TECHNOLOGY INTEGRATION INTO UNDERGRADUATE CURRICULA AND INSTRUCTIONAL SETTINGS IN ETHIOPIAN PUBLIC UNIVERSITIES

PhD DISSERTATION

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I confirm that I have reviewed the dissertation titled "Technology Integration into Undergraduate Curricula and Instructional Settings in Ethiopian Public Universities", which has been prepared by Gadissa Bekele Geda under my supervision. I recommend that the Dissertation be submitted as it fulfills the requirements for the award of a PhD Degree.

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DEDICATION

I dedicate this Dissertation to my family and the Management of Rift Valley University, especially Dinku Deyasa, who supported me throughout this entire journey. I am grateful for their unconditional support and love. Furthermore, I hope that my efforts to achieve a doctorate degree will inspire my children to have the confidence and work ethic to achieve their goals in the future.

STATEMENT OF THE AUTHOR

I certify that this Dissertation is my bona fide work. I have adhered to the ethical and technical requirements of scholarship when preparing, gathering data, analyzing, and compiling this Dissertation. This Dissertation has proper citations for all scholarly material used. The Dissertation is submitted to Harmaya University in partial fulfillment of the requirements for the Degree of Doctor of Philosophy in Education (Stream: Adult Education and Community Development). Following the guidelines and norms of the library, borrowers will be able to access the Dissertation which will be kept at the Haramaya University Library and Information Services.

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BIOGRAPHICAL SKETCH

The author was born on 22 September 1971, in the East Shewa Zone of the Oromia National Regional State, Ethiopia. He hails from Ada’a district, Bishoftu city. His educational journey started at Bekejo Primary and Atse Libne Dingle Junior Secondary Schools and led him to Bishoftu Comprehensive High School. Then, after completing his Bachelor’s degree in Education in Pedagogy with a composite major in English at Bahir Dar University in July 2000, he began his career as a teacher and director at Deder Senior High School and Deder TVET College. Following this stint, he took on the role of the Dean of the Rift Valley University's Bishoftu Campus. Subsequently, he pursued further education at Adama Science and Technology University, earning a Master of Arts degree in Curriculum Studies and Instructional Skills in September 2010.

Furthermore, he started working at Dire Dawa University and served as the head of curriculum development and review for one and a half years. After that, he returned to work at the Rift Valley University headquarters, where he held various positions including director of institutional and strategic development, as well as director of quality and academic program development. Currently, he is serving as the Vice-President for Academic Affairs of the Rift Valley University. In October 2017, he joined Haramaya University to pursue a study leading to the Degree of Doctor of Philosophy in Education (Stream: Curriculum Studies).

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I feel that am reaching a new professional milestone and advancing to a level where I need to fulfill my dream as a qualified expert and serve my country and society with greater objectivity, curiosity, enthusiasm, caution, and selflessness. I am eager to take on new challenges, expand my skill set, and continue to grow both personally and professionally. Besides, I am committed to approaching this next phase of my career with dedication, integrity, and a strong sense of purpose. The hard work and support I received from those who have helped and motivated me through my toughest and most disappointing times have brought me to this milestone. They have provided me with a lot of support when I needed it most, and I remember a few of these supporters from a different perspective.

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ABBREVIATIONS AND ACRONYMS

AR	Augmented Reality
ASTU	Adama Science and Technology University
ASU	Assosa University
DDU	Dire Dawa University
EPU	Ethiopian Public University
FDRE	Federal Democratic Republic of Ethiopia
HEIs	Higher Education Institutions
ICT	Information Communication Technology
JU	Jimma University
MoE	Ministry of Education
MWU	Mada Walabu University
OBU	Oda Bultum University
OCED	Organization for Economic Co-operation and Development
SAMR	Substitution Augmentation Modification Redefinition
SDGs	Substitutable Development Goals
TIUCIS	Technology Integration into Undergraduate Curriculum and Instructional Settings
TPACK	Technological Pedagogical Content Knowledge
UN	United Nation
UNESCO	United Nations Education Scientific and Cultural Organization
WCU	Wachamo University

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ABSTRACT

The study examined technology integration into undergraduate curricula and instructional settings in Ethiopian public universities. It employed a mixed approach with a convergent parallel mixed design aligned with the pragmatist paradigm. Seven Ethiopian public universities were selected from the target population of 31 universities using a simple random sampling technique. The researcher further selected colleges and departments by using multi-stage sampling techniques. In this study, 331 instructors were selected using a stratified sampling technique followed by a simple random sampling technique after allocating proportionality to each department (stratum) in respective colleges, while 24 key informants also were using a purposive sampling technique based on their rich experiences as educational leaders and experts. Quantitative data were collected from instructors using self-constructed structured questionnaires and analyzed using descriptive statistics (frequency, percentage, average means, standard deviation, and rank order), and inferential statistics (one-sample t-test, factorial analysis, Pearson moment product correlation, stepwise multiple regression analysis, and one-Way-ANOVA) using SPSS-26. In addition, the researcher collected qualitative data through semi-structured interviews, document review, and classroom observation, and analyzed through thematic analysis. The findings revealed a clear understanding of policy directions for technology integration in undergraduate curricula (GM=3.124), exceeding the neutral mean of 3.00. However, integration faces challenges due to inadequate infrastructure (GM=2.820), limited smart tools, poor connectivity, and low internet access. Instructors lack digital competence and familiarity with technology use in teaching (GM=2.832). The correlation among questionnaire items was r=.672, with reliability coefficients averaging α=.831, showing strong internal consistency. These factors explained 53.10% of total variance, with infrastructure contributing the most to TIUCIS (16.40%), followed by digital literacy (10.60%), policy and support (9.40%), digital divide/connectivity (8.20%), and curriculum integration (8.50%). Technology integration in Ethiopian public universities is still in its early stages, hindered by infrastructure gaps, low digital literacy, and insufficient support. The study concluded that while implementation is inadequate, variations exist among universities based on rationale, extent, and influencing factors. Therefore, the Ministry of Education, university leaders, and instructors are recommended to improve the quantity and quality of technological infrastructures, curriculum and pedagogical contents, digital divide, connectivity, internet access, digital literacy and digital competencies need policy, administrative, and technical supports.

Keywords: Instructional settings; public universities, technology infrastructure; technology integration; undergraduate curriculum.

1. INTRODUCTION

This chapter deals with the introduction to key topics that provide related information about the background of the study, the statement of the problem, the research questions, and the objectives of the study. It also treats the delimitations, limitations of the study, and operational definitions of key terms. Finally, theoretical framework explanations are provided, and the organization of the study.

1.1 Background of the Study

In today's globalized world, technology has revolutionized education by enhancing efficiency in time, cost, and logistics (Lestari, 2018). It has transformed teaching methods, improved learning outcomes (Raja & Nagasubramani, 2018; Kalyani, 2024), and bridged educational gaps by overcoming geographical barriers (Prestridge, 2017). Technological advancements are reshaping society, influencing communication, work, and trade while driving innovation and opening new pathways for adaptable nations (FDRE, 2023; Ng, 2015). Consequently, technology has become a vital tool in improving the quality and accessibility of education.

The 21st century has driven rapid advancements in individualized growth and socio-cultural, political, economic, and technological development through effective learning environments (Schwab, 2010). Preparing young people for workplace challenges and addressing societal issues are global priorities. Developing 21st-century skills is essential for academic and life success worldwide (Giacomazzi et al., 2022a; Jukes et al., 2021a). Positive, tech-integrated learning environments are crucial for fostering competencies like communication, collaboration, digital literacy, critical thinking, and problem-solving (Santos et al., 2024; Kalyani, 2024; Ramaila & Molwele, 2022). Education, central to the 2030 UN Sustainable Development Goals, promotes economic growth, social cohesion, and lifelong learning, aiming for inclusive and equitable quality education (UNESCO, 2018; UN, 2015).

Technology integration in education enhances access, relevance, and interactivity while reducing teachers' workload (Masana, 2020). It fosters 21st-century skills like collaboration, critical thinking, communication, and creativity (Boholano et al., 2020). Technology-enriched teaching improves instructional delivery and outcomes, transforming educational practices (Na'im, 2019).

It also supports Sustainable Development Goals by promoting equal opportunities and addressing disparities in academic performance and school conditions (Gangmei & Thomas, 2022; Masana, 2020).

Excellence in education relies on innovative curriculum and teaching philosophies (Al-Balushi, 2017; Turner & Morelli, 2017; Merkel, 2020; Lopes, 2021). To enhance education, technology-supported curriculum design must foster strong connections within educational settings (Campbell-Phillips, 2020). Effective technology integration enriches learning experiences for students and teachers (Power, 2019), improving teaching quality and innovation. Barriga (2010) advocates shifting from a techno-centric to learner-centered instructional design, while Rahadian (2017) highlights the need for teacher training in ICT to boost teaching quality. Brunner (1992) notes faculty interest is key for integrating technology, and Tamilmani & Nagalakshmi (2019) stress embedding technology to meet digital-native learners' needs.

As elucidated by Aagaard the power of technology over traditional teaching is as follows:

> Digital technologies in education allow students to check on the teacher and challenge the traditional educational power structure in which the teacher is the sole gatekeeper of knowledge in the classroom. However, it enacts an antagonistic student-teacher relationship in which the teacher becomes a watchful eye from whom students must conceal their activities (Aagaard, 2017, p. 1135).

Technology-enriched teaching fosters collaboration, critical thinking, communication, and creativity (Boholano et al., 2020). Effective integration requires shifting from a techno-centric approach to using technology as a cognitive tool (Barriga, 2010). The New Zealand Curriculum and 21st Century Learning Framework highlight technology education's role in lifelong learning (Snape & Fox-Turnbull, 2011). However, many educators lack the skills to integrate technology effectively. A conceptual model combining constructivist theory with TPACK and SAMR frameworks can support this integration (Tunjera & Chigona, 2020). Additionally, students often fail to fully engage and take responsibility for knowledge-building through digital technologies (Linda, 2019).

Linda summarized that technologies are often criticized for causing issues like job loss, reduced learning motivation, shorter attention spans, and laziness. However, they are also seen as tools of fascination, capable of solving problems, enhancing learning, motivating students, fostering knowledge growth, and supporting societal well-being (Lind, 2019, p.7).

In advanced nations, education increasingly integrates technology into students' daily routines (Buckingham et al., 2012). The digital world is reshaping education by delivering knowledge and skills innovatively (Prestridge, 2017). However, practical digitalization faces challenges like inadequate infrastructure, limited Internet access, and poor stakeholder coordination (Temtim, 2017; Hussein, 2018; Gizealew & Sisay, 2019). ICT significantly impacts human life, transforming education into more interactive and productive practices (Gnambs, 2021; Lin et al., 2017).

