observation focused on how effectively the instructor utilized digital resources across three key stages: initial, mid, and final. In the beginning, the instructor mainly relied on PowerPoint presentations, with minimal use of interactive or advanced digital tools. This indicated a teacher-centered, lecture-based approach with limited student engagement through digital platforms like Padlet or Google Docs. By the mid-phase, the instructor began integrating collaborative tools such as Padlet and Google Docs, encouraging group participation and interaction. AI resources like ChatGPT were also explored for tasks like summarizing content and creating quizzes, reflecting an expanding digital toolkit. Students responded positively to these tools, noting increased interactivity and real-time collaboration. In the final phase, digital tools were used more strategically AI was applied to simplify complex concepts, and collaborative platforms supported peer discussions and shared content editing. Observers noted a well-developed collaborative learning environment, demonstrating the instructor's improved competency in leveraging digital platforms to enhance teaching and learning.

Alongside this, the instructor's methods for sharing digital content showed clear progress. Initially, materials were shared through informal platforms such as group messaging apps and emails, leading to scattered and unstructured

access. As students struggled to manage the disorganized content, the instructor gradually adopted a Learning Management System (LMS) by the mid-phase, providing centralized access to videos, e-books, and class materials. Students appreciated the improved accessibility and organization. While this system continued through the final phase, the instructor still did not fully incorporate digital libraries or broader academic repositories, limiting the variety and depth of available content. Feedback suggested that integrating more curated, scholarly sources could further strengthen content quality. Overall, the instructor showed good digital sharing practices, with scope for deeper academic resource exploration.

In terms of digital resource management, the instructor initially faced challenges with unstructured file storage, which often caused interruptions during lessons. As the observation progressed, improvements were evident. Files were systematically arranged in labeled Google Drive folders and linked to the LMS, making access more efficient. By the final phase, course materials were clearly labeled by topic and week and accessible to all students. However, the instructor still underutilized institutional digital libraries, academic databases, and advanced archiving tools. One observer noted that while the LMS was well-organized, further integration with academic repositories would enhance its academic value. Overall, the instructor demonstrated steady improvement in organizing and managing digital content, earning a positive evaluation with clear opportunities for continued enrichment through more extensive digital resource utilization.

Ethical use of Digital Tools

The responses reflected varying levels of awareness and application of digital ethics among participants. Many participants demonstrated a clear understanding of ethical digital behavior. Majority stated:

> *They prepare digital content carefully and think whether it is ethically right before sharing with others; They follow copyright laws and prefer to use open access and properly licensed resources*.

These responses reflect responsible digital practices, including citation, copyright respect, and attribution. Several respondents reported using AI tools and videos while ensuring ethical considerations:

> *They use videos, AI tools, and platforms for teaching while ensuring safety, digital ethics, and copyright compliance; they cite sources and use content information with appropriate attribution*.

Participants also highlighted awareness of plagiarism and research ethics, stating:

> *They include reference lists and maintain academic honesty*; *they avoid plagiarism and cite sources properly. Some explicitly follow institutional or licensing guidelines: they follow institutional cyber policies for content use; they follow licensing policies like Creative Commons (CC) when using or sharing content*

These practices indicate a positive trend toward academic integrity and policy-based content sharing.

Online safety and digital security were also acknowledged. Participant stated:

> *They never share personal information or passwords online and practice online safety; they recognize cyberbullying, phishing, and data threats, and practice online caution.*

These views demonstrate an understanding of risks associated with digital engagement and a commitment to maintaining safe digital environments for both teachers and learners.

However, a number of responses exposed knowledge gaps and inconsistencies in practice. Some admitted,

> *They have no idea about digital ethics; Although they try, they have not always been successful in maintaining complete digital ethics*; *Sometimes, they act randomly and may not fully follow ethical guidelines.*

Such statements point to inconsistent application of ethical standards, which could compromise content credibility and learner safety.

Additionally, financial limitations and access barriers were mentioned:

> *As a layperson, they sometimes use videos and recorded lectures, but they can't always afford licensed materials*.

This highlights a contextual constraint that may limit full adherence to copyright and licensing policies, even when there is awareness and intent.

In terms of digital safety and ethical handling of content, the instructor initially lacked awareness of copyright guidelines, digital identity protection, and safe online practices. Observations revealed that image sources were uncredited and students were not instructed on cybersecurity. Consequently, the rating for this phase was Needs Improvement.

