CJLT RCAT
Canadian Journal of Learning and Technology
La Revue canadienne de l'apprentissage et de la technologie

Volume 51 (1) Winter / Hiver 2025

Educational Technology Integration Strategies in Colleges of Teacher Education in Ethiopia

Stratégies d'intégration des technologies éducatives dans les établissements de formation des personnes enseignantes en Éthiopie

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Abstract

Research on educational technology (EdTech) integration has extensively explored determinants; however, strategies remain underexamined. Existing models predominantly focus on identifying the determinants of technology adoption yet fail to offer systemic frameworks for sustainable EdTech integration. This study bridges that gap by investigating strategies proposed by stakeholders in a college of teacher education, culminating in a theoretical framework. The research was conducted across four Ethiopian colleges of teacher education by employing a constructivist grounded theory. Data were collected through semi-structured interviews and document analysis, involving 23 participants selected through purposive and theoretical sampling. Data analysis was performed using MAXQDA (Version 2020) software. The results revealed six key strategies categorized into teacher-related, institution-related, and organization-related. A co-constructed theoretical framework illustrates the roles of various stakeholders in EdTech integration, underpinned by ecological systems theory, diffusion of innovations, and the unified theory of acceptance and use of technology. Credibility was ensured through a member-checking survey. The study advocates for further quantitative research to evaluate the correlation between strategies and educational technology integration outcomes, with replication across diverse contexts and stakeholders.

Keywords: Ethiopia, constructivist grounded theory, educational technology, teacher education, strategies

Résumé

La recherche sur l'intégration des technologies éducatives (EdTech) a largement exploré les déterminants, mais les stratégies restent sous-examinées. Les modèles existants se concentrent principalement sur l'identification des déterminants de l'adoption des technologies, mais ne parviennent pas à proposer des cadres de référence systémiques pour une intégration durable des EdTech. Cette étude comble cette lacune en examinant les stratégies proposées par les parties prenantes dans les établissements de formation des personnes enseignantes, pour aboutir à un cadre théorique. La recherche a été menée dans quatre établissements éthiopiens de formation des personnes enseignantes en utilisant une théorie constructiviste ancrée. Les données ont été collectées par le biais d'entretiens semi-structurés et d'une analyse de documents, impliquant 23 personnes participantes sélectionnées par le biais d'un échantillonnage raisonné et théorique. L'analyse des données a été réalisée à l'aide du logiciel MAXQDA (version 2020). Les résultats ont révélé six stratégies clés classées en trois catégories : liées à l'enseignant, liées à l'institution et liées à l'organisation. Un cadre théorique coconstruit illustre les rôles des différentes parties prenantes dans l'intégration des EdTech, étayé par la théorie des systèmes écologiques, la diffusion des innovations et la théorie unifiée de l'acceptation et de l'utilisation de la technologie. La crédibilité a été assurée par un sondage de vérification auprès des membres. L'étude préconise la poursuite des recherches quantitatives pour évaluer la corrélation entre les stratégies et les résultats de l'intégration des technologies éducatives, avec une reproduction dans divers contextes et auprès de diverses parties prenantes.

Mots-clés : Éthiopie, théorie constructiviste ancrée, technologie éducative, formation des personnes enseignantes, stratégies

Introduction

Digital educational technology (EdTech) is becoming an indispensable component of modern-day education. Multiple studies claim its importance for promoting student performance (Asratie et al., 2023; Saal et al., 2020) and teacher development (Hennessy et al., 2022). However, integrating EdTech is not without challenges (Scanlon, 2021). Many studies have addressed challenges in terms of technology infrastructure, technical support, equipment, and software (Maatuk et al., 2022), poor digital competence of teachers and students (Turnbull et al., 2021), and poor technology leadership (Elsholz et al., 2021). Further, there is a growing interest in exploring how EdTech can be effectively implemented in higher education (Ray, 2020).

Recent studies on EdTech integration in higher education have predominantly focused on identifying determinants, with limited attention devoted to formulating actionable strategies. While existing research offers discrete recommendations for key stakeholders (e.g., Chugh et al., 2023; Dexter & Richardson, 2020), the absence of a holistic, evidence-based strategy framework remains a critical gap in guiding comprehensive integration efforts. The problem worsens in developing countries where the culture of EdTech integration is at its early stage (Alemu, 2017). Deacon et al. (2023) indicated the existence of a scholarly gap in understanding the organizational layers involved in EdTech implementation in higher education.

Ethiopia is a developing nation and home to over 120 million people—Africa's second most populous country (World Bank, 2023). The government endorsed the Digital Ethiopia 2025 strategy to harness technology in various sectors, including education (Federal Democratic Republic of Ethiopia, 2020). However, poor Internet connection, inadequate information and communication technology (ICT) infrastructure, and poor digital competence deter digitalization in higher education (Adamu, 2024). A recent study on EdTech integration in colleges of teacher education (CTE) revealed the existence of systemic challenges including gaps in institutional readiness, teacher preparedness, ICT infrastructure, and disparities in digital literacy among educators and students (Woldemariam et al., 2025).

Teaching and learning activities in Ethiopian CTEs are confronted with various problems that affect the quality of education. Studies have argued that pedagogical insufficiencies lead to a decline in the quality of education (Mihiretie, 2023). Additionally, poor quality educational resources such as modules, inadequate facilities, low staff compensation, and academic staff commitment are some of the challenges (Nemomsa & Beyesa, 2023). The strategic integration of EdTech holds potential to mitigate systemic quality deficits in education by deploying adaptive digital solutions and evidence-based pedagogical frameworks. Ultimately, it enhances instructional efficacy and learning outcomes.

Despite the recognized potential of EdTech to improve teaching quality and address critical challenges in higher education in developing countries, research on actionable strategies is scarce. Current studies primarily address the determinants of EdTech integration (Ferede et al., 2022a), leaving a substantial gap in practical, context-specific strategies. This study aimed to fill this critical gap by exploring context-specific strategies and developing a theoretical framework. The resulting strategy framework could serve as a valuable resource for educational leaders, policymakers, and educators, offering structured guidance to promote EdTech integration.

The paper first details the grounded theory (GT) methodology used in this research. GT intentionally omits a traditional literature review phase to avoid preconceived theoretical biases; instead, emergent findings are inductively derived and integrated post hoc with the existing literature. The results consist of several co-constructed categories, verified through a member-checking survey, and we discuss the theory development, which consists of the emergent theory and theoretical mapping, and key findings with support from the literature and implications for policy and practice. Finally, this article concludes with the major findings, limitations, and future research avenues.

Methods

A qualitative research approach was employed to explore the insights of teacher educators (TEs), academic, research, and community service vice deans (ARVDs), and ICT directors into strategies for effectively integrating EdTech. Grounded theory is a qualitative methodology useful to understand insights and experiences affecting processes and events (Glaser & Strauss, 1999). Based on the aim of this study, constructivist GT was selected for exploring strategies and developing theoretical explanations (Charmaz, 2014).