Effective use of technology enhances collaborative learning, engagement, critical thinking, and problem-solving through interactive multimedia and simulations (Jadhav et al., 2022). Online learning promotes accessible education for all (Conrad et al., 2022; Voitovska et al., 2023). Educational games foster active participation, personalized experiences, and enjoyable learning (Muñoz-Repiso, 2014). However, many teachers and students in developing countries lack proficiency in utilizing ICT for diverse subjects (Hussein, 2018). Technology-integrated teaching improves quality, boosts motivation, and enhances knowledge acquisition (Akram et al., 2021; Chen et al., 2018), fostering proactive classroom environments in both online and face-to-face settings (Jogezai et al., 2021).

A study by Ferede et al. (2022) highlights that instructors' ICT competence and attitudes are key predictors of their ICT use, which further enhances these traits. While ICT has the potential to improve higher education, its effective use in developing countries like Ethiopia faces challenges, including lack of know-how and skepticism (Tefera, 2022). Ferede emphasizes that ICT serves as a tool to enhance teaching and learning, not an end goal, as evidenced by past failures in developed countries. Achieving effective ICT integration requires planned actions and a commitment to overcoming these barriers.

Education is a fundamental right, yet global disparities exist in providing educational facilities due to the influence of globalization on educational philosophies and practices (Adeoye, 2020). The increasing demand for higher education pressures governments and diversifies educational systems, affecting employment and socioeconomic development (Altbach et al., 2017). Globalization aims to rapidly spread technology, knowledge, and ideas, with technology-integrated learning enhancing students' cognitive understanding and achievements (Liu et al., 2022).

Higher education must adapt to technological advancements by developing innovative teaching methods (Khare, Stewart & Khare, 2018). Education reform emphasizes digital competencies and skills for transformation, leveraging technology to enhance equity and quality in education through personalized tools and adaptive approaches (Al-Rawashdeh et al., 2021; Burns, 2023). Raising awareness and integrating ICT into curricula are essential practices (Solomon and Yilfashewa, 2022). This involves blending human interaction with technologies like online platforms, software, lecture capture systems, and videoconferencing (Bolldén, 2016; Pischetola et al., 2021; Knox, 2014; Luke, 2022; Meyer, 2015).

Globalization demands 21st-century skills from learners, driven by innovative teaching practices and digital technologies, particularly during the shift to online learning caused by COVID-19 (Beason-Abmayr et al., 2021; Lindeiner-Strasky et al., 2022; Ullah & Ali, 2021). Digitalization reshapes learning, human development, and consciousness (Langemeyer, 2019). The pandemic accelerated changes in work dynamics, turning students' homes into a ‘third place’ for learning and working (Kukulska-Hulme et al., 2022), highlighting the critical need for technology integration.

The COVID-19 pandemic has driven innovation in digital pedagogy, transitioning traditional teaching to online and blended formats (Birhanu, 2021). Despite this, Tilahun (2021) found that Ethiopian higher education still heavily depends on conventional face-to-face methods, which are ineffective in remote, under-equipped institutions. The hybrid model aims to integrate face-to-face and online learning for a cohesive experience, offering flexibility in attending classes (Kukulska-Hulme et al., 2022). While there are reservations, this shift advances technology integration in education. Glenn (2008) noted that digital technologies are reshaping various domains, including education, marking the onset of a new digital age.

The curriculum and instructional processes adapt to current and future technologies due to rapid advancements in information and knowledge (Lee, 2020). Integrating technological resources into higher education impacts learning outcomes, teaching methods, and assessments, enhancing academic and professional competencies (Moges, 2021). Technology improves learning efficiency by providing reliable information and enabling diverse instructional approaches.

Digitalization is transforming higher education, influencing teaching, learning, research, and administration (Rampelt, 2018). Digital technologies affect interpersonal relationships between students and instructors and reshape resource utilization (Guðmundsdóttir & Hatlevik, 2020). Thoughtful use of digital tools in pedagogy includes deciding when to use or avoid them and assessing their impact on learning (Rousseau, 2022). Rampelt et al. (2018) emphasize that digital transformation requires new infrastructures, increased use of digital media, and skill development for future workplaces.

Higher education plays a vital role in nation-building and socio-economic development by creating and sharing global knowledge (Seppo, Annica & Elias, 2015). This is achievable through well-designed curricula that enhance educational outcomes (Stephanie, 2008). To address 21st-century technological demands, integrating technology into undergraduate curricula is crucial to reduce institutional uniformity, tackle graduate unemployment, and align skills with labor market needs (Adula et al., 2023). Ethiopian higher education faces challenges due to homogenization, which limits job opportunities for graduates lacking market-relevant competencies (Adula et al., 2023, p.15).

Higher education is transforming teaching-learning processes by integrating technology to enhance student knowledge and skills (Buckingham & Deakin, 2016). This integration addresses the limitations of traditional methods with technology-based tools (Jesson, 2019). Modern classrooms require both instructors and students to effectively implement curricula with technological innovations (Girma & Aklilu, 2023). Constructive alignment of technology with curriculum often follows a systematic curriculum renewal process (Schul, 2014).

Adapting curricula for a tech-savvy generation involves incorporating technology to stimulate and enhance learning, as noted by Tamilmani and Nagalakshmi. Current curriculum design must integrate technology to improve student performance, with stakeholders expecting technology-embedded curricula to ensure quality education (Tamilmani & Nagalakshmi, 2019).

Technology integration in curriculum design focuses on using technology as an instructional delivery mechanism (Maree & Ifenthaler, 2014), offering new teaching and learning opportunities (Schul, 2014). Technology optimizes instructor performance by simplifying tasks and enhancing productivity. It significantly impacts instructional delivery and outcomes, meeting the demands for 21st-century skills like collaboration, critical thinking, communication, and creativity, essential for quality education (Boholano et al., 2020).

Teachers benefit from technology in diagnosing student progress (Peterson et al., 2018), as technology-based learning uses electronic tools to access curricula beyond traditional classrooms (Gizealew & Sisay, 2019). However, teachers may lack strategies to enhance pedagogical skills, requiring knowledge of technology, proper training, quality management, and leadership to integrate it effectively (Berhanu, 2016; Giacomazzi et al., 2022a). Research shows students using computers feel more motivated (Fleischer, 2012; Zheng et al., 2016). Curriculum materials must be carefully designed and embedded in sound instructional approaches with teacher and peer support (Peterson et al., 2018). Traditional methods no longer suffice as the digital economy demands new skills, requiring curricula and teaching methods to adapt (Becirovic, 2023). Aligning curriculum development with new learning materials, multimedia, and interactive tools is crucial. Universities emphasize sharing practices during curriculum renewal phases (Maree & Ifenthaler, 2014).

Ng (2015) highlights that incorporating digital technologies in learning supports successful outcomes, workplace skills, responsible digital citizenship, and lifelong learning. Educators design tech-enhanced experiences aligned with curricula to improve teaching (Frye et al., 2010). Debele and Plevyak (2012) emphasize educators' supportive roles in executing tech-integrated projects, as technology enhances curriculum planning, content delivery, communication, assessment, and teaching effectiveness (Lee, 2020). Collaborative tools should clarify their pedagogical purpose early on (Peterson, 2012), while digital materials boost learning interest (Rong-Jyue, 2008) and foster individual and collaborative skills (Biasutti, 2017).

Technology integration in curricula enhances instruction and learning (Davies, 2011). Davis highlights that its success depends on (1) access to educational technologies, (2) their instructional use, and (3) effective implementation in teaching. Adaptive learning technologies further personalize education by analyzing student progress and tailoring content to individual learning styles, improving outcomes (Huang & Yang, 2023).

The demand for a workforce with soft skills and higher-order thinking emphasizes basic literacies like literacy, numeracy, ICT skills, and cultural awareness (Omala et al., 2016). It highlights students' ability to tackle complex challenges using critical thinking, problem-solving, creativity, collaboration, and communication (Guàrdia et al., 2021). Applying these competencies enhances motivation, cognitive understanding, transformative learning, and achievements (Liu et al., 2022; Wang, 2008). Tools like flipped instruction, cloud computing, mobile devices, interactive whiteboards, and video-conferencing are key for integrating technology into curriculum development.

Technological tools such as Google Drive, WhatsApp, augmented reality, and social networking enhance personalized learning, engagement, and outcomes (Yue et al., 2024). These tools often rely on self-reported measures of skills (Deitz et al., 2021; Smart et al., 2019) and foster collaboration in problem-solving (Giacomazzi et al., 2022a). Their use in higher education promotes global collaboration and active learning integration (Ferns et al., 2020; Tomei, 2011). Ethiopia’s ICT policy for HEIs and TVET institutions addresses challenges and opportunities to enhance teaching, learning, research, and administration (MoSHE, 2020). This study explores technology integration into undergraduate curricula in Ethiopian public universities.

1.2. Statement of the Problem

Ethiopian universities lack strategies for integrating IT into teaching and learning (MoE, 2018). Moges (2021) highlighted insufficient digital literacy alignment in curricula and inadequate learner digital competencies, hindering instructional quality. Motivated by these issues, the researcher posed key questions: (1) How can technology make teaching active and participatory? (2) How can technology-based curricula foster creativity, critical thinking, civic responsibility, and lifelong learning in students?

Technology plays a crucial role in contemporary life, and digital natives increasingly expect curricula to incorporate it for enhanced learning experiences (Tamilmani & Nagalakshmi, 2019). In higher education, technology facilitates global collaboration and overcomes geographical barriers, making its integration into curricula indispensable (Meda, 2019).

Ethiopia is ranked 151st on the UN E-Government Development Index (2018), highlighting the limited integration of ICT in its education system (Moges, 2021). Despite efforts by teachers and policymakers to embed technology into learning, ICT adoption remains in its infancy due to inadequate infrastructure and a shortage of trained professionals (Moges, 2021). Nonetheless, Ethiopia's higher education policy underscores the importance of integrating technology and regularly updating curricula to keep pace with technological advancements (MoSHE, 2020).

The rapid advancement of technology has transformed education, altering how teachers teach and students learn (Hashim, 2018). Increased access to diverse, high-quality educational materials via the Internet and satellite links has introduced innovative learning methods, simplified complex concepts, expanded geographic reach, and driven global educational transformation (Adeoye, 2020). Integrating technology into curricula is crucial, as its flexibility and adaptability enhance learning environments for all students (JISC, 2019). This shift necessitates reforming traditional teaching models to incorporate creative, technology-driven approaches in higher education.

The process of teaching has drastically changed from oral to virtual classroom and changed learning styles. Initially, memorization was the only way of learning but now educators modified it to problem-based and experiential learning modes. In education, technological tools play important roles in both teaching and learning processes. Technological tools give power to teachers to deliver information more effectively and help learners more conveniently (Stosic, 2015). Thus, teachers stand as one concrete model and instructional engines during curriculum change and its actual practices in classrooms.