By the mid-phase, the instructor responded to earlier gaps by incorporating discussions on cyberbullying, phishing, and the importance of verifying sources. Copyright practices improved, and students were advised against unauthorized copying. Observers noted increased emphasis on citation and responsible content use.

In the final stage, the instructor adopted robust digital safety practices. Copyright-cleared visuals were used, student work was protected through watermarking, and technical guidance was provided to support safe file management.

One observer highlighted that students learned to protect files and recognize harmful links, contributing to a more secure learning environment. These efforts reflected a strong ethical stance and digital responsibility, improving the final rating to Good.

In conclusion, the findings reveal a positive but evolving trajectory in the responsible and ethical use of digital tools for content creation and sharing. Many participants demonstrated strong awareness of digital ethics, including proper copyright compliance, safe use of AI tools, and adherence to institutional policies. Their reflections indicate a commitment to academic honesty, online safety, and respectful content sharing. Classroom observations further confirmed this trend, with instructors increasingly integrating ethical practices such as using copyright-cleared materials, setting appropriate access controls, and fostering digital responsibility among students. However, gaps remain some participants reported limited understanding, inconsistent application, or constraints due to financial and technical barriers. These challenges highlight the need for continued support and capacity building, particularly in areas such as AI ethics, licensing, and cybersecurity. Overall, the results underscore the importance of embedding ethical digital practices into both teacher training and classroom implementation to ensure safe, inclusive, and credible digital learning environments.

Discussion

The qualitative analysis was based on classroom observations and focused on areas like Digital Transformation in Teaching Practices, Digital Resource Proficiency and Classroom Integration, Enhancing Digital Content Creation and Integration, Digital Resource Utilization and Management, and the Ethical Use of Digital Tools.

Research on digital technology in education suggests that teacher educators' use of digital resources varies across professional development, collaboration, and instructional activities (Rana et al., 2024; Zinger, 2017). Participants' reflections highlighted purposeful technology use in classrooms, particularly peer-supported content creation emphasizing consultation, collaboration, and networking. However, gaps existed in motivation to explore beyond familiar tools. Guided by these reflections, classroom observations examined teachers' preparation of digital materials, integration strategies, and sustained use of technology. Observations revealed progression from static, teacher-centered practices to interactive, student-centered approaches, with growing use of collaborative platforms and increased student participation. Strong familiarity with tools like MS Teams, Zoom, and Google Meet was evident, though barriers such as poor infrastructure and lack of training persisted. These findings resonate with previous research emphasizing that digital integration depends on both skill and systemic support (Tunjera, 2019).

Observation results confirmed the instructor's progression in digital transformation from Satisfactory to Excellent. Early use of basic tools (Google Meet, email) evolved to effective use of Google Calendar, Google Drive, and MS Teams. Content utilization shifted from static PDFs to MOOCs, YouTube, and peer-reviewed resources. Collaboration advanced from minimal engagement to meaningful use of OERs and the university digital library. Content creation expanded from MS Word and PowerPoint to AI applications, interactive slides, instructional videos, and LMS integration. Digital assessment moved from hard-copy submissions (Needs Improvement) to structured Google Classroom use with rubrics and auto-grading (Good). The most significant improvement was in AI and collaborative platforms, progressing from Not Observed to Good (e.g., ChatGPT, QuillBot, Google Docs). Despite progress, challenges such as limited mastery, institutional support gaps, and underdeveloped collaboration persisted. These results confirm the need for sustained capacity-building to consolidate digital gains and achieve consistent teaching excellence (Xie, 2017).

Digital ethics showed steady improvement, moving from Needs Improvement in the initial phase to Good by the final stage. Early gaps, such as uncredited visuals and lack of cybersecurity guidance, were addressed through interventions on phishing, cyberbullying, and proper citation. By the final stage, participants applied copyright-cleared materials, watermarked student work, and followed safe file management practices. These improvements enhanced classroom safety and fostered students' awareness of ethical content use. Nonetheless, uneven understanding and limited AI ethics application highlight the ongoing need for targeted support in cybersecurity, licensing, and responsible AI use (Livingstone et al., 2018).