Participant Information

According to the Ethiopian Ministry of Education (2023), 39 CTEs are distributed across 12 regional states. Our study includes four CTEs from four different states. A total of 23 participants (17 TEs, three ICT directors, and three ARVDs) were selected using purposive and theoretical sampling techniques. As constructivist GT follows an iterative approach, 7, 14, and 2 participants were involved in the first, second, and third phases of the study, respectively. Participants were selected from the language, natural and social science, information technology, education, and mathematics departments to ensure the depth and breadth of data. Table 1 summarizes the aggregated demographic characteristics of participants.

Table 1

Participant Demographic Information

Participant role	*n*	Qualification		Departments represented, *n*	Years of experience		
		MSc	PhD		*n*	*M*	*SD*
Teacher educator	17	14	3	6	5–25	15.5	5.5
Academic vice dean	3	2	1	2	4–5	4.7	0.58
ICT director	3	3	0	1	1	1	0

Note. Departments = total unique departments across roles (e.g., 6 departments for teachers). ICT = information and communication technology.

Data Collection

Data were collected using a separate semi-structured interview protocol developed for each data source (Charmaz & Belgrave, 2012). Domain area experts and supervisors validated the protocols before actual data collection. Additionally, the TE interview protocol was piloted with four participants from one of the CTEs. Face-to-face and online platforms were used, and the interviews were recorded and transcribed manually using MAXQDA software (Version 2020; https://www.maxqda.com/). To supplement the interview data, additional data were collected from the institution's strategic plan document.

Data Analysis

The constructivist GT data analysis involved coding, memo writing, constant comparison, and theoretical saturation (Charmaz, 2014). It started with data collected from the first teacher educator (TE1) and then iterated back and forth between new data and the previous until saturation was reached. The initial coding used gerunds and in vivo codes to represent the meanings and processes. Recurring initial codes were used to categorize related codes to form categories. This process continued until saturation was reached in each category. The categories reached saturation points at the 13th, 14th, and

15th TEs. Categorical saturation implies the point at which no new properties, dimensions, or insights emerge within a specific category (Charmaz, 2014).

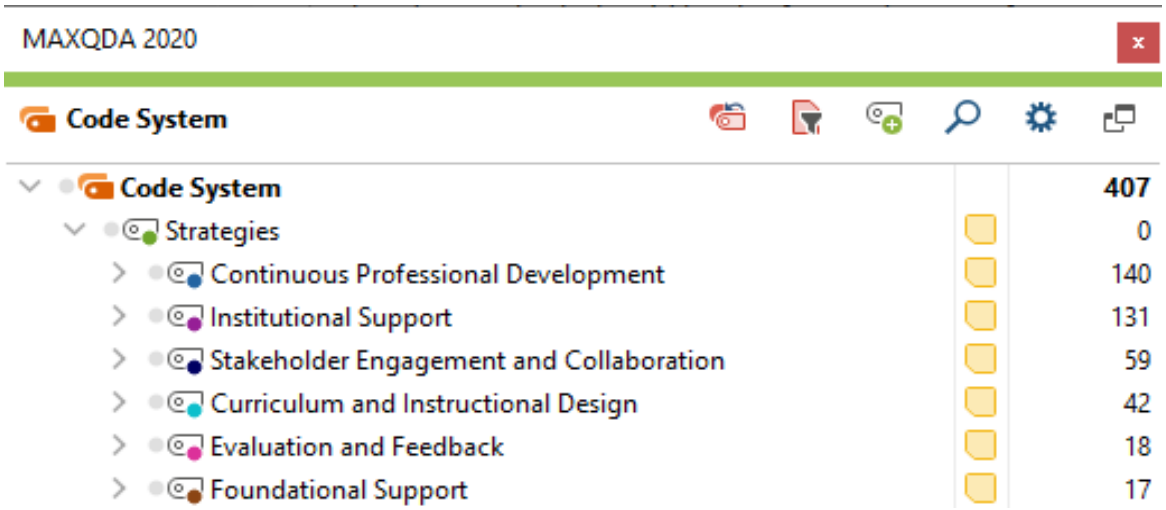
Next, core categories were constructed by connecting categories with related concepts. After interviewing and analyzing two more TEs (16 and 17), theoretical saturation was confirmed. Theoretical saturation is the stage at which further data collection and analysis no longer generate new theoretical insights (Saunders et al., 2018). Despite caution to not impose prior understandings during the initial stages of analysis, we believe that our preconceived concepts, experiences, and theoretical perspectives affected our interpretations. The constructivist GT recognizes that researchers cannot fully bracket preconceptions but can transparently account for their role in knowledge co-construction (Charmaz, 2014). We employed strategies such as recording positionality memo, theoretical sampling, peer debriefing, member checking, and constant comparison to ensure participants' voices were truly incorporated. All data analysis activities were conducted using MAXQDA software.

Results

The core categories and subcategories that were co-constructed between the participants and the researchers are described. Six core categories were co-constructed through a high-level categorization of 23 subcategories (Figure 1). These included continuous professional development, institutional support, stakeholder engagement and collaboration, curriculum and instructional design, evaluation and feedback, and foundational support. We identified and categorized 407 coded segments, representing the categories, through rigorous, cyclic data collection and analysis. Evidence from the interview excerpts supported all findings. Furthermore, a member-checking survey was conducted to confirm the credibility of the key findings.

Figure 1

Number of Coded Segments Used to Determine Each Core Category



Continuous Professional Development

Continuous professional development (CPD) refers to the ongoing process of acquiring new skills, knowledge, and expertise that help TEs improve their teaching practices and, in this case, integrate EdTech. CPD consists of three subcategories: comprehensive training programs, professional development, and self-directed learning. CPD was the most common concept among the identified strategies, with 140 coded segments (34.4%). Table 2 shows the three subcategories with interview excerpts that support the findings.

Table 2

Subcategories of Continuous Professional Development

Subcategory	Coded segments		Example quote
	n	%	
Comprehensive training programs	68	48.6	"CTEs should plan trainings for all staffs." (TE1)
Professional development	54	38.6	"Updating self, filling the gap, giving continuous trainings, are very important." (TE14)
Self-directed learning	18	12.8	"I am exerting my effort to familiarize myself with the new technologies." (TE8)

Note. TE = teacher educator.

Comprehensive training programs are structured and systematic training provided by CTEs aimed at equipping educators with the necessary skills and knowledge for integrating EdTech. Most participants stressed the significance of training programs for integrating EdTech. For example, six TEs claimed that training on emerging technologies could help them prepare electronic lessons, animations, and simulations.

Professional development is an aspect of CPD that ensures educators maintain and enhance their teaching competencies throughout their careers. Almost all participants revealed the importance of professional development in becoming successful in EdTech integration. Further, a few participants highlighted the benefit of establishing staff development programs to foster EdTech integration.

Self-directed learning refers to the efforts of TEs to learn new skills and knowledge through personal initiatives, such as taking online courses, reading, and peer collaboration. It is a flexible and personalized element of CPD, allowing TEs to focus on areas of interest or need at their own pace. More than half the participants claimed it as an option for effectively integrating technologies in education. Five TEs emphasized the use of existing Internet connections to engage in self-paced training and acquire essential skills.

Institutional Support

Institutional support is crucial for creating an environment conducive to EdTech integration. It was the second most frequently perceived strategy with 131 coded segments (32.2%). As indicated in Table 3, this subcategory comprised different dimensions of support from the institution.