The integration of technology in higher education is vital for enhancing learning and achieving sustainable development goals (Alshammari et al., 2023). Modern education's global nature demands technology to enable cross-border collaboration (Meda, 2019). While academic views vary from critical to enthusiastic, the focus remains on improving student experiences and gaining institutional support. Studies link technology use to better academic performance, stressing the need for infrastructure, training, and support (Zulfikhar et al., 2024). Benefits include flexible curriculum delivery and addressing diverse learning needs (Jackson, 2016). Technology has become essential in 21st-century learning, enabling global collaboration and transcending borders (Meda, 2019). Thus, embedding technology in higher education curricula is crucial.

The e-Learning Ethiopia initiative improved access to digital education, enhancing teaching effectiveness and boosting students' academic performance (Barasa, 2021). However, Moges (2021) highlighted barriers like limited digital skills, insufficient funding, poor program design, and inadequate teacher training.

The study by Solomon and Yilfashewa (2022) revealed that lack of training, technical knowledge, high costs of devices and internet, and poor connectivity hinder ICT integration in education. Birhanu (2015) emphasized the growing importance of ICT in teaching-learning practices in the 21st century. Sisay (2017) highlighted the need for higher education institutions to invest in technology access with clear strategies, as ICT serves as a vital source of information and innovation. Other studies identified challenges like inadequate infrastructure, unreliable electricity, insufficient computer labs, lack of maintenance, poor internet access, and gaps in digital literacy, all of which obstruct seamless ICT integration in education (Chala & Yilfashewa, 2023; Moges, 2021; Mugai, 2014).

Recent empirical studies in Ethiopia (e.g., Birhanu, 2015, 2021; Chala & Yilfashewa, 2023; Moges, 2021; Sisay, 2017; Solomon & Yilfashewa, 2022; Tilahun, 2021) reveal gaps in integrating technology into curricula and instructional settings in public higher education. Most studies focused narrowly on ICT use, overlooking broader applications of technology to enhance teaching and learning. These gaps highlight the need for immediate policy and practical measures to improve curriculum quality. This study aimed to address these gaps by exploring technology integration in undergraduate curricula and instructional settings in Ethiopian public universities, contributing new insights to the field.

1.3. Research Questions

The present study investigated the following questions based on the identified research gaps in the literature, and experientially observed problems in selected Ethiopian public universities.

1. What are the reasons behind for incorporating technology into the undergraduate curricula and teaching environments in public universities in Ethiopia?
2. To what extent is technology integrated into undergraduate curricula and instructional settings in Ethiopian public universities?
3. What roles do instructors play in integrating technology into undergraduate curricula and instructional settings in Ethiopian public universities?
4. To what extent are the prevailing factors affecting technology integration into curricula and instructional settings in Ethiopian public universities?
5. How do technology integration practices differ among Ethiopian public universities in the context of undergraduate curricula and instructional settings?

1.4. Objective of the Study

This section presents the general and specific objectives.

1.4.1. General objective

The main objective of the present study was to examine the extent of technology integration into undergraduate curricula and instructional settings in Ethiopian public universities.

1.4.2. Specific objectives

1. To identify the reasons behind for incorporating technology into the undergraduate curricula and teaching environments in public universities in Ethiopia.
2. To assess the extent of technology integration into undergraduate curricula and instructional settings within Ethiopian public universities.
3. To explore the roles of instructors in the integration of technology into undergraduate curricula and instructional settings in Ethiopian public universities.
4. To examine the prevailing factors that affect technology integration into curricula and instructional settings in Ethiopian public universities.
5. To analyse how technology integration practices vary among different Ethiopian public universities in terms of undergraduate curricula and instructional settings.

1.5. Significance of the Study

The findings of the present study have social, policy, practice, and academic significance to the higher education institutions' instructors, students, leaders, researchers, curriculum designers, policymakers, and the public at large. The results of the current study revealed the existing gaps in technology integration practices in undergraduate curricula and instructional settings in Ethiopian higher education and provided feasible recommendations for instructors, university academic leaders, curriculum experts, and students to implement successful and proper technology integration in both curricula and instructional settings.

The findings created opportunities for long and short-term professional training and bridged knowledge and skill gaps of instructors and curriculum/course designers. The findings of the study contribute to possible pathways of getting the latest information and knowledge to existing literature and then extend the body of knowledge regarding technology integration into undergraduate curricula and instructional settings in Ethiopian public universities. The findings of the present study have momentous benefits to higher education institutions' leaders, academicians, and researchers in areas of formulating strategic designing policies and making informed decisions at different levels of higher education and the Ministry of Education. Finally, the findings of this empirical study serve as stepping-stones for researchers and academicians interested in conducting further research regarding technology integration into curricula and instructional settings at different educational levels.

1.6. Delimitation of the Study

The researcher delimited the scope of the present study geographically, conceptually, and methodologically. The present study focused on examining technology integration into Ethiopian public universities' undergraduate curricula and instructional settings.

Geographically, the study covered seven universities from the four strata (research, applied science, comprehensive, and special technology universities) of Ethiopian public universities based on their differentiation (Adula, *et* al., 2020). The samples included Jimma University, Assosa University, Dire Dawa University, Wachamo University, Madda Walabu, Oda Bultum, and Adama Science and Technology Universities. The researcher further delimited the study to instructors, curriculum experts from MoE, academic program directors, quality assurance directorates, and students' council presidents of the sample universities.

Methodologically, the study adopted a pragmatic research paradigm and a convergent parallel mixed design to provide the researcher with a wide platform to achieve the objectives envisaged in the study. Conceptually, the study focused on rationales, extent/practices, roles of instructors, and factors affecting technology integration into undergraduate curricula and instructional settings in Ethiopian public universities. Finally, from the commonly existing undergraduate curricula of the sample universities, the researcher selected second years of six undergraduate curricula which include language, economics, civil engineering, nursing, plant sciences, and physics because the students started learning different majors and miner courses in their new department.

1.7. Limitations of the Study

Although this study has some strengths, it is important to remain critical and consider potential limitations. First, It focuses on public universities that participated in the study, with private higher education excluded due to resource constraints. This might affect generalization despite all the efforts the researcher has made to maintain other issues that may affect external validity.

Secondly, the study includes only instructors, students' council president representatives, quality assurance directorates, and academic leaders as sample respondents. Thirdly, despite the current study's promising support to an overall understanding of technology integration into undergraduate curricula and instructional settings, and promising development of new insights and wisdom, the study did not guarantee detailed causal-effect relationships. Finally, the other practical restriction the researcher faced during data collection was the reluctance of key informants against audio recording which obliged the researcher to use handwritten field notes. This constraint consumed extra time ahead of the researcher's plan during data collection. Thus, future researchers may address these areas to further explore and understand the implications and potential applications related to these issues.

1.8. Operational Definitions of Terms

Curriculum: refers to the written document/course module/syllabus/curriculum framework of a given discipline.

Undergraduate curriculum: The formal curricula given to higher education students to achieve their first degree in their field of study in higher education institutions.

Higher education institution: refers to public education institutions that legally acknowledge educating students with undergraduate and postgraduate programs in Ethiopia.

Instructional settings: refer to settings, in which the interaction of the teacher with students, the students with themselves, and with the contents of the lessons delivered in a specific period; is taking place.

Ethiopian Public Universities: Higher education institutes, funded and financed by the government or Ministry of Education of the Federal Democratic Republic of Ethiopia.

Technology: refers to any electronic tool, system, equipment, or device and resource that generate, stores, or processes data, online applications, multimedia, software, and cloud computing that serve for the teaching-learning settings.

Technology integration: refers to the inclusion or incorporation of technologies in the curriculum and instructional settings that can help students achieve specified learning goals.

Technology integration areas: Technology integration areas into curriculum and instructional settings include contents, learning experiences, learning objectives and outcomes, teaching and learning strategies, and assessment and feedback techniques.

1.9. Theoretical Frameworks of the Study

Theoretical frameworks emphasize the understanding of educational phenomena and guiding research design. As explained by Parker (2022) theoretical frameworks help researchers develop coherent conceptual models, justifying research approaches and importance. The critical role of theoretical and conceptual frameworks in shaping research routes, from breaking down concepts to formulating hypotheses and determining philosophical foundations (Costa, 2020). Thus, concerning the theoretical and conceptual frameworks of the study, Ravitch and Riggan (2016) suggested that bridging the conceptual, theoretical, and methodological knowledge of the researcher is needed to conduct rigorous and valid research.

Technology integration in higher education has become increasingly important to enhance teaching and learning practices. Technology integration frameworks provide simplified models or best practices to understand and implement technology in educational settings. For instance, the TPACK model emphasizes the interplay of technological, pedagogical, and content knowledge while the SAMR model focuses on levels of technology integration (Bajracharya, 2021). These frameworks help explain technology adoption, inform decision-making, and support pedagogical reforms (Niederhauser & Lindstrom, 2018). However, these models focus only on teacher training practices and are not as mature as theories. Therefore, this framework for technology integration in education has faced criticism and limitations. As a result, the researcher could not use these two models as theoretical frameworks for this particular investigation.

The integration of technology in education has led to the development of multiple frameworks to facilitate effective implementation. The Technological Pedagogical Content Knowledge (TPACK) framework is a conceptual model for effective technology integration in teaching (Padmavathi, 2017). It emphasizes the complex interaction between content, pedagogy, and technology knowledge, suggesting that teachers need competence in all three domains for optimal educational outcomes (Mupita et al., 2018). TPACK is viewed as a dynamic process, with some researchers proposing the term "TPACK-of-practice" to reflect its evolving nature (Niess, 2016). While TPACK has been recognized as a powerful framework for guiding teacher development projects, it may not be comprehensive enough to address all aspects of such initiatives (McGrath et al., 2011).

TPACK emphasizes the interplay between technology, pedagogy, and content knowledge, highlighting the importance of teachers developing flexible knowledge to successfully incorporate technology in teaching (Schmidt et al., 2009). SAMR provides a model for evaluating technology integration, ranging from substitution to redefinition of learning tasks (Hilton, 2016). Both TPACK and SAMR have been applied in various educational contexts, including social studies and language teaching, to enhance student learning by employing technology (Alivi, 2019).

The TPACK framework combines technological, pedagogical, and content knowledge for effective teaching with technology (Schmidt et al., 2009). Research mainly focuses on education levels using case studies and mixed methods, but lacks longitudinal studies on daily TPACK application (Moreno et al., 2019). Critics highlight its limitations, such as neglecting logistics, adult learning principles (McGrath et al., 2011), and its focus on product over process, which may stifle creativity and problem-solving (Hamilton et al., 2016). Meanwhile, the SAMR model, popular among educators, lacks theoretical grounding and empirical support, as it was developed from experience rather than research (Green, 2014, cited in Franco, 2019).