Overall, the findings demonstrate a positive trajectory in digital integration, with strong core competencies, growing awareness of ethics, and emerging use of advanced tools. While gaps remain in LMS management, AI integration, content creation, and collaboration, continued professional development, institutional support, and mentorship can strengthen digital fluency and teaching excellence (Gupta et al., 2024; Lyngdoh, 2025).

Conclusion

The study concludes that Nepalese teacher educators possess moderate to high digital competencies but face challenges in advanced digital integration, collaborative tools, and structured LMS use. While educators showed progressive improvement in digital classroom integration evolving from static PowerPoint usage to interactive tools their adoption of structured LMS and ethical digital practices remained inconsistent. These results support the Technological Pedagogical Content Knowledge (TPACK) framework, emphasizing that effective digital integration requires more than technical skills; it demands pedagogically driven training. For instance, while many educators could create presentations, few effectively used AI or LMS platforms to enhance student engagement. This suggests that institutional support and professional development are crucial for bridging the gap between digital awareness and practical implementation.

To enhance digital transformation in Nepalese higher education. Institutional Support for Digital Infrastructure must provide reliable Wi-Fi, LMS access, and AI-enabled tools. Mandatory training on AI, video editing, and digital collaboration tools (e.g., Canva, Kahoot) should be introduced. Workshops on ethical digital practices, such as copyright compliance and cybersecurity, are also essential. Teacher education programs should include digital literacy modules, emphasizing blended learning approaches that combine online and offline resources. Regular digital competency assessments for faculty and policy audits to ensure equitable access to digital resources will help sustain progress.

These recommendations align with Nepal's National Education Policy (2019), which emphasizes technology-integrated education (MOE, 2019). For instance, if universities implement structured LMS training, educators could transition from email-based resource sharing to organized digital classrooms, improving accessibility and engagement.

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References

Al-Adwan, A. S., Li, N., Al-Adwan, A., Abbasi, G. A., Albelbisi, N. A., & Habibi, A. (2023). Extending the technology acceptance model (TAM) to predict university students' intentions to use metaverse based learning platforms. *Education and Information Technologies.* https://doi.org/10.1007/s10639-023-11816-3.

Alam, S. S., Makmor, N., Masukujjanman, M., Makhbul, Z. K. M., Ali, M. H., & Mamun, A. A. (2023). Integrating the social support theory and technology acceptance model of social commerce websites. *Special Issue. Entrepreneurship in the age of the digital economy 32*(2). https://doi.org/10.15304/rge.32.2.8558

Alblooshi, S., & Hamid, N.A.B.A., (2021). The role of unified theory of acceptance and use of technology in e-learning adoption in higher education institutions in the UAE. *IBIMA Publishing* 2021 (2021) https://doi.org/10.5171/2021.730690

Almulla, M (2021). Technology Acceptance Model (TAM) and e-learning system use for education sustainably. *Academy of Strategic Management Journal 20*(4). https://shorturl.at/esyTY

Aslam, R., Khan, N., Asad, M.M. & Ahmed, U. (2021). Impact of technological pedagogical content knowledge on teachers' digital proficiency at classroom in higher education institution of Pakistan. *Interactive Technology and Smart Education, 18*(1), 119-130, https://doi.org/10.1108/ITSE-11-2020-0222

Basilotta-Gómez-Pablos, V., Matarranz, M., Casado-Aranda, LA., Otto, A., (2022). Teachers' digital competencies in higher education: a systematic literature review. *International Journal of Education Technology in Higher Education 19* (8). https://doi.org/10.1186/s41239-021-00312-8

Camilleri, M. A., & Camilleri, A. C. (2017). Digital learning resources and ubiquitous technologies in education. *Technology, Knowledge and Learning, 22*(1), 65-82. https://doi.org/10.1007/s10758-016-9287-7

Cebi, A., Özdemir, T. B., Reisoğlu, I., Çolak. C. (2022). From digital competences to technology integration: Reformation of pre-service teachers' knowledge and understanding, *International Journal of Educational Research. 113.* https://doi.org/10.1016/j.ijer.2022.101965.