Table 3

Subcategories of Institutional Support

Subcategory	Coded segments		Example quote
	n	%	
Leadership support	31	23.7	"The leadership tries to facilitate the materials needed for EdTech in our college." (TE13)
IT infrastructure development	24	18.3	"Internet access should be in every corridor of the college, and even teachers should have their own laptop." (TE4)
Strategic planning	21	13.7	"In addition to clear vision, the college should have a clearly prepared strategic plan." (TE8)
Resource provision	19	14.5	"The college should try to avail different apps for supporting teaching and learning practices." (TE7)
Student support	12	9.2	"It would be good to provide trainings to develop the technology knowledge and skills of students." (TE15)
Technical support	11	8.4	"Experts who are well trained must be standby always to support TEs when they face a challenge while utilizing those technologies." (TE3)
IT facility development	9	6.9	"The college should plan to install digital technologies in the classrooms." (ICT director 2)
Policy development	4	3	"It needs some rules which should be developed and included in the college's laws to facilitate the use of technologies." (TE10)

Note. TE = teacher educator; IT = information technology; ICT = information and communication technology.

Leadership support highlights the role of administrative support, budget allocation, facilitation, and cultural shifts within an institution to promote and sustain the integration of EdTech. Four TEs described its key role in facilitating technology integration.

IT infrastructure development in terms of hardware, software, and the Internet plays a significant role in effective EdTech integration. Such tools must be provided in sufficient amount and strength to

accommodate every faculty member. Nine of the interviewed TEs indicated the strategic benefit of IT infrastructure development in CTEs to facilitate EdTech integration.

Strategic planning involves defining long-term goals, objectives, and actions for integrating EdTech within an institution, aligning these goals with that institution's overall mission and vision. Seven TEs, one ARVD, and one ICT director stated that EdTech integration should be adopted as a strategic direction.

Resource provision refers to the allocation of material resources, such as educational software, computers, projectors, and access to digital content, to support EdTech initiatives. Similarly, this category of institutional support was highlighted by seven TEs and two ARVDs.

Student support refers to providing services and resources, such as training, resources, and academic advice, to help students effectively use EdTech. Out of the 17 TEs involved in the interview, seven argued that student support is key to facilitate the effective integration of EdTech in CTEs.

Technical support involves the provision of ongoing technical assistance to TEs, including technical and user support. Several participants stated that technical support could facilitate the path toward effective integration of EdTech. One college administrator and two ICT directors indicated their commitment to providing technical support to facilitate the integration of EdTech in CTEs.

IT facility development refers to creating or upgrading physical spaces such as computer labs, smart classrooms, and collaborative learning environments. For instance, One TE claimed the importance of organizing classrooms with Internet access for EdTech integration. Overall, six participants stated the importance of having technology-enabled classrooms, digital libraries, and computer laboratories to promote technology integration.

Policy development involves the development and implementation of policies to guide the effective integration of EdTech. Our findings revealed that CTEs do not have institutional policies to govern technology use. One TE expressed the opinion that rules or guidelines should be developed and integrated into each CTE's laws to facilitate technology integration.

Stakeholder Engagement and Collaboration

This core category emphasizes the active involvement and cooperation of various internal and external stakeholders in the process of integrating EdTech. It was the third most frequently mentioned core category, with 59 coded segments (12.5%). As shown in Table 4, this category comprises resource use, stakeholder collaboration, stakeholder engagement, experience sharing, and external support.

Table 4

Subcategories of Stakeholder Engagement and Collaboration

Subcategory	Coded segments		Example quote
	n	%	
Resource use	19	32.2	"I usually use Google Classroom to assist my students in the classroom." (TE6)

Subcategory	Coded segments		Example quote
	n	%	
Stakeholder collaboration	14	23.7	"The college has to work with different stakeholders to effectively integrate EdTech." (TE17)
Stakeholder engagement	10	16.9	"The college should seriously engage and plan to prepare a kind of training, assign technicians for this service, and engage the TEs through continuous practice with the help of those technicians." (TE3)
Experience sharing	8	13.6	"Experienced teachers should share their experience among the college staff." (TE1)
External support	8	13.6	"The government should finance CTEs to get ample resources." (TE4)

Note. TE = teacher educator; CTE = college of teacher education.

Resource use refers to the effective use of existing resources, including personal, Internet, simple technologies, and educational software. Seven TEs and one ARVD stated that TEs should try to incorporate technologies that may be simple but essential for enhancing their teaching practices.

Stakeholder engagement involves stakeholders, including TEs, curriculum developers, EdTech experts, administrators, and ICT directorate staff, promoting EdTech integration. The significant role of engaging concerned stakeholders in designing EdTech-integrated activities, lessons, and contents was identified by four TEs.

Stakeholder collaboration refers to cooperation and coordination among various stakeholders to ensure the effective practice of EdTech. Four TEs as well as two of the ICT directors described the significant role of collaboration within an institution and beyond to bring a change in technology integration.

Experience sharing involves TEs' engagement in communicating their experiences, challenges, and successes with EdTech integration through formal or informal networks, communities of practice, and peer mentoring. Only three TEs discussed the importance of experience sharing among academic staff to increase EdTech integration practices.

External support refers to partnerships and collaborations with external entities such as government and nongovernmental organizations, EdTech companies, and educational institutions. The need for external support to reinforce institutional EdTech initiatives was mentioned by four TEs and one ICT director. Support in terms of funds, expertise, and infrastructure development was identified by two TEs.

Curriculum and Instructional Design

As presented in Table 5, this core category focuses on ensuring technology integration at the curriculum, course, and instruction levels. It was the fourth most frequently stated strategy, with 42 coded segments (10.4%). It reflects the need for a coordinated effort to redesign curricula, innovate instructional methods, and refine course offerings to meet the demands of technology-enhanced education.

Table 5

Subcategories of Curriculum and Instructional Design

Subcategory	Coded segments		Example quote
	n	%	
Curriculum redesign	32	76.2	"Especially the Ministry of Education and other stakeholders at a higher rank should consider EdTech integration in the curriculum." (TE5)
Instructional innovation	6	14.3	"One of the strategies is, due attention has to be given to technology, our teaching has to be based on technology, and we should have to use it." (TE1)
Course redesign	4	9.5	"The courses need to be integrated with technology." (TE10)

Note. TE = teacher educator.

Curriculum redesign refers to the modification of existing curricula to better integrate EdTech. More than 82% of participants identified the significance of redesigning the curriculum by incorporating technology. The revision should consider more about the practical aspects of technology use to enable TEs to become competent, according to one TE and one ICT director. Additionally, one TE said that curriculum developers should pay attention to incorporating EdTech into the curriculum and teaching materials.

Instructional innovation involves the adoption of new teaching and assessment methods, leveraging technology to create engaging, interactive, and effective learning experiences. For example, one TE indicated the positive aspect of integrating technologies with teaching methods and assessment techniques.

Course redesign involves revising the structure, content, and delivery of individual courses to incorporate EdTech effectively. Three TEs underscored the significance of incorporating technologies in each unit or specific lesson.