The Technology Integration Matrix (TIM) framework provides a comprehensive approach for evaluating and implementing technology in educational settings. This framework is for evaluating and enhancing technology integration and consists of five characteristics of meaningful learning (active, constructive, authentic, collaborative, and goal-directed) and five levels of integration (entry, adoption, adaptation, infusion, and transformation), forming a 25-cell matrix (Harmes et al., 2016). It serves as a tool for professional development and lesson planning, emphasizing pedagogy-technology alignment for meaningful learning experiences (Bonfiglio-Pavisich, 2018). TIM has been used to assess teachers' experiences in creating digital content and promoting active, constructive, authentic, and goal-directed learning (Goodoory, 2020). The framework's applicability extends to vocational education and training contexts, alongside other models like SAMR, to assess technology adoption in blended learning environments (Reich et al., 2020). The Technology Integration Matrix framework exists for technology integration in higher education, but it often lacks practical guidance for instructors (Rhode & Krishnamurthi, 2017). The TIM Matrix is proposed as a model that prioritizes pedagogy and technology integration, enabling teachers to plan and implement student-focused lessons that align with meaningful learning (Bonfiglio-Pavisich, 2018).

The researcher analyzed constructivism and connectivism learning theories as the dominant theoretical frameworks of the study. Accordingly, constructivism as a framework for educational technology has the potential of technology implementation to improve the teaching-learning process and causes affect classroom practices (Rechards, 1998; Brush & Saye, 2009). As the theoretical framework for educational technology in the classroom, constructivist teachers have to make sure that they are using it as part of an approach that involves the students in activities. Constructivist approaches, with their focus on student-centered learning, have long advocated student involvement in the process of gaining knowledge and have sought ways for teachers to become advocates in the learning process rather than as figures who only dictate information. This approach seems a good match for the technological applications developed today. While being an advocate of constructivism is not a requirement for the use of technology and while using technology will not necessarily convince someone to change from their traditional teaching approach, the two tend to increase the other and provide the best results from both an application and a theoretical perspective.

In addition, connectivism covers the way for a new model of learning adequate to a knowledge society where learning is a process of connecting specialized nodes or information sources (Siemen, 2004) since the internet made a huge shift in the understanding of knowledge nature. In implementing the learning theory of connectivism, the formal organization does not create or control a knowledge network although it can plug into the world of constant information flow and draw meaning from it (Bates, 2015). Connectivism as a learning theory has its origins in distributed learning (Siemens, 2004), is relevant to digital society, and holds an epistemological position. This ranges from objectivism (linked to behaviorism as learning theory), pragmatism (linked to cognitivism), and interpretivism (linked to constructivism), and at the end of the current scheme enshrined evolution of learning theories (connectivism). The connectivist theory focuses on knowledge dissemination across a network of connections into its nodes and learning consists of the ability to construct and traverse those nodes connected into networks (Downes, 2012), and seeks to describe successful networks and practices that lead to such networks.

Constructivism and technology integration in education are closely intertwined, benefiting the implementation of the other (Chuaungo et al., 2022). The constructivist approach to technology integration plays a significant role in enhancing learning experiences and outcomes in modern classrooms (Chuaungo et al., 2022). Constructivism and technology integration in education are closely connected and offer valuable opportunities for meaningful learning experiences. Constructivist approaches prioritize student-centered, context-rich activities that promote deep understanding (Raihan & Han, 2012). Contemporary technologies like wikis, social networks, and blogs align well with constructivist principles, allowing students to control their learning direction and build knowledge through rich, contextual experiences (Requena, 2008).

Constructivism emphasizes active, situated, authentic, and experiential learning. Connectivism extends learning beyond the individual to social networks and technological tools (Mattar, 2018). Technology integration based on constructivism can support meaningful learning through student-centered environments (Raihan & Han, 2012). The use of technology and constructivism is transforming teaching methods, with recent efforts embracing constructivist approaches to integrating technology (Chuaungo et al., 2022). Integrating technology with constructivist principles involves using internet-based resources (Prajapati & Singh, 2018). Integrating technology with constructivist and connectivist approaches offers promising opportunities for enhancing teaching and learning in contemporary classrooms. Constructivism and connectivism are key learning theories for technology integration in education. Constructivism posits that learning occurs in contexts, while technology provides engaging environments (Gilakjani et al., 2013). Connectivism extends this idea, viewing learning as distributed across social networks and technological tools (Mattar, 2018). Successful technology integration often aligns with constructivist principles, promoting student-centered, meaningful learning experiences (Raihan, & Han, 2012). Integrating technology within a constructivist framework can transform pedagogy and enhance student learning outcomes (Mattar, 2018). The theory contributes to competency-based learning by allowing students to explore, modify, and apply knowledge using technology-enhanced strategies and skills (Baque et al., 2020). Connectivism offers an optimistic view of education, where individuals collaboratively create knowledge in a global, networked environment (Darrow, 2009), potentially leading to more meaningful learning experiences in the digital age.

Connectivism, a learning theory for the digital age developed by Siemens and Downes, suggests that knowledge is distributed across networks and learning involves constructing and navigating these networks (Khatibi & Fouladchang, 2015). The theory emphasizes building active connections and utilizing intelligent social networking to keep learners current in a rapidly changing knowledge landscape (Darrow, 2009). Connectivism is positioned as a new philosophy of education for the digital age, building upon Vygotsky's concept of the zone of proximal development (Mattar, 2018), emphasizing the importance of social networks and technology in learning. This theory emerged as a response to the limitations of behaviorism, cognitivism, and constructivism in explaining learning in the digital era (Boyraz & Ocak, 2021). Connectivism emphasizes the role of technology and social software in altering how learners access information and interact with instructors and peers (Khatibi & Fouladchang, 2015). Thus, Masethe et al. (2016) advocate for connectivism as a suitable framework for 21st-century education, arguing that it optimally integrates technology into teaching practices. Connectivism offers a contemporary lens for integrating technology, constructivism remains foundational, and its integration can enhance educational practices (Liu & Li, 2021).

Connectivism offers an effective learning environment by establishing explicit connections between social interaction and knowledge sharing, potentially improving student engagement in higher education (Al-Mutairi, & Mubayrik, 2021). Connectivism learning theory contributes to competency-based learning by leveraging technology to help students discover, transform, and apply knowledge in real-world scenarios (Baque et al., 2020). As traditional learning theories like behaviorism, constructivism, and cognitivism may not fully address 21st-century instructional design needs, connectivism is recommended as a suitable approach for teaching and learning with technology (Masethe et al., 2016). It allows for an optimistic perspective on education, where individuals co-create knowledge in a global, networked environment (Darrow, 2009).

1.10. Organization of the Study

This study has been organized into five chapters, each with distinct sections that present the information logically and coherently. Thus, the first chapter introduces the study, addressing components such as the background, statement of the problem, research questions, objectives, significance, delimitations, limitations, definitions of key terms, and organization of the study. Then, the second chapter reviews related literature, to mention some of them it focusing on the concepts of curriculum and technology integration, technology integration into higher education curricula and instructional settings, and theoretical frameworks. Besides, chapter three discusses the research design and methodology, including the study area, research paradigms, designs, methods, data sources, sample size, instruments, validity, reliability, data collection procedures, analysis methods, and ethical considerations. The fourth chapter presents the study results and discussion sections. The fifth and final chapter presents a summary of the study, conclusions, and recommendations. Finally, the study also includes a list of references and appendices at the end.

2. REVIEW OF RELATED LITERATURE

Introduction

This chapter deals with higher education curriculum, technology as a foundation of curriculum, technology integration in higher education curriculum and instructional settings, summary of review literature, theoretical underpinnings of integrating technology into curricula and instructional settings, and conceptual framework of the study.

2.1. Technology and Globalization

The process of joining various countries at a global level around a common denominator is referred to as globalization. Political, social, economic, and technological factors are among the supporting dimensions of globalization; in the context of technological globalization and globalized technology, additional technological aspects are highlighted (Değerlendirme & Baygül, 2020). Therefore, globalization and technology have significantly impacted higher education curricula and institutional practices. Globalization has forced higher education into a new world, a world of change, instability, and ambiguity, shaped by an increasingly integrated world economy, technology, an international knowledge network, and other forces beyond the control of higher education institutions (Mense *et* al., 2018). Globalization has significantly transformed the landscape of higher education, presenting both opportunities and challenges for curriculum development and institutional management (Hasmun, 2024).

Globalization challenges traditional conceptualizations of higher education curricula, requiring institutions to adapt to a complex, rapidly changing global context (Butucha, 2015). This transformation demands interdisciplinary, culturally responsive curricula that promote global citizenship and employ innovative teaching methodologies (Hasmun, 2024). Technology plays a crucial role in this globalization process, facilitating knowledge transfers and reshaping higher education's educational, social, economic, and cultural aspects (Woodard et al., 2011). Institutions must rethink their educational practices, focusing on internationalization, technology integration, and global mobility to enhance resilience and competitiveness in the global higher education landscape (Hasmun, 2024). These changes necessitate strategic planning, quality assurance mechanisms, and leadership development to meet the challenges and opportunities presented by globalization. Globalization and technology are two sides of the same coin (Qadri, & Bhat, 2018). They are complementary and a good interface between the two is sine-qua-non for growth and development in the contemporary global village.

Globalization and technology are deeply interconnected, with technology serving as a crucial enabler of globalization (McMahon, 2001; Değerlendirme & Baygül, 2020). The relationship between the two is complementary, with each supporting and driving the development of the other (Qadri & Bhat, 2018). Technology has revolutionized the global economy, fostering new markets and becoming a critical competitive strategy (Lamba & Malhotra, 2009). The interplay between technology and social processes, particularly institutional structures, has shaped the long process of globalization (McMahon, 2001). However, the benefits of this technological globalization have not been evenly distributed, with economically developed countries benefiting more (Lamba & Malhotra, 2009). A good interface between globalization and technology is essential for reducing economic inequalities and achieving a fair distribution of income, output, and employment (Qadri & Bhat, 2018). To this end, technology influenced globalization, and higher education institutions can adapt to its positive and negative aspects by integrating technology into their curricula and instructional processes (Frye et al., 2010). The curriculum is a dynamic tool for achieving educational goals and is essential for these institutions.

2.2. The Concepts of Curriculum

The concept of curriculum refers to the overall educational plan of a school aimed at achieving specific outcomes in both academic and non-academic settings (Derebssa, 2004). This encompasses the entirety of the school's educational efforts. On the other hand, the term curriculum can be used to describe the content and subject matter taught in a particular educational program. It encompasses the way information is structured, organized, and absorbed by students (Ornstein and Hunkins, 2018). Besides, the concept of curriculum has evolved alongside educational theory and practice, encompassing various interpretations (Ahid, 2006). It is not merely a written document but a functional guide for classroom activities and environments (Ahid, 2006). The curriculum serves as a tool to achieve educational goals, guiding learning at all levels (Isnaeni, 2023). It includes detailed student activity plans, teaching materials, strategies, and program settings aimed at achieving desired targets (Hermawan et al., 2020). The curriculum must align with national values and reflect a country's vision, influencing its education system and life patterns (Isnaeni, 2023).