Chung, J. H. J., & Wei, X., (2020). Teach effectively or guide wisely? Discussing the application of wisdom approach to language teaching in Thai higher education. *International Journal of Language Education. 4*(3). 322-333. https://doi.org/10.26858/ijole.v4i3.15097

Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. *Journal of Educational Technology Systems, 49*(1), 5–22. https://doi.org/10.1177/0047239520934018

Dinc, E. (2019). Prospective teachers' perceptions of barriers to technology integration in education. *Contemporary Educational Technology. 10*(4), 381-398. https://doi.org/10.30935/cet.634187

Germuth, A. A., (2018). Professional development that changes teaching and improves learning. *Journal of Interdisciplinary Teacher Leadership 2*(1), 77-90. https://doi.org/10.46767/kfp.2016-0025

Gomez, F. C., Trespalacios, J., Hsu, YC. & Yang D., (2022). Exploring Teachers' Technology Integration Self-Efficacy through the 2017 ISTE Standards. *TechTrends* 66, 159–171. https://doi.org/10.1007/s11528-021-00639-z.

Gupta, M., Kumar, P., & Mishra, A. (2024). A Review of the Discussion on Digital Transformation in Higher Education. *Digital Transformation in Higher Education, Part B: Cases, Examples and Good Practices*, 197-229.

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operation and Computers 3*. 275-285. https://doi.org/10.1016/j.susoc.2022.05.004

Hubers, M. D., Endedijk, M. D., & Veen K. V., (2022), Effective characteristics of professional development programs for science and technology education. *Professional Development in education. 48*(5). 827-846. https://doi.org/10.1080/19415257.2020.1752289.

Kaputa, V., Loučanová, E., Tejerina-Gaite, F.A. (2022). Digital Transformation in Higher Education Institutions as a Driver of Social Oriented Innovations. In: Păunescu, C., Lepik, KL., Spencer, N. (eds) Social Innovation in Higher Education. Innovation, Technology, and Knowledge Management. Springer, Cham. https://doi.org/10.1007/978-3-030-84044-0_4

Khanom, M., Hoque, A., Sharif, P. I., Uddin, A. T. M. M., Hossain, A., Sabuj, M. U., (2021). Teachers' Perception on Virtual Teaching Learning Activities and Assessment: Web-based Study on a Non-Government Medical College in Bangladesh. *Bangladesh Journal of Bioethics*, doi: 10.3329/BJME.V12I1.52303

Khomenko, L. (2023). Professional development of the subject teacher in the conditions of digital transformation of education. *Scientific notes of Ternopil National Pedagogical University named after Volodymyr Hnatyuk. Series: pedagogy*, *1*(1), 111–120. https://doi.org/10.25128/2415-3605.23.1.14

Kitari, J, W., Buhere, P., Obaki, S., (2019). ICT infrastructure and Pupils Learning Outcomes: A Case of Matete Sub-County Primary Schools, Kakamega County. *International journal of scientific and research publications*, doi: 10.29322/IJSRP.9.10.2019.P9450

Koyuncuoglu, D. (2022). Analysis of digital and technological competencies of university students. *International Journal of Education in Mathematics, Science, and Technology (IJEMST), 10*(4), 971-988. https://doi.org/10.46328/ijemst.2583

Lawless, K. A., & Pellegrino, J. W. (2007). Professional development in integrating technology into teaching and learning: Knowns, unknowns, and ways to pursue better questions and answers. *Review of Educational Research*, *77*(4), 575–614. https://doi.org/10.3102/0034654307309921

Livingstone, S., Mascheroni, G., & Staksrud, E. (2018). European research on children's internet use: Assessing the past and anticipating the future. *New media & society*, *20*(3), 1103-1122.

Lyngdoh, M. D., & Kharbirymbai, B. B. (2025). Reconfiguring Teacher Identity In The Digital Age: A Critical Review Of Multi-Role Negotiation, Professional Challenges, And Emerging Opportunities In 21st-Century Education.

Lynn, T., Rosati, P., Conway, E., Curran, D., Fox, G., O'Gorman, C., (2022). Infrastructure for Digital Connectivity. doi: 10.1007/978-3-030-91247-5_6

Malil, R. S., (2018). Educational challenges in 21st century and sustainable development. *Journal of Sustainable Development Education and Research. 2*(1), 9-20.

Mtebe, J.S., & Raphael, C., (2018). Eliciting in-service teachers' technological pedagogical content knowledge for 21st-century skills in Tanzania. *Journal of Learning for Development, 5*(3), 263-279.

Okoye, K. Nganji, J. T., Escamilla, J., Fung, J. M., & Hosseini, S. (2022). Impact of global government investment on education and research development: A comparative analysis and demystifying the science, technology, innovation, and education conundrum. *Global Transitions, 4*. 11-27. https://doi.org/10.1016/j.glt.2022.10.001.