Evaluation and Feedback

This category refers to the systematic process of assessing the effectiveness of EdTech integration and providing actionable insights to improve teaching and learning practices. It focuses on evaluating EdTech integration efforts and advancing research in CTEs. Ranked as the fifth most significant strategy according to participants' comments, it comprised 18 coded segments (4.5%). Subcategories, along with illustrative interview excerpts, are detailed in Table 6.

Table 6

Subcategories of Evaluation and Feedback

Subcategory	Coded segments		Example quote
	n	%	
Assessment and feedback	12	66.7	"There should be a continuous follow up." (TE14)
Promotion of EdTech research	6	33.3	"The college should conduct different studies on lessons that are conducted with integration of EdTech vs. lessons taught using conventional methods of teaching." (TE1)

Note. TE = teacher educator.

Assessment and feedback involve the evaluation of TEs' integration of EdTech and provide data-driven feedback for their improvement. Findings revealed the absence of strategies to monitor and evaluate technology integration in CTEs, according to two ARVDs interviewed. However, participants stated its potential to ensure integration and sustainability.

The promotion of EdTech research refers to encouraging research activities aimed at exploring the effectiveness, challenges, and opportunities related to EdTech integration. It was claimed by three TEs and one ARVD that promotion of research would be a vital tool to explore the existing scenario and identify future directions.

Foundational Support

This core category highlights the importance of starting EdTech integration early in primary and secondary education to build a strong foundation for higher education. Although ranking last in the category of codes with only 17 coded segments (4.2%), foundational support was mentioned in the interviews at all study sites (Table 7).

Table 7

Subcategories of Foundational Support

Subcategory	Coded segments		Example quote
	n	%	
Early integration	13	76.5	"The curriculum has to accommodate technologies beginning from the lower level to higher education." (TE17)
IT infrastructure support	4	23.5	"The primary and secondary schools should be equipped with an IT infrastructure to nurture the usage of technology in education." (TE15)

Note. TE = teacher educator; IT = information technology.

Early integration highlights the importance of starting EdTech integration in lower grades. Eight participants claimed the inclusion of technologies in the curriculum of primary and secondary education would provide foundational support.

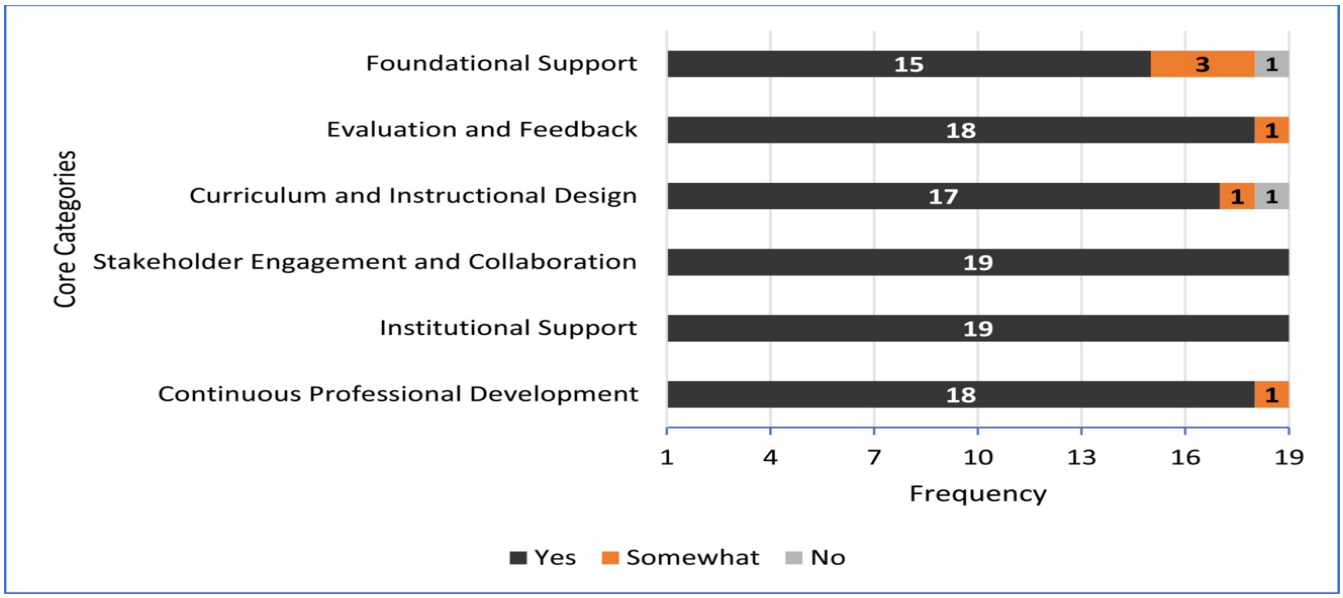
IT infrastructure support involves equipping primary and secondary schools with essential IT infrastructure. Some participants highlighted its impact on EdTech integration; infrastructure support promotes TEs' engagement and students' learning in CTEs. They said the absence of an IT infrastructure in primary and secondary schools had greatly contributed to students' digital illiteracy in CTEs.

Validation of Findings

A member-checking survey was used to assess the credibility of the key findings. Among the 23 survey participants, 19 completed and returned their feedback on each co-constructed core category (Figure 2). Institutional support and stakeholder engagement received unanimous agreement. Evaluation and feedback and continuous professional development had near-unanimous approval. Curriculum and instructional design also received a clear majority, with only one dissent. Though it was also predominantly agreed upon, foundational support showed the lowest consensus, suggesting a more nuanced perception. Results confirm the credibility of the categories, with minor discrepancies highlighting areas for refinement.

Figure 2

Participants' Feedback Collated From the Member-Checking Survey



Theory Development

In this section, the prevailing theory, grounded in empirical data and theoretical mappings, is presented. The theory was developed based on the principles of constructivist GT, highlighted in the Methods section (Charmaz, 2014). To confirm theoretical saturation, we performed theoretical mapping based on the reviewed literature. Demonstrating how the GT integrates with and contributes to existing theories is important in GT research. This argument is also supported by the methodological suggestions made for GT research (Idrees et al., 2011).

The Emerging Theory

As evident in the findings, EdTech integration involves the collaborative effort of multiple stakeholders. Each stakeholder plays a particular role in integrating EdTech. Thus, the emerging theory solely depends on the strategies identified based on the GT data analysis. This implies strategies for integrating EdTech demand the effective engagement and collaboration of stakeholders, including TEs, college deans, ICT directors, curriculum developers, government, and nongovernmental organizations.

Considering the role of stakeholders in EdTech integration, the strategies were grouped into three categories: teacher-, institution-, and organization-related. Teacher-related strategies rely directly on the practices of TEs in integrating EdTech. Institution-related strategies are those deemed to be executed by CTEs. Organization-related strategies require the involvement of the government (Ministry of Education and Regional Education Bureau) and nongovernmental organizations (Table 8).

Concerning teacher-related strategies, CPD, SEC, and CID were included. We included CPD considering the subcategory self-directed learning, which requires a TE's self-initiative. Similarly, SEC

is another strategy that falls under this category, which involves the engagement and collaboration of TEs in existing EdTech initiatives. Under this core category, all subcategories except external support represent the role of TEs. Finally, CID was included because of the role of TEs in innovating instruction. Hence, instructional innovation is an individual teacher's role in transforming pedagogical practices.