Curriculum is the transfer of values, beliefs, and principles about learning, understanding, knowledge, disciplines, individuality, and society through curricula. The curriculum is all the selected, organized, integrative, innovative, and evaluative educational experiences provided to learners consciously or unconsciously under the school authority to achieve the designated learning outcomes because of growth, maturation, and learning utilized for life in a changing society (Mulenga, 2018). Thus, the curriculum is an overall plan or design for a course of study, including the educational goals, content, teaching methods, and assessment strategies (Li and Li, 2023).

In addition, the curriculum is a comprehensive plan designed to provide the structure and direction for teaching and learning activities in educational institutions. It encompasses the learning objectives, content, instructional strategies, and assessment methods intended to facilitate the acquisition of knowledge, skills, and attitudes by learners. One key aspect of the curriculum is the alignment between the intended learning outcomes and the content, instructional methods, and assessment practices employed within the program (Wanget al, 2013). This concept, known as "constructive alignment," emphasizes the importance of ensuring that the curriculum is designed to support the achievement of the desired learning outcomes by students (Livingstone, 2014).

Another important consideration in the conceptualization of curriculum is the balance between breadth and depth of knowledge. Undergraduate programs often strive to provide a well-rounded education, exposing students to a diverse range of disciplines and perspectives, while also allowing for in-depth exploration of specific areas of interest (Zohar, 2023). This balance is crucial in developing the critical thinking and problem-solving skills that are highly valued in today's job market (Bridgstock, 2017). It is a multifaceted term connoted by different meanings by different scholars of different backgrounds although it has been commonly associated with academic study and training in education. In sum, curriculum is concerned with the planning, implementation, evaluation management, and administration of educational programs (McNeil, 2009).

Curriculum is the totality of learning experiences provided to students so that they can attain general skills and knowledge at a variety of learning sites. Emphasis is on learning rather than teaching, especially learning skills and knowledge at sites other than schools. The assumption is that all sites including workplace sites are conducive to learning general knowledge. Scholars heavily publicized this approach to curriculum in many countries and supported for economic reasons by business organizations, other vocationally oriented groups, and advocates of explicit competency standards (Marsh, 2009). Further, the curriculum sets out what all learners are entitled to learn, but they do not all need to experience it at the same rhythm or in the same locations. Accordingly, technology makes it possible to be more flexible about when and where teaching and learning take place and makes it easier for the curriculum to build on learners' interests and abilities (Derebssa, 2004; QCDA, 2011).

Curriculum development is an ongoing process that involves the systematic planning, implementation, and evaluation of educational programs to ensure that they meet the changing needs of learners and society (Schneiderhan et al., 2019). In addition, the curriculum requires regular review and updating to maintain its relevance and effectiveness (Cleary et al, 2017) stated that Taylor, 2016). A balanced curriculum concerned with contemporary living skills such as critical thinking, project-based learning, and social skills and includes higher-order skills such as teaching students to think critically and to communicate complex ideas clearly, and focuses on key competencies for the world of deficient paid employment (Kennedy, 2005; Reid, 2007; Rothstein, Wilder & Jacobsen, 2007; & Wilson, 2002 cited in Marsh, 2009). These authors stated that the curriculum should 'include a full range of skills and competencies relevant throughout the life span and takes a wider view of competencies which indicate capacities such as communication, civic participation, health, and well-being.

Another important consideration in the conceptualization of curriculum is the balance between breadth and depth of knowledge. Undergraduate programs often strive to provide a well-rounded education, exposing students to a diverse range of disciplines and perspectives, while also allowing for in-depth exploration of specific areas of interest (Zohar, 2023). This balance is crucial in developing the critical thinking and problem-solving skills that are highly valued in today's job market (Bridgstock, 2017).

A good curriculum includes a full range of skills and competencies that are relevant throughout the life span of every human person. A wide view of competencies which we may term as ‘capacities’ such as good communication skills, civic participation, living in harmony, respecting and caring for other people, and taking care of one’s health and well-being are some of the content areas (Mulenga, 2018). The curriculum is a dynamic and systematic reconstruction of knowledge and experiences and a means of achieving specific educational goals and objectives (Su, 2012). The curriculum helps learners acquire skills, values, knowledge, and attitudes that will help them solve social, political, and economic challenges in society. Thus, it focuses on teaching the essential elements of academic and moral knowledge, which constitute a strong core curriculum and high academic standards. Furthermore, Mulenga (2018) stated that a curriculum embodies the intentions of education and it carries the beliefs, values, attitudes, skills, knowledge and all that education is about.

The changes in the techno-socio-economic environment and the dawn of the digital era contributed to a successful curriculum becoming essential to higher education (Law, 2022). An effective curriculum is a crucial aspect of education, alongside infrastructure, technology, policies, procedures, and leadership. As stated by Blackmore & Kandiko (2012) smooth teaching and learning processes depend on efficient and practical guidelines that guide the transmission of knowledge from educators to learners. Thus, curriculum entails all experiences learners gain through workshops, classrooms, playgrounds, and interaction with educators. Consequently, Kandiko & Kingsbury (2021) curriculum encompasses all aspects of a student's life, necessitating the need for educational stakeholders to devise a curriculum that enriches learners' social, political, and economic well-being. Besides, a sound curriculum should exhaustively align learners with the prevailing market needs on a global scale.

2.3. Higher Education Curriculum

Higher education curricula are evolving in response to globalization and increasing diversity. Institutions are shifting from traditional liberal education towards more vocational and functional programs to meet economic priorities and workforce needs (Stoneham, & Feltham, 2009). Curricula incorporate elements like citizenship, sustainable development, and multiculturalism to address human and social development in a globalizing world (Taylor, 2008). The rapid pace of globalization is challenging traditional conceptualizations of higher education curricula, necessitating a rethinking of educational practices (Butucha, 2015). To prepare students for a diverse, globally interdependent society, institutions are modifying curricula and instructional strategies. These changes are leading to more flexible, personalized, and innovative program structures, including work-based, distance, and online learning options to meet stakeholder expectations (Stoneham & Feltham, 2009). The evolving curricula aim to equip graduates with the awareness, knowledge, and skills needed for success in an increasingly diverse and interconnected world.

The higher education curriculum in the twenty-first century is a highly contested arena in which different epistemological constructs and paradigms compete to shape and determine its form, content, and character (Stoneham, & Feltham, 2009). The role of curriculum is the sine qua non of higher education, providing quality and relevant programs and services to current and potential learners in the United States of America and elsewhere in the world, making it crucial for the effectiveness and well-being of educational institutions (Khan, & Law, 2015). A competency-based curriculum in higher education is crucial for sustaining the knowledge-based economy and meeting job market demands, requiring discipline-specific competencies and performance measurement methods (Barman, & Konwar, 2011)

Higher education has entered a new era, and administrators must be knowledgeable about technology. Because technology has made the world more interconnected, it is transforming higher education and changing social, cultural, educational, and economic aspects of life (Woodard *et* al., 2011). Thus, the integration of technology in higher education curricula has become increasingly important in the 21st century, offering opportunities for global collaboration and enhanced learning experiences (Meda, 2019; Meda & Makura, 2017). Educational technology has become ubiquitous, enabling real-time, anytime learning and fostering creative innovation (Meda & Makura, 2017). While technology-driven innovations such as flipped classrooms, blended learning, and mobile technologies offer numerous options for course design and delivery, they also present challenges for instructors in effectively implementing these tools (Strecker et al., 2018). The digital age demands that higher education curricula adapt to keep students updated with technological advancements, as early exposure to the internet has shaped student expectations (Enghagen, 1997). Despite differing perspectives on technology's role in education, an intellectual approach to integrating technology in curricula is supported for its potential to enhance student-learning outcomes (Meda, 2019).

Higher education instructors design curricula to provide students with the knowledge, skills, and attitudes necessary to succeed in their personal and professional lives. It is a comprehensive plan that outlines the learning objectives, content, instructional strategies, and assessment methods intended to facilitate the acquisition of knowledge and skills by learners. Curriculum development in higher education is an ongoing process that involves the alignment of educational goals, learning objectives, instructional strategies, and assessment methods to ensure that students acquire the knowledge, skills, and attitudes necessary to succeed in their personal and professional lives (Gulbahar & Kalelioglu, 2014).

Curriculum in higher education presents significant challenges because there are many contexts in which one could use the term as well as an array of stakeholders (lecturers, students, designers, planners, institutional leaders, government regulators, employer groups) with the potential to give the term different meanings. That means, in the context of higher education, the curriculum is highly influenced by the social, physical, economic, and cultural environment (O’Neill, 2015). The higher education curriculums undergraduate programs encompass the overall plan or design for a course of study, including the alignment between intended learning outcomes, content, instructional methods, and assessment practices, as well as the balance between breadth and depth of knowledge and the responsiveness to societal and labor market needs. Thus, higher education curriculum is important for educational developers in higher education institutions as it allows an educational course designed to meet defined needs (Roffe, 2010).

The higher education curriculum targets meeting societal needs and aspirations in every case. Subsequently, society, government, alumni, and others are affecting higher education curriculum development and the curricular change process (Lattuca & Stark, 2009). However, higher education curriculum is the formal mechanism through which practitioners achieve the intended educational aims and incorporate the social, cultural, and even political background of the program course (Robertson, 2006). Thus, the curricula have a linkage with current thinking and action on educational concerns and reforms around the world.

2.4. Technology as a Foundation of Curriculum Development

In talking about curriculum, technology is one of the different foundations of curriculum. That means the curriculum needs to align itself with the current and future advancement of technology because as technology advances from time to time, things will continue to be obsolete (Lee, 2020). Thus, technology is increasingly recognized as a crucial foundation for curriculum development, extending beyond its role as a mere facilitator of learning. Kuboja and Ngussa (2015) argued that technology has become a body of knowledge in itself, warranting consideration as a core educational foundation alongside philosophical, historical, sociological, and psychological pillars. Concerning this, Camelia (2020) noted that the need for curriculum development is based on science and technology to meet future challenges. The framework for technology education curricula focuses on developing intellectual processes, reinforcing academic content, and enhancing higher-order thinking skills (Johnson, 1992). Accordingly, Mubarok et al. (2021) identified scientific and technological foundations as one of the four main bases for curriculum development, alongside philosophical, psychological, and socio-cultural foundations. They stress the importance of adapting curricula to keep pace with technological advancements and societal changes.