Osamwonyi, E.F., (2016). In-Service education of teachers: overview, problems and the way forward. *Journal of Education and practice. 7*(16).

Pinto, M., & Leite, C. (2020). Digital technologies in support of students learning in higher education: Literature review. *Digital Education Review. 22*, 343-360.

Poudel, P. P., (2015). Information and communication technologies and teacher educators of english in Nepal. *Journal of NELTA 20*(1), 27-33.

Rana, S., Sheshadri, T., Malhotra, N., & Basha, S. M. (2024). Creating Digital Learning Environments: Tools and Technologies for Success. In *Transdisciplinary Teaching and Technological Integration for Improved Learning: Case Studies and Practical Approaches* (pp. 1-21). IGI Global.

Regalado-Pezua, O. & Toro Galeano, M. L. (2022). From Face-to-Face Education to Online Education: Challenges at a Business School in Peru. In A. Zhuplev & R. Koepp (Eds.), *Global Trends, Dynamics, and Imperatives for Strategic Development in Business Education in an Age of Disruption* (pp. 149-170). IGI Global. https://doi.org/10.4018/978-1-7998-7548-2.ch008

Samaniego Erazo, G. N., Esteve-González, V. & Vaca, B., (2015). Teaching and learning in digital worlds: strategies and issues in higher education. Publicacions Universitat Rovira i Virgili (1st Ed.).

Siswanto, D., Priyandoko, G., Tjahjono, N., Putri, R. S., Sebela, N. B., & Muzakki M. I. (2023). Development of information and communication technology infrastructure in school using an approach of the network development life cycle method. *Journal of Physics: Conference series.* https://doi.org/10.1088/1742-6596/1908/1/012026

Sothayapetch, P., & Lavonen, J. (2022). Technological pedagogical content knowledge of primary school science teachers during the COVID-19 in Thailand and Finland. *EURASIA Journal of Mathematics, Science and Technology Education. 18*(7), https://doi.org/10.29333/ejmste/12118.

Tunjera, N. (2019). *Teacher educators' instructional strategies in preparing pre-service teachers to teach with digital technology in the 21st century* (Doctoral dissertation, Cape Peninsula University of Technology).

Tusiime, W. E., Johannesen, M. & Gudmundsdottir G. B., (2022) Teaching art and design in a digital age: challenges facing Ugandan teacher educators. *Journal of Vocational Education & Training, 74*(4), 554-574. https://doi.org/10.1080/13636820.2020.1786439

Upadhayaya, P. R. (2022). Students' Perception towards Online Teaching Learning Activities During COVID-19. *Ganeshman Darpan, 7*(1), 26-38. https://doi.org/10.3126/gd.v7i1.53531

Upadhayaya, P. R. (2023). Information Communication Technology in Education: Bringing Innovation in Classroom. *Ganeshman Darpan, 8*(1), 96-110. https://doi.org/10.3126/gd.v8i1.57335

Venkatesh, V., Morris, M. G., Davis, G. B. and Davis, F. D. (2003). User acceptance of information technology: toward a unified view. *MIS Quarterly. 27*(3) 425–478.

Xie, K., Kim, M. K., Cheng, S. L., & Luthy, N. C. (2017). Teacher professional development through digital content evaluation. *Educational Technology Research and Development*, *65*(4), 1067-1103.

Yang, TC. (2023). Assessment of the digital competencies of university instructors through use of the machine learning method. *SN Social Sciences*. https://doi.org/10.1007/s43545-023-00617-7

Yilmaz, A., (2021). The effect of technology integration in education on prospective teachers' critical and creative thinking, multidimensional 21st-century skills, and academic achievements. *Participatory Educational Research (PER). 8*(2), 163-199. https://doi.org/10.17275/per.21.35.8.2

Záhorec, J., Hašková, A., Poliaková, A., & Munk, M. (2021). Case Study of the Integration of Digital Competencies into Teacher Preparation. *Sustainability, 13*. http://dx.doi.org/10.3390/su13116402

Zinger, D., Tate, T., & Warschauer, M. (2017). Learning and teaching with technology: Technological pedagogy and teacher practice. *The SAGE handbook of research on teacher education*, *1*, 577-593.