Table 8

Summary of Teacher-, Institution-, and Organization-Related Strategies

Core category	Teacher-related	Institution-related	Organization-related
Continuous professional development	✓	✓	
Institutional support		✓	
Stakeholder engagement and collaboration	✓	✓	✓
Curriculum and instructional design	✓		✓
Evaluation and feedback		✓	
Foundational support		✓	✓

As evident in Table 8, institution-level strategies were those owing to institutional stakeholders. Concerning CPD, the subcategories of comprehensive training programs and professional development are the roles of CTEs. Subcategories representing IS and EF exclusively represented institution-level strategies. SEC was included because of the following subcategories: stakeholder engagement, stakeholder collaboration, and experience sharing. These subcategories indicate the role of CTE engagement and collaboration as key contributors to effective EdTech integration. FS was not mentioned in any way as a role of the CTE before the member-checking survey. However, almost all participants (15 of the 19 who completed the survey) drew our attention to the importance of CTEs' engagement in supporting primary schools through training and IT resources.

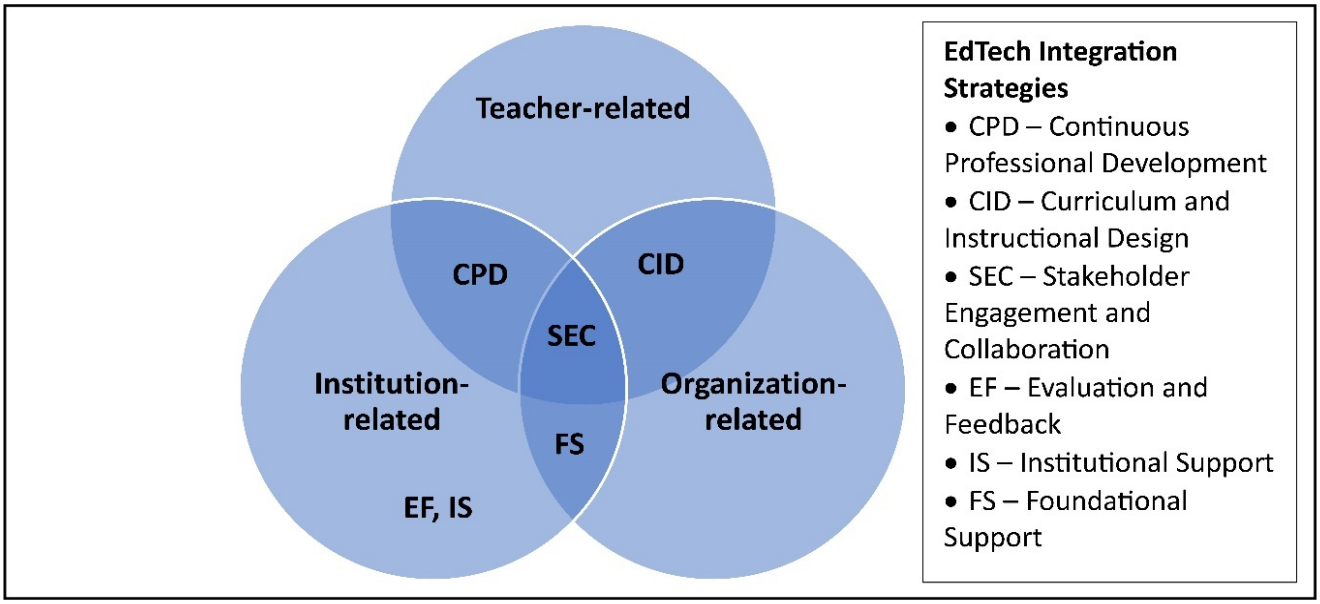
Concerning organization-related strategies, the core categories that call out the involvement of external organizations, including SEC, CID, and FS, were included (Table 8). In SEC, the subcategories of stakeholder engagement, collaboration, and external support were evidence of its inclusion. Similarly, curriculum redesign and course redesign are subcategories under CID, highlighting its inclusion in this group. Moreover, all the subcategories within FS represent organization-level strategies; therefore, it would be rational to include it as part of this group.

Based on the identified theoretical connections among the three groups of strategies, a theory was generated. SEC was a role shared among the three groups. CPD was found to exist under teacher-related and institution-related strategies. CID was identified as the role of both teacher-related and organization-related strategies. FS was found under institution-related and organization-related

strategies. The strategies IS and EF were found only under the institution-related group. Overall, the indicated relationships inform the development of a theory representing the roles in common, as well as exclusive to each group. Figure 3 presents the theoretical framework explaining the strategies for effective EdTech integration in CTEs.

Figure 3

A Strategy Framework for Effective EdTech Integration



Theoretical Mapping

The final stage of GT research (known as the maturity stage) involves mapping emergent theory to existing theories (Idrees et al., 2011). Integrating the constructed GT with literature supports verification of the theory and unveils its contribution to the field. Accordingly, ecological systems theory (Bronfenbrenner, 1979), diffusion of innovations (Rogers, 2003), and unified theory of acceptance and use of technology (Venkatesh et al., 2003) were found fit for theoretical mapping.

The ecological systems theory is a developmental psychology theory used to explain how various environmental systems interact to influence human development (Bronfenbrenner, 1979). This theory emphasizes the complex interplay between an individual and the surrounding environment. It highlights development as not exclusively the result of individual characteristics; rather, it is shaped by the broader set of ecological systems. The ecological systems theory comprises five categories of ecological systems: microsystems, mesosystems, exosystems, macrosystems, and chronosystems (Yang & Sanborn, 2021). The microsystem is the immediate environment where an individual directly interacts. The mesosystem refers to the interrelations between the settings containing the person. The exosystem links environments that do not involve individuals but affect the microsystem. The macrosystem consists of the larger cultural and societal context that shapes the environments in which

an individual lives. The chronosystem encompasses the dimension of time, reflecting the environmental events, transitions, and changes that occur throughout an individual's life.

Considering the involvement of multiple stakeholders in the constructed GT, mapping with ecological systems theory could maximize its robustness. Teacher-related strategies of the constructed GT align with the microsystem; hence, strategies including CPD, SEC, and CID can be performed at an individual level. The institution-related strategies such as IS, EF, CPD, and SEC are accomplished by CTEs, which align with the mesosystem. The organization-related strategies align with the exosystem. Hence, strategies such as FS, CID, and SEC can be managed at the organizational level. Due to high-level categorization, the overlapping strategies of CPD, SEC, CID, and FS, connecting the three systems, emerged. These strategies contain related categories; however, they differ in terms of the stakeholders being represented. Further, recent studies used ecological systems theory as a theoretical lens to explain EdTech integration (Nyanzi et al., 2024; Tanhan et al., 2023). Thus, it is plausible to use and explain the constructed GT through the lens of ecological systems theory.

The diffusion of innovations is an important theory in the information system literature that explains how, why, and at what rate new ideas, technologies, or practices diffuse through cultures or social systems (Rogers, 2003). According to Rogers (2003), relative advantage, compatibility, complexity, trialability, and observability are the characteristics that explain why a technology is adopted more quickly. These features can effectively explain the constructed strategies. Furthermore, recent studies have employed this theory as a lens to elucidate technology integration in education (Damiano et al., 2024). Consequently, it is reasonable to map the strategies in the theoretical framework to the characteristics of the diffusion of innovations.