As we face the hilltops of the 21stcentury, educationists and curriculum developers have no other option except to admit to redefining the concept of technological function as one of the core foundations of education and not just a mere tool to aid learning and teaching transaction(Kuboja, & Ngussa, 2015). The integration of technology in curricula serves multiple purposes, including naturalizing evolving work practices and legitimizing differences between technical elites and functionaries (Rassool, 1993). As technology continues to shape education, its role in curriculum formation remains a subject of ongoing discussion and development. Technology enhances interactivity, personalization, and access to learning resources, creating adaptive environments that improve overall education quality (Hasanbasri et al., 2023). The integration of emerging technologies is redefining curriculum development and implementation in schools, promoting communicative interactivity, and facilitating meaningful knowledge construction (Lino et al., 2024).

Technology-driven curriculum design has become increasingly important in modern education, particularly in language learning and higher education. The integration of technology in curriculum development enhances student engagement and learning outcomes (Yuyun, 2018; Tamilmani & Nagalakshmi, 2019). Researchers emphasize the need for a theory-based approach that prioritizes learning outcomes before selecting appropriate technologies (Marek & Wu, 2020). This approach ensures that technology serves pedagogical goals rather than being an end in itself. Accordingly, various digital tools, such as Google applications, and interactive book applications, can be incorporated into curriculum design to support diverse learning activities (Yuyun, 2018). Hence, the adoption of technology-driven curricula is particularly relevant in African countries, where higher education institutions are adapting to meet the needs of 21st-century students who expect real-time, flexible learning opportunities (Meda & Makura, 2017). Therefore, technology integration in curriculum design is essential for preparing students for the digital era.

Researchers argue that technology is considered as a core foundation of education rather than just a facilitating tool (Kuboja & Ngussa, 2015). This perspective is supported by the recognition of scientific and technological foundations as crucial starting points for developing adaptive curricula (Mubarok et al., 2021). The advancement of information technology and its convergence with science demands a more comprehensive approach to curriculum development (Camelia, 2020). Educational institutions must anticipate and support technological progress, incorporating contemporary scientific and technological developments into teaching materials. Furthermore, curriculum designers should embed technology to enhance student performance and achievement, particularly for digital native learners captivated by technology-mediated learning opportunities (Tamilmani K T & Nagalakshmi R, 2019).

However, challenges persist, including infrastructure barriers, insufficient educator training, and curriculum incompatibility (Hasanbasri et al., 2023). Therefore, to address these issues, a holistic approach involving infrastructure provision, comprehensive training, and policy support is necessary. As indicated by Mustafa & Suryadi (2022), the e-Curriculum Journal has contributed significantly to this field, emphasizing the convergence of teacher training and technology-based projects in school settings. Additionally, Almeida et al. (2020) educational technology serves as a foundation for improving education quality, supporting problem-solving, and facilitating learning in various conditions. Thus, a country's progress relies on its human resources, technological advancements, and knowledge. Future challenges include information technology, the convergence of science and technology, creative industries, and curriculum development with a comprehensive science and technology foundation (Camelia, 2020).

At present, educational institutions that are supposed to prepare students to live in a knowledge-based society need to consider ICT integration in their curriculum (Ghavifekr, Afshari & AmlaSalleh, 2012; Moges, 2021). Technology has continued to become central to teaching and learning and its use in education is consistently increasing (D'Angelo & Woosley, 2007; Li, 2007; & Nickerson & Zodhiates, 2013, cited in Riegel and Tong, 2018). Several studies indicate that technology increases learning efficiency, provides fast and reliable information, allows for professional presentations of their work, and enables diverse approaches to learning and to use of technology for instruction (Moges, 2021). In this 21st century, the term "technology" is an important issue in many fields including education because technology has become the knowledge transfer highway in most countries (Ghavifekr & Rosdy, 2015). Technology integration of course has gone through innovations and transformed our societies that have changed the way people think, work, and live (Grabe, 2007).

In addition, Cant and Bothma (2011) delineated that the use of technology is becoming more and more important in education where higher education institutions look at new ways of learning and teaching by adapting the changing profile of their students and learning habits. According to Saykili (2019), digital connective technologies in the 21st century, are deeply influencing all domains of life including the social, economic, and political scenarios. The 21st century has triggered dramatic changes in the ways people interact with content, communicate with one another, and function in society as well. Thus, in the 21st century, which is marked by digital innovations, economic, social, political, and societal domains are reshaped by digital connective technologies on a scale unprecedented before a new age has been reached; the digital age (Glenn, 2008).

In addition to access, connection, and interaction possibilities afforded by digital technologies, exponentially increasing information, changing and diversifying learner profiles, and new understandings developed as to what it means to learn in the digital age require higher education institutions to reconsider their structures and functions which were developed centuries ago. In the 21st century, the skills the learner needs to develop are changing so are the roles and skill sets the instructors need to have. In addition, the variety of learning environments where learners can construct knowledge is also increasing. However, higher education institutions are falling behind in dealing with these changes because of traditional administrative structures (Saykili, 2019).

Technology is a crucial part of education in the digital era where emerging technologies such as cloud computing, augmented reality (AR), and 3D printing are paving the way for the future of education. In this digital era, it is all about access, anywhere learning, and collaboration, both locally and globally (Hashim, 2018). Undeniably, education is starting to move its way with the emergence of current technology. With the rapid development of technology, the emergence and development of technology and its application to teaching come into full play in education (Hashim, 2018). The help of technology in the process of teaching and learning is no longer restricted and plays many more roles in this digital era than it did for previous generations. Today's generation has a high level of technological literacy coupled with recent technological advances that led to the expansion of technological applications in education.

Technology becomes an integral part of virtually all aspects of education, broadly covering curriculum planning, content development, and delivery, communication between learners, instructors, and institutions, assessment, and program evaluation. The latest technological advances and new and innovative measures improve teaching and learning effectiveness (Lee, 2020). Besides, technology transforms our day-to-day lives and it is a cause of change in the curriculum, the way we work and study, and how we spend our leisure time. Similarly, technology has an important part to play in the design and development of curriculum and has the potential to give learners an enjoyable, engaging, challenging, and motivating experience of learning, raising achievement and improving learning outcomes (Saykili, 2019). Thus, technology should not just replicate what we do already; it should offer new ways of working and offer learners new ways of interacting with information and gaining knowledge, understanding, and skills (QCDA, 2011). Furthermore, Marsh (2009) stated that the new computing technologies have created a culture for increasingly active learning; students can construct their meanings as they locate sources on the Internet, explore issues, communicate with others by inference develop their social skills through chat groups, conferences, and e-mail communications. Therefore, the curriculum is what the student constructs working with the computer and its various networks, for instance, the Internet.

2.5. Technology Integration in Curriculum

Technology integration in the curriculum is crucial for meeting 21st-century educational needs and addressing knowledge explosion (Joan et al., 2013). Thus, it enhances lesson delivery, student assessment, and learning engagement while promoting lifelong learning. A curriculum-based approach using content-specific learning activity-type taxonomies has been proposed to support technology integration in instructional planning (Harris et al., 2010). Some argue that technology should be considered a core foundation of education rather than just a facilitating tool, as it has become a body of knowledge itself (Kuboja & Ngussa, 2015). Hence, this shift in perspective requires redefining technology's role in curriculum formation and acknowledging its contribution to knowledge creation and transformation.

Furthermore, technology integration is the term used to describe intentional classroom practices that utilize technology to support instruction, promote learning of content, and demonstrate mastery of that content (Cradler et al., 2002; Koruyan, 2016; Okojie et al., 2006). Technology integration in higher education curricula has been the subject of extensive research and debate. Numerous studies have highlighted the potential benefits of incorporating technology into teaching and learning, including enhanced student engagement, improved learning outcomes, and the development of critical digital skills (Rosenberg & Koehler, 2018; Mishra & Koehler, 2006).

Technology integration involves incorporating technology into curricula and teaching processes to enhance learning outcomes. Technology integration is using computers effectively and efficiently in the general content areas to allow students to learn how to apply computer skills in meaningful ways (Dockstader, 1999). However, effective technology integration goes beyond simply using computers in classrooms, requiring teacher training, purposeful integration into the curriculum, and a purposeful approach to teaching and learning (Dockstader, 1999). Thus, it directly relates technology skills to content areas and classroom assignments. It enables deeper exploration of content, increases student motivation, and develops critical thinking skills

(Karakoyun & Kuzu, 2013). However, challenges persist in meaningful technology integration by teachers (Morehead, 2005). To address this, curriculum mapping can help teachers understand their curriculum more deeply, facilitating technology integration (Morehead, & LaBeau, 2005). Additionally, technology integration should be viewed as an integral part of instruction, not an isolated component (Okojie et al., 2006). It involves selecting appropriate technologies, demonstrating their use, evaluating their effectiveness, and customizing them to address instructional problems (Okojie et al., 2006). This comprehensive approach can lead to more successful implementation of technology in classrooms. The importance of technology integration lies in its potential to deepen content understanding, motivate students, and develop essential computer skills (Dockstader, 1999).

Technology integration into curricula is necessary for the systematic application of technology in educational settings. Especially in the modern world, when it's critical to properly incorporate technology into learning environments as opposed to utilizing it in teaching procedures, this is true. According to Jonassen et al. (1999), a curriculum that actively assists students in creating their own relevant knowledge and makes use of more interdisciplinary project-based learning activities is referred to as technology integration. When integrating technology into a curriculum, it must be used as a tool in trans-disciplinary settings or to successfully teach the curriculum's subject matter (Harris, 2005). Strommen and Lincoln (1992) believe that how technology is employed in the classroom to foster student engagement in the learning environment is more significant than the nature of the technology itself. 21st-century abilities are developed by students through the effective use of ICT resources, especially in learning contexts (Sadik, 2008). Numerous strategies for integrating technology into learning environments exist, enabling students to gain the skills necessary for the twenty-first century. The digital storytelling technique is one of these strategies (Karakoyun, & Kuzu, 2013).

However, the successful implementation of technology integration remains a challenge for many institutions (Ertmer & Ottenbreit-Leftwich, 2010). Technology integration encompasses all types of technology-based instructional practices including information and communication technologies, e-learning, distance education, and online learning. While researchers use these terms interchangeably, they involve different levels and types of software, hardware, electronic information systems, and communication devices (Bhatia & Mittal, 2009; Moore et al., 2011).

Technology integration comprises “the incorporation of technology resources and technology-based practices into daily routines, work and management of schools” (National Center for Education Statistics [NCES], 2002).

Technology integration into higher education curricula has become an increasingly important topic in recent years (Staley and Trinkle, 2011). Undergraduate programs in particular have faced growing pressure to adapt their curricula and instructional practices to leverage the capabilities of emerging technologies (Liu et al., 2023). Technology integration in higher education curricula has been the subject of extensive research and debate. Numerous studies have highlighted the potential benefits of incorporating technology into teaching and learning, including enhanced student engagement, improved learning outcomes, and the development of critical digital skills (Rosenberg and Koehler, 2018; Mishra & Koehler, 2006). However, the successful implementation of technology integration remains a challenge for many institutions (Ertmer & Ottenbreit-Leftwich, 2010).