The unified theory of acceptance and use of technology is another theory in the information system literature that predicts technology adoption using the constructs performance expectancy, effort expectancy, facilitating conditions, and social influence (Venkatesh et al., 2003). Similar to diffusion of innovations, GT constructs can be effectively explained by the unified theory of acceptance and use of technology constructs. Further, considering the wide applicability of unified theory of acceptance and use of technology in technology integration studies (Alowayr, 2022; Qiao et al., 2021), embedding the GT constructs to this theory enhances the theoretical framework's robustness.

Discussion

The purpose of this GT research was to explore the insights of TEs, ARVDs, and ICT directors into effective EdTech integration strategies and construct a theoretical framework. As illustrated in Figure 3, CPD, IS, SEC, CID, EF, and FS were the key strategies that emerged. These strategies were grouped into three ecosystems: teacher-related, institution-related, and organization-related. Additionally, a theoretical framework claiming multistakeholder engagement and collaboration as a central strategy was constructed and explained based on existing theories such as ecological systems theory, diffusion of innovations, and unified theory of acceptance and use of technology. This section presents a discussion of the key strategies and theoretical and practical implications.

Engaging TEs in CPD was the first key strategy suggested in the study. Previous studies have also highlighted the importance of enhancing CPD programs to strengthen EdTech integration practices (Atabek, 2020; Koh, 2020). According to Wohlfart and Wagner (2023), institutions are expected to provide CPD for in-service teachers to promote the effective integration of EdTech. Similarly, Rich et al. (2021) highlighted the impact of CPD in changing teachers' beliefs about teaching coding and computational thinking. Furthermore, Ferede et al. (2022b) recommended crafting CPD-based interventions to empower teachers with ICT competence and attitudes. Therefore, the strategic role of CPD in proliferating EdTech integration was found to be in line with the literature.

According to Trevisan et al. (2023), the IS determines faculty members' online teaching competence. For instance, leadership support was found to be a key strategic direction for promoting and sustaining EdTech integration. Multiple reviews (Deacon et al., 2023; Dexter & Richardson, 2020) and empirical evidence (Landa et al., 2023; Uzorka & Olaniyan, 2023) boldly ascertained its impact. Notably, IT infrastructure development was found to be a key IS and was claimed by prior reviews (Chugh et al., 2023; Deacon et al., 2023). As a further illustration, a study conducted in Nigerian universities highlighted leadership support, IT infrastructure, policies, equitable access, and motivation as key strategies for effective EdTech integration (Uzorka & Olaniyan, 2023).

Petko and Prasse (2018) claimed stakeholder engagement as fundamental for effective EdTech integration. The engagement is a foundation to collaborate and leverage EdTech. For example, through a collaboration of different stakeholders, virtual labs can be implemented in higher education (Kleine & Pessot, 2024). Moreover, in a community of practice, stakeholders can share the best experiences related to innovative classroom pedagogies (Smith & Becker, 2021). However, a review by Chugh et al. (2023) claimed that stakeholders' perceptions favour technology use rather than pedagogy, which affects the effective integration of EdTech. Therefore, SEC has an undeniable role in integrating EdTech and impacting implementation success.

The finding concerning CID aligns with studies emphasizing curriculum redesign as crucial for integrating modern technologies (Shohel et al., 2023; Stahl, 2021). Owing to the COVID-19 pandemic, most countries redesigned their curricula to sustain teaching practices (Clausen et al., 2021). Likewise, technologies were used to redesign courses for blended learning during the pandemic (Stahl, 2021). Additionally, an experimental study conducted in Ethiopian higher education revealed the impact of blended instruction on improving students' writing performance (Bekele Sime et al., 2024). Therefore, CID can be regarded as one of the enablers of effective EdTech integration.

The effective integration of EdTech demands a holistic EF strategy to assess and provide feedback on the use of EdTech tools and their impact on teaching and learning. This finding is supported by the literature, where the use of automated classroom analytics, such as TEACHActive (Kelley et al., 2021) and student grade improvement (Jaiswal, 2020), were suggested mechanisms to evaluate the effective use of EdTech. Additionally, studies have revealed that the usability of EdTechs in CTEs can be evaluated via a well-established system usability scale (Vlachogianni & Tselios, 2022). Overall, holistic EF mechanisms are pivotal for EdTech integration effectiveness.

EdTech integration in developing countries primarily focuses on tertiary education. Primary and secondary schools, which are believed to lay the foundation for tertiary education, have not gotten

enough attention. For example, in Ethiopia, primary school teachers do not have access to EdTech tools (Gonfa et al., 2024). The problem also extends to secondary schools (Hunduma & Seyoum, 2023). This has resulted in students joining higher education with poor digital capabilities. Accordingly, the FS strategy has a fundamental role in creating opportunities for effective EdTech integration beginning from the lower grades. Although most of the strategies are already recommended in previous studies, the FS strategy is a new contribution to the EdTech literature.

The current study contributes a novel theoretical framework for planning and implementing EdTechs in higher education. The framework is grounded in empirical data and aligns with prominent theories such as ecological systems theory (Bronfenbrenner, 1979), diffusion of innovations (Rogers, 2003), and unified theory of acceptance and use of technology (Venkatesh et al., 2003). The strategies are categorized into three overlapping categories based on the stakeholders. Notably, the constructed framework highlighted the need for multistakeholder engagement to effectively integrate EdTech. Moreover, recent systematic reviews on EdTech have shown a scarcity of research outputs, particularly from the Global South (Granić, 2022). Therefore, this study begins to fill the gap in the literature in terms of new insights and methodological knowledge, particularly concerning GT. Furthermore, the constructed GT would be a new addition; hence, the existing models and theories address factors contributing to the diffusion, acceptance, and use of technology. In contrast, the current study unveils new theoretical explanations for governing EdTech integration, particularly in developing countries.

The constructed theory offers a roadmap for stakeholders to plan effective EdTech integration. Teacher educators could leverage the framework's CID component to reshape their instruction using existing EdTechs. To address this issue, they should engage in professional development endeavours. Institutional leaders could use the framework to prioritize resource allocation, plan appropriate EdTech integration evaluation and feedback strategies, and develop a CPD implementation plan. The framework could alert policymakers to revisit the educational policies through the lens of EdTech. The Ethiopian Ministry of Education, the Regional Education Bureau, and CTEs should support EdTech integration practices at primary and secondary schools. Generally, the framework highlighted the significant role of stakeholder engagement and collaboration in realizing effective EdTech integration.

Conclusion

In this study, we explored and identified EdTech integration strategies and constructed a theoretical framework that could help in planning and implementing technologies in education. The strategies include CPD, IS, SEC, CID, EF, and FS. SEC was found significant in the framework; it promotes the engagement and collaboration of every stakeholder in the ecosystem of higher education. Additionally, CPD, CID, and FS link teachers and institutions, teachers and organizations, and institutions and organizations, respectively. The theoretical framework is grounded in empirical data and explained by existing theories. Additionally, the member-checking survey contributed to reinforcing the credibility of the identified strategies.

Despite this study's significant contribution, it has limitations. First, the data was collected from four CTEs until reaching saturation, which is susceptible to subjectivity. Second, the methods used to

collect data relied on interviews and document analysis, which need to be reinforced with quantitative methods. Third, a lack of perspectives from policymakers and students could lower the comprehensiveness of the framework. Future research could expand to other educational contexts, involve diverse stakeholders, conduct a comparative study in other developing countries, experiment with intelligent systems to support EdTech integration, and employ quantitative methods to assess the correlation between the strategies and EdTech integration outcomes.

References

Adamu, A. Y. (2024). Digitalization of higher education in Ethiopia. *Journal of Comparative and International Higher Education, 16*(2), 13–24. https://files.eric.ed.gov/fulltext/EJ1427232.pdf

Alemu, B. M. (2017). Transforming educational practices of Ethiopia into development and the knowledge society through information and communication technology. *African Educational Research Journal,* 5(1), 1–17. https://www.netjournals.org/pdf/AERJ/2017/1/16-050.pdf

Alowayr, A. (2022). Determinants of mobile learning adoption: Extending the unified theory of acceptance and use of technology (UTAUT). *The International Journal of Information and Learning Technology, 39*(1), 1–12. https://doi.org/10.1108/IJILT-05-2021-0070

Asratie, M. G., Wale, B. D., & Aylet, Y. T. (2023). Effects of using educational technology tools to enhance EFL students' speaking performance. *Education and Information Technologies, 28*(8), 10031–10051. https://doi.org/10.1007/s10639-022-11562-y

Atabek, O. (2020). Experienced educators' suggestions for solutions to the challenges to technology integration. *Education and Information Technologies, 25*(6), 5669–5685. https://doi.org/10.1007/s10639-020-10243-y

Bekele Sime, T., Geta, G. M., & and Olamo, T. G. (2024). Effects of blended instruction on students' paragraph writing performances: The case of first year health science pharmacy students at Pharma College Hawassa Campus, Ethiopia. *Cogent Education, 11*(1), Article 2321309. https://doi.org/10.1080/2331186X.2024.2321309

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design.* Harvard University Press.

Charmaz, K. (2014). *Constructing grounded theory* (2nd ed.). SAGE Publications Ltd.

Charmaz, K., & Belgrave, L. L. (2012). Qualitative interviewing and grounded theory analysis. In J. F. Gubrium, J. A. Holstein, A. B. Marvasti, & K. D. McKinney (Eds.), *The SAGE handbook of interview research: The complexity of the craft* (pp. 347–365). SAGE. https://doi.org/10.4135/9781452218403.n25

Chugh, R., Turnbull, D., Cowling, M. A., Vanderburg, R., & Vanderburg, M. A. (2023). Implementing educational technology in higher education institutions: A review of technologies, stakeholder perceptions, frameworks and metrics. *Education and Information Technologies, 28*, 16403–16429 https://doi.org/10.1007/s10639-023-11846-x

Clausen, J. M., Borthwick, A. C., & Rutledge, D. (2021). Teacher educator perspectives on technology infusion: A closer look using Q methodology. *Journal of Technology and Teacher Education, 29*(1), 5–43. https://doi.org/10.70725/670709xtdrfm

Damiano, A. D., Lauría, E. J. M., Sarmiento, C., & Zhao, N. (2024). Early perceptions of teaching and learning using generative AI in higher education. *Journal of Educational Technology Systems, 52*(3), 346–375. https://doi.org/10.1177/00472395241233290

Deacon, B., Laufer, M., & Schäfer, L. O. (2023). Infusing educational technologies in the heart of the university—A systematic literature review from an organisational perspective. *British Journal of Educational Technology, 54*(2), 441–466. https://doi.org/10.1111/bjet.13277

Dexter, S., & Richardson, J. W. (2020). What does technology integration research tell us about the leadership of technology? *Journal of Research on Technology in Education, 52*(1), 17–36. https://doi.org/10.1080/15391523.2019.1668316

Elsholz, U., Fecher, B., Deacon, B., Schäfer, L. O., & Laufer, M. (2021). Implications of the COVID-19 pandemic for digital teaching: Organised freedom as a paradigm of change. *MediaEducation: Journal for Theory and Practice of Media Education, 40*(CoViD-19), 472–486. https://doi.org/10.21240/mpaed/40/2021.11.29.X

Federal Democratic Republic of Ethiopia. (2020). *Digital Ethiopia 2025: A digital strategy for Ethiopia inclusive prosperity*. https://www.pmo.gov.et/media/other/b2329861-f9d7-4c4b-9f05-d5bc2c8b33b6.pdf

Ferede, B., Elen, J., Van Petegem, W., Hunde, A. B., & Goeman, K. (2022a). Determinants of instructors' educational ICT use in Ethiopian higher education. *Education and Information Technologies, 27*(1), 917–936. https://doi.org/10.1007/s10639-021-10606-z

Ferede, B., Elen, J., Van Petegem, W., Hunde, A. B., & Goeman, K. (2022b). A structural equation model for determinants of instructors' educational ICT use in higher education in developing countries: Evidence from Ethiopia. *Computers & Education, 188*, Article 104566. https://doi.org/10.1016/j.compedu.2022.104566

Glaser, B., & Strauss, A. (1999). *The discovery of grounded theory: Strategies for qualitative research* (1st ed.). Routledge. https://doi.org/10.4324/9780203793206

Gonfa, M. H., Birhanu, A. L., & Gendo, K. M. (2024). Review on practice and challenges of ICT integration as pedagogical tools in Ethiopian primary school curriculum implementation. *Discover Education, 3*(1), Article 88. https://doi.org/10.1007/s44217-024-00184-w

Granić, A. (2022). Educational technology adoption: A systematic review. *Education and Information Technologies, 27*(7), 9725–9744. https://doi.org/10.1007/s10639-022-10951-7

Hennessy, S., D'Angelo, S., McIntyre, N., Koomar, S., Kreimeia, A., Cao, L., Brugha, M., & Zubairi, A. (2022). Technology use for teacher professional development in low- and middle-income countries: A systematic review. *Computers and Education Open, 3*, Article 100080. https://doi.org/10.1016/j.caeo.2022.100080

Hunduma, C. M., & Seyoum, Y. (2023). Constraints hindering ICT integration in Ethiopian public secondary schools: A literature review. *International Journal of Membrane Science and Technology, 10*(2), 691–702. https://doi.org/10.15379/ijmst.v10i2.1271

Idrees, I., Vasconcelos, A. C., & Cox, A. M. (2011). The use of grounded theory in PhD research in knowledge management. *Aslib Proceedings, 63*(2/3), 188–203. https://doi.org/10.1108/00012531111135655

Jaiswal, P. (2020). Integrating educational technologies to augment learners' academic achievements. *International Journal of Emerging Technologies in Learning (iJET), 15*(02), 145–159. https://doi.org/10.3991/ijet.v15i02.11809

Kelley, J., AlZoubi, D., Gilbert, S. B., Baran, E., Karabulut-Ilgu, A., & Jiang, S. (2021). University implementation of TEACHActive—An automated classroom feedback system and dashboard. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 65*(1), 375–379. https://doi.org/10.1177/1071181321651186