In the same manner, Karkouti (2021) discussed that technology integration is often narrowly perceived by educators and researchers who disregard the importance of aligning specific technological resources with course content, student learning outcomes, and methods of instruction (Okojie et al., 2006). Diaz and Bontenbal further explain this point as,

> “Using technology to enhance the educational process involves more than just learning how to use a specific piece of hardware and software. Technology requires an understanding of pedagogical principles that are specific to the use of technology in instructional settings in classrooms” (2000, p. 2).

In an attempt to correct this common misconception, Okojie et al. (2006) first, stated technology integration is an integral component of teaching if faculty members are to facilitate learning and enhance students’ academic achievement. Technology integration occurs during lesson preparation when faculty members are “developing learning objectives, methods of instruction, feedback, and evaluation and assessment strategies including follow-up activities” (p. 66). Secondly, technology integration requires faculty members to mobilize and utilize technological resources, such as software applications, hardware, and electronic media at the classroom level during the process of instructional preparation and not as an afterthought activity. These techniques are beneficial for educators because they allow them to use appropriate technology resources based on the learning needs of their students and the objectives of their lessons. Thirdly, technology, learning, and instruction viewed technology as a tripartite model that supports and facilitates students' academic success and develops educators' critical thinking skills as they practice technology integration and "examine the appropriateness of the technologies they are using and whether such technologies are compatible with their lesson plan and learning outcomes" (p. 68).

According to Okojie *et* al. (2006), technology integration is a major element of instructional settings that needs acknowledgment by educators trying to implement technology in their classrooms. The failure to consider the strong association between technology integration, learning, and instruction degrades the quality of education in a technology-based learning environment and leads to poor use of technology for instructional and learning purposes. The integration of educational technology in curricula and its contribution to learning and instruction is of great concern to governments, researchers, policymakers, and educators. Technology integration involves increasing investments in facilities, software, communication, workforce, and professional development (Spektor-Levy *et* al., 2005*).* This includes the integration of technology into content toward transforming roles of technology as a pedagogical agent it is very important to boost the instructional process.

In the context of undergraduate programs, technology integration can take various forms, such as the use of digital learning resources, online course delivery, and the integration of emerging technologies like virtual reality, artificial intelligence, and data analytics (Säljö, 2010). However, several factors hindered the effective integration of technologies into the curriculum and instructional settings. These include faculty resistance, institutional barriers, and a lack of professional development opportunities (Reid, 2014; Akram *et* al., 2023). The use of technology can enhance the quality of education by providing students with access to a wide range of resources and learning opportunities. It can also facilitate the development of critical thinking, problem solving, and communication skills that are essential for success in a rapidly changing digital world (Delgado et al., 2015).

In short, the integration of technology into the Ethiopian public universities' undergraduate curriculum and instructional settings is essential to enhance the quality of education and prepare students for the demands of a digital world. The adoption of various approaches such as blended learning, mobile learning, online learning, and e-learning can provide several benefits for students. However, there is a need for adequate resources, training, and support for instructors to ensure successful integration (Bati & Workneh, 2021).

2.6. Technology Integration into Higher Education Curricula and Instructional Settings

2.6.1. Rationales for integrating technology into curriculum and instruction

Understanding the rational foundations of technology can inform curriculum development and teaching methods in the context of IT integration (Nasution, 2024). From a philosophical standpoint, educational technology plays a crucial role in integrating information technology with curriculum reform (Rong-jie, 2010). However, the focus of technology integration efforts can vary, with some emphasizing student-centered information acquisition and others prioritizing content learning assisted by technology (Harris, 2005). Technology integration in higher education has the potential to revolutionize pedagogy and enhance learning experiences. It can improve teacher performance, student engagement, and learning outcomes (Panakaje et al., 2024; Torres, 2022). The use of e-learning platforms, augmented reality, and virtual reality can positively impact student achievement (Zulfikhar et al., 2024). Technology integration in higher education offers numerous pedagogical advantages, including enhanced student engagement, improved learning outcomes, and access to real-world content (Torres, 2022). Institutional support plays a crucial role in facilitating technology adoption and improving teacher performance and student engagement (Panakaje et al., 2024). Effective integration involves considering pedagogical factors, aligning with educational strategies, and adapting to emerging technologies (Xakaza-Kumalo, 2018).

The integration of technology in higher education curricula can enhance student engagement, retention, and access to real-world content (Torres, 2022). Besides, technology enables collaborative learning across borders, making it essential for 21st-century higher education curricula (Meda, 2019). Learning theories like behaviorism, cognitivism, and constructivism provide a basis for understanding how students learn with technology (Cruz, 2013). While technology offers numerous advantages, it's crucial to consider its intellectual impact on students' learning experiences (Meda, 2019) and use appropriate technological tools to enhance instruction aligned with Bloom's taxonomy (Cruz, 2013).

Likewise, curriculum integration with technology has become a focal point in education, aiming to enhance learning and prepare students for the 21st century (Sun, 2008). The rationale for integration includes promoting quality education, fostering creativity, and improving overall national competitiveness (Sun, 2008). Technology integration is not merely about placing computers in classrooms, but rather seamlessly incorporating technology into content areas to deepen learning and develop essential skills (Harris, 2005). Effective integration requires teacher training, purposeful application, and a focus on content learning rather than isolated technology skills (Harris, 2005). The shift toward curriculum integration is significant for policymakers, curriculum developers, and implementers (Magoma, 2016).

Furthermore, technology integration in education is a multifaceted process that aims to enhance learning outcomes and promote equity (Eden et al., 2024). It involves using online resources, tools, and apps to engage learners and develop their ability to acquire, analyze, and present information effectively (Khan & Alamri, 2017). The integration of technology can positively impact student achievement and change the roles of teachers and students, with students taking more responsibility for their learning (Gupta & Goel, 2024). However, successful implementation faces external barriers such as inadequate hardware and support, as well as internal obstacles related to personal beliefs and confidence (Bagley & Ryan, 2015). Effective integration requires aligning technology with pedagogical goals, fostering digital literacy, and promoting critical thinking (Eden et al., 2024). To improve technology integration, schools need structured initiatives, extensive professional development, and ongoing support for teachers (Gupta & Goel, 2024).

As elucidated by, Darling-Hammond *et* al. (2019) highlighted that technology supports personalized learning in American public universities. The effective use of technology can enhance teaching and learning experiences, improve student outcomes, and prepare graduates for the demands of the digital age. Technology integration into the curriculum enhances student engagement and active learning. Technology tools such as multimedia presentations, online discussion forums, and virtual simulations provide opportunities for students to participate in their learning, collaborate with peers, and apply knowledge in real-world contexts. A study conducted by Means *et* al. (2017) emphasized that technology integration promotes active learning and student engagement in American public universities. Technology integration facilitates personalized and adaptive learning experiences. Educational software, learning management systems, and data analytics can tailor instruction to individual student needs, providing personalized feedback, adaptive assessments, and customized learning pathways.

In addition, technology integration fosters the development of digital literacy skills among students. A study conducted by Bailey *et* al. (2018) emphasized the role of technology integration in enhancing digital literacy skills among American university students. A study carried out by Allen and Seaman (2018) highlighted the potential of technology integration in expanding access to education in American public universities. Integrating technology in curriculum and instructional practices has also become increasingly important in Australian public universities. The effective use of technology can enhance teaching and learning experiences, promote student engagement, and prepare graduates for the digital era. A review of the literature highlights the significance of technology integration in Australian higher education. The benefit of integrating technology into the curriculum is the promotion of active and student-centered learning. Technology tools such as multimedia presentations, online collaboration platforms, and virtual simulations provide opportunities for students to engage with course content, collaborate with peers, and apply knowledge in practical contexts. A study by conducted by Kennedy et al. (2020) emphasized that technology integration facilitates student-centered approaches in Australian public universities. Technology integration enables personalized and adaptive learning experiences. Learning management systems, educational software, and data analytics can tailor instruction to individual student needs, providing personalized feedback, adaptive assessments, and customized learning pathways. This promotes self-paced learning, accommodates diverse learning styles, and supports students with varying levels of proficiency. A study conducted by Henderson et al. (2019) highlighted the importance of technology in supporting personalized learning in Australian public universities.

In addition, technology integration fosters digital literacy skills among students. In an increasingly digital world, graduates need to possess digital literacy skills to thrive in their careers. By incorporating technology into the curriculum, Australian public universities can equip students with the necessary skills to navigate digital tools, critically evaluate online information, and effectively communicate using various digital platforms. A study by Herrington et al. (2018) emphasized the role of technology integration in enhancing digital literacy skills among Australian university students. Moreover, technology integration expands access to education and promotes inclusivity. Online learning platforms, open educational resources (OER), and mobile learning initiatives can reach students who face geographical or other barriers to education. This allows for flexible learning options, increased educational opportunities, and the ability to support a diverse range of learners. A study conducted by Colvin et al. (2019) highlighted the potential of technology integration in expanding access to education in Australian public universities.

Integrating technology in curriculum and instructional practices is of great importance in African public universities. The effective use of technology can enhance teaching and learning experiences, promote student engagement, and prepare graduates for the digital era. A review of the literature highlights the significance of technology integration in African higher education. One key benefit of integrating technology into the curriculum is the promotion of active and student-centered learning. Technology tools such as multimedia presentations, online collaboration platforms, and virtual simulations provide opportunities for students to engage with course content, collaborate with peers, and apply knowledge in practical contexts. A study conducted by Sife *et* al. (2017) emphasized that technology integration facilitates student-centered approaches in African public universities. Furthermore, technology integration enables personalized and adaptive learning experiences. Learning management systems, educational software, and data analytics can tailor instruction to individual student needs, providing personalized feedback, adaptive assessments, and customized learning pathways. This promotes self-paced learning, accommodates diverse learning styles, and supports students with varying levels of proficiency.

A study conducted by Chigona *et* al. (2019) highlighted the importance of technology in supporting personalized learning in African public universities. Technology integration fosters digital literacy skills among students. In an increasingly digital world, graduates need to possess digital literacy skills to succeed in their careers. By incorporating technology into the curriculum, African public universities can equip students with the necessary skills to navigate digital tools, critically evaluate online information, and effectively communicate using various digital platforms. A study conducted by Mtebe & Raisamo (2014) emphasized the role of technology integration in enhancing digital literacy skills among African university students.

Moreover, technology integration expands access to education and promotes inclusivity. Online learning platforms, open educational resources (OER), and mobile learning initiatives can reach students who face geographical or other barriers to education. This allows for flexible learning options, increased educational opportunities, and the ability to support a diverse range of learners. A study conducted by Ng'ambi (2013) highlighted the potential of technology integration in expanding access to education in African public universities. Integrating technology in the curriculum and instructional practices of African public universities brings numerous benefits. It promotes active learning, enables personalized instruction, fosters digital literacy skills, and expands access to education. By embracing technology integration, African public universities enhance the quality of education and better prepare students for the challenges of the digital age.

2.6.2. Technology integration strategies in curriculum and instructional settings

The integration of technology into the curriculum has become increasingly important in today's digital age. The integration of technology into universities' curricula and instructional settings has become increasingly important in recent years because technology can enhance the quality of education by providing students with access to a wide range of resources and learning opportunities. It can also facilitate the development of critical thinking, problem-solving, and communication skills that are essential for success in a rapidly changing digital world (Delgado et al, 2015). The integration of technology into universities' curricula and instructional settings in undergraduate programmers is essential to enhance the quality of education and prepare students for the demands of a digital world. The adoption of various approaches such as blended learning, mobile learning, online learning, and e-learning can provide several benefits for students. However, there is a need for adequate resources, training, and support for instructors to ensure successful integration (Bati and Workneh, 2021).

One key aspect of technology integration is the alignment between the curriculum and the instructional settings where researchers emphasize the importance of a cohesive and intentional approach to technology integration that aligns curriculum, pedagogy, and technological tools to work together to support student learning (Harris et al., 2009; Grimus, 2020; Livingstone, 2014; Wanget al, 2013). This requires a comprehensive understanding of the interplay between content, pedagogy, and technology, known as the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra and Koehler, 2006). In the context of undergraduate programs, technology integration can take various forms, such as the use of digital learning resources, online course delivery, and the integration of emerging technologies like virtual reality, artificial intelligence, and data analytics (Säljö, 2010).

Moreover, blended learning is another approach to technology integration into the higher education curriculum. This approach combines traditional face-to-face instruction with online learning. Blended learning provides students with the flexibility to learn at their own pace while still having access to the guidance and support of their instructors. Online learning is another approach to integrating technology into the higher education curriculum. It involves delivering educational content through online platforms such as Model or Blackboard, which allows students to access educational materials from anywhere at any time. e-learning is yet another approach that uses electronic devices such as computers or laptops to deliver educational content. e-learning is particularly useful for delivering multimedia content such as videos, animations, and simulations. The integration of technology into universities' curricula and instructional settings is essential to enhance the quality of education and prepare students for the demands of a digital world. The adoption of various approaches such as blended learning, mobile learning, online learning, and e-learning can provide several benefits for students. However, there is a need for adequate resources, training, and support for instructors to ensure successful integration (Sharma & Kitchens, 2018).

Computers and internet connections are becoming widely available in schools and classrooms. In 1999, 99 percent of teachers in the United States had access to a computer in their schools, and 84 percent had one or more computers in their classrooms. At the same time, Internet connections were also widespread, with 95 percent of schools and 63 percent of classrooms having access. Worldwide, many countries are making the creation and diffusion of information and communications technology an important priority. Even in developing countries, the usage is increasing dramatically. Nowadays, information and communication technology are becoming more widely available, and teachers and policymakers are turning their attention to the difficult task of understanding how best to integrate this technology into learning environments (Williams, 2022). Of course, the majority of higher educational institutes tried to integrate emerging Internet technologies into the teaching and learning process in higher education (Kim and Curtis, 2006). For instance, a survey on higher education in the United States found that more than 2.35 million students enrolled in online courses in 2004 and online education is becoming an important long-term strategy for many postsecondary institutions (Ibid.).

According to the Asian Development Bank (2010), education is the formal process by which society deliberately transmits its accumulated knowledge, skills, customs, and values from one generation to another. Higher education is a part of education and it involves work towards a degree-level qualification. One part of the economic growth depends on the usage of current technologies. Technology plays a major role in this process. Technology plays an important role in the development and expansion of online education; therefore, many universities have reported an increased use of online tools. Most of them are interested in wireless technologies, simulations, digital libraries, and reusable content objects (Kim & Curtis, 2006).

In Ethiopian public universities, there is a growing need to integrate technology into the curriculum to enhance the quality of education and prepare students for the demands of a digital world. According to a study by Alemayehu and colleagues (2021), the integration of technology in higher education in Ethiopia is essential to improve access to educational resources and promote student engagement. For instance, blended learning provides students with the flexibility to learn at their own pace while still having access to the guidance and support of their instructors. A study conducted by Tadesse and colleagues (2019) found that blended learning is an effective approach to teaching in Ethiopian universities, as it provides students with a more interactive and engaging learning experience. Online learning is another approach to integrating technology into the curriculum. It involves delivering educational content through online platforms such as Moodle or Blackboard, which allows students to access educational materials from anywhere at any time. A study conducted by Gebrehiwot and colleagues (2020) found that online learning is an effective approach to teaching in Ethiopian universities, as it provides students with greater access to educational resources and promotes self-directed learning.

E-learning is yet another approach that uses electronic devices such as computers or laptops to deliver educational content. It is particularly useful for delivering multimedia content such as videos, animations, and simulations. According to Gebre and colleagues (2018), e-learning has the potential to improve the quality of education in Ethiopia by providing students with a more interactive and engaging learning experience. Mobile learning is another approach to integrating technology into the curriculum. It involves the use of mobile devices such as smartphones and tablets to deliver educational content to students. This approach is particularly useful for reaching students in remote areas who may not have access to traditional classroom settings. According to Mekonnen and colleagues (2018), mobile learning has the potential to improve access to education in Ethiopia, especially in rural areas.

With the rapid growth of online education higher education institutes have to focus on providing high-quality online programs (Guven, 2009). A study conducted by Lorenzo et al, (2006) found that frequent Internet users are willing to use e-learning systems and students believe that an e-learning system will be more useful to them if it is easy to use. Curtis & Bonk, (2009) identified Wiki books and shared online videos, YouTube, Google, or Teacher Tube videos and course concepts widely used in higher education. YouTube technology is highly popular in the USA for higher education. Those videos can augment or illuminate the weekly assigned readings. Curtis & Bonk (2009) argue that YouTube videos will help in many ways to uplift higher education in the world. They provide a context for extending learning beyond text to visual or episodic memory and provide a common experience for learners to discuss and reflect on concepts and ideas anchored instruction.

2.6.3. Frameworks of technology integration into higher education curriculum and instruction

Technology integration in higher education has become increasingly important to enhance teaching and learning practices. Technology integration frameworks provide simplified models to understand and implement technology in educational settings. The TPACK model emphasizes the interplay of technological, pedagogical, and content knowledge, while the SAMR model focuses on levels of technology integration (Bajracharya, 2021). These frameworks help explain technology adoption, inform decision-making, and support pedagogical reforms (Niederhauser & Lindstrom, 2018). A systemic approach to sustaining technology integration considers people, processes, and systems as key components (Hsu & Sharma, 2010). Hence, Ruthven (2009) proposes a naturalistic conceptualization that situates technology adoption within everyday teaching practices, identifying structuring features such as working environment, resource system, activity format, curriculum script, and time economy. While these models offer macro-level concepts, instructors and trainers need specific, chronological guidance for effective implementation (Bajracharya, 2021). Henceforward, understanding and applying these frameworks can help educators overcome challenges and leverage technology to enhance teaching and learning experiences

2.6.3.1. TPACK framework and technology integration

The technological pedagogical content knowledge (TPACK) framework, while popular for examining teacher knowledge needed for technology integration, has faced criticism. Brantley-Dias and Ertmer (2013) argue that TPACK's seven knowledge domains may be too vague for practical application, suggesting a return to simpler conceptualizations. Cavanagh and Koehler (2013) highlight issues in TPACK measurement, including epistemological confusion and lack of clarity in measurement purposes. Willermark's (2018) review of empirical studies reveals diverse approaches to identifying teacher TPACK, with self-reporting being most common and performance evaluations rare. The study also notes the implicit operationalization of TPACK, making result comparisons difficult. Pamuk (2012) found that preservice teachers struggle with developing new knowledge within the TPACK framework, particularly due to limited pedagogical experience. The study emphasizes the importance of developing pedagogical content knowledge before integrating technology and suggests supporting this development with actual teaching experience in pre-service education.

The TPACK framework has become a popular construct for examining the types of teacher knowledge needed to achieve technology integration. However, TPACK, with its seven knowledge domains, may be too large (vague or ambiguous) of a construct to enable reasonable application (Brantley-Dias, & Ertmer, 2013). Technological pedagogical and content knowledge (TPACK) has been introduced as a conceptual framework for the knowledge domains teachers need to master to use technology successfully and has drawn much attention across the educational field. Yet, the framework has been criticized for not being practically useful, due to inaccurate and insufficient definitions. To better understand the critics and the usefulness of the framework, an investigation of how the framework has been applied to show teacher TPACK is needed (Willermark, 2018)

The TPACK framework, while valuable for understanding technology integration in education, has several drawbacks. Preservice teachers often struggle to develop new knowledge bases and integrate technology effectively due to limited pedagogical experience (Sonmez Pamuk, 2012). The framework's static classification of knowledge is a limitation, prompting the proposal of a more dynamic "TPACKing" approach to analyzing teachers' knowledge construction practices (Olofson et al., 2016). Despite its widespread use and positive results in enhancing teachers' capabilities, there are still gaps in TPACK research, particularly in developing technological environments and studying students' learning conceptions with technology (Chai et al., 2013). Furthermore, the integration of technology into curriculum development is complex and highly context-dependent, influenced by factors such as technology availability, teaching contexts, and teachers' attitudes (Bai, 2021). These challenges highlight the need for a more holistic approach to technology integration in education.

2.6.3.2 Augmentation Modification Redefinition framework and technology integration

The Substitution Augmentation Modification Redefinition (SAMR) model, developed in 2010 by the education researcher Ruben Puentedura (Terada, 2020; Mohebi, 2021), is an important guideline and a fundamental framework for the integration of technology in today’s classrooms. The SAMR is a framework for technology integration in education that aims to enhance student engagement and motivation (Boateng & Kalonde, 2024). Research suggests a positive relationship between technology integration using the SAMR model and improved student motivation and engagement, particularly when technology creates interactive and personalized learning experiences (Boateng & Kalonde, 2024). However, educators may require specific instructional guidance to effectively implement these models (Bajracharya, 2021).

However, the SMAR framework for technology integration in education has faced criticism and limitations. While it provides a macro-level concept, instructors require more detailed, step-by-step guidance for effective implementation (Bajracharya, 2021). Similar to other technology acceptance models, SMAR may struggle with reliably quantifying behavior in observed investigations (Malatji et al., 2020). Critics argue that such models often fail to consider factors like cost and structural constraints that influence technology adoption (Malatji et al., 2020). Additionally, technology acceptance models are generally more suitable for individual use rather than