Kleine, K., & Pessot, E. (2024). Virtualising labs in engineering education: A typology for structure and development. *Higher Education Research & Development, 43*(1), 119–133. https://doi.org/10.1080/07294360.2023.2228227

Koh, J. H. L. (2020). Three approaches for supporting faculty technological pedagogical content knowledge (TPACK) creation through instructional consultation. *British Journal of Educational Technology, 51*(6), 2529–2543. https://doi.org/10.1111/bjet.12930

Landa, E., Zhu, C., Sesabo, J., & Machumu, H. (2023). Leader support and the integration of innovative teaching-learning technologies: The mediating role of technological level of knowledge. *Education and Information Technologies, 28*(12), 15523–15541. https://doi.org/10.1007/s10639-023-11776-8

Maatuk, A. M., Elberkawi, E. K., Aljawarneh, S., Rashaideh, H., & Alharbi, H. (2022). The COVID-19 pandemic and e-learning: Challenges and opportunities from the perspective of students and instructors. *Journal of Computing in Higher Education, 34*(1), 21–38. https://doi.org/10.1007/s12528-021-09274-2

Mihiretie, D. M. (2023). The pedagogy of teacher education in Ethiopia: Reconstructing understandings and practices on teaching about teaching and learning to teach. *Bahir Dar Journal of Education, 23*(2), 22–58. https://doi.org/10.4314/bdje.v23i2.3

Ministry of Education. (2023). *Education statistics: Annual abstract (ESAA) 2022/23*. https://www.moe.gov.et/resources/annual-abstract/4

Nemomsa, K., & Beyesa, F. (2023). The status of quality education in college of teachers education in West Oromia regional state. *Journal of Science, Technology and Arts Research, 12*(4), 76–95. https://doi.org/10.20372/star.v12i4.07

Nyanzi, R., Mahmood, F., & Nahar, L. (2024). Investigating faculty use of assistive technology through closed captioning and reading aloud through the lens of ecological systems theory. In J. Cohen & G. Solano (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference* (pp. 1933–1935). Association for the Advancement of Computing in Education (AACE). https://www.learntechlib.org/p/224236

Qiao, P., Zhu, X., Guo, Y., Sun, Y., & Qin, C. (2021). The development and adoption of online learning in pre- and post-COVID-19: Combination of technological system evolution theory and unified theory of acceptance and use of technology. *Journal of Risk and Financial Management, 14*(4), Article 162. https://doi.org/10.3390/jrfm14040162

Petko, D., & Prasse, D. (2018). Exploring the impact of stakeholder engagement on the integration of educational technology in elementary schools: Expanding the will-skill-tool model with contextual variables. In E. Langran & J. Borup (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference* (pp. 1068–1074). Association for the Advancement of Computing in Education (AACE). https://www.learntechlib.org/p/182657

Ray, A. (2020). E-learning: The new normal in the post-COVID world. *International Research Journal of Modernization in Engineering Technology and Science, 2*(9), 866–876.

Rich, P. J., Mason, S. L., & O'Leary, J. (2021). Measuring the effect of continuous professional development on elementary teachers' self-efficacy to teach coding and computational thinking. *Computers & Education, 168*, Article 104196. https://doi.org/10.1016/j.compedu.2021.104196

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.

Saal, P. E., Graham, M. A., & van Ryneveld, L. (2020). The relationship between integrating educational technology in mathematics education and the mathematics achievement of German students. *Eurasia Journal of Mathematics, Science and Technology Education, 16*(12), Article em1905. https://doi.org/10.29333/ejmste/8939

Saunders, B., Sim, J., Kingstone, T., Baker, S., Waterfield, J., Bartlam, B., Burroughs, H., & Jinks, C. (2018). Saturation in qualitative research: Exploring its conceptualization and operationalization. *Quality & Quantity, 52*, 1893–1907. https://doi.org/10.1007/s11135-017-0574-8

Scanlon, E. (2021). Educational technology research: Contexts, complexity and challenges. *Journal of Interactive Media in Education, 2021*(1), 2. https://doi.org/10.5334/jime.580

Shohel, M. M. C., Babu, R., Ashrafuzzaman, M., & Azim, F. (2023). Redesigning curriculum and using technologies during emergency remote teaching and learning in higher education in Bangladesh. In S. Silva, P. Peres, & C. Silva (Eds.), *Developing curriculum for emergency remote learning environments* (pp. 196–215). IGI Global. https://doi.org/10.4018/978-1-6684-6071-9.ch011

Smith, C., & Becker, S. (2021). Using communities of practice to facilitate technology integration among K–12 educators: A qualitative meta-synthesis. *Journal of Technology and Teacher Education, 29*(4), 559–583. https://www.learntechlib.org/primary/p/219900

Stahl, G. (2021). Redesigning mathematical curriculum for blended learning. *Education Sciences, 11*(4), Article 165. https://www.mdpi.com/2227-7102/11/4/165

Tanhan, A., Taş, B., Agilkaya-Sahin, Z., Hayden, S. C. W., Korkmaz, O., & Gürsu, O. (2023). Perception of online education during COVID-19: Online photovoice (OPV) and ecological systems theory. *British Journal of Guidance & Counselling*, *53*(1), 81–100. https://doi.org/10.1080/03069885.2023.2247544

Trevisan, O., De Rossi, M., Christensen, R., Knezek, G., & Smits, A. (2023). Factors shaping faculty online teaching competencies during the COVID-19 pandemic. *Educational Technology Research and Development, 71*(1), 79–98. https://doi.org/10.1007/s11423-023-10197-1

Turnbull, D., Chugh, R., & Luck, J. (2021). Transitioning to e-Learning during the COVID-19 pandemic: How have higher education institutions responded to the challenge? *Education and Information Technologies, 26*(5), 6401–6419. https://doi.org/10.1007/s10639-021-10633-w

Uzorka, A., & Olaniyan, A. O. (2023). Leadership role and professional development of technology. *Education and Information Technologies, 28*(1), 713–723. https://doi.org/10.1007/s10639-022-11201-6

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly, 27*(3), 425–478. https://doi.org/10.2307/30036540

Vlachogianni, P., & Tselios, N. (2022). Perceived usability evaluation of educational technology using the system usability scale (SUS): A systematic review. *Journal of Research on Technology in Education, 54*(3), 392–409. https://doi.org/10.1080/15391523.2020.1867938

Wohlfart, O., & Wagner, I. (2023). Teachers' role in digitalizing education: An umbrella review. *Educational Technology Research and Development, 71*(2), 339–365. https://doi.org/10.1007/s11423-022-10166-0

Woldemariam, M. T., Ergado, A. A., & Jimma, W. (2025). Factors influencing effective integration of educational technology in the colleges of teacher education in Ethiopia: A constructivist grounded theory. *Australasian Journal of Educational Technology*, *41*(2), 50–70. https://doi.org/10.14742/ajet.9993

World Bank. (2023). *Population, total—Ethiopia*. https://data.worldbank.org/indicator/SP.POP.TOTL?locations=ET

Yang, E., & Sanborn, B. (2021). Ecological systems theory. In R. Appel-Meulenbroek & V. Danivska (Eds.), *A handbook of theories on designing alignment between people and the office environment* (1st ed., pp. 101–114). Routledge. https://doi.org/10.1201/9781003128830-9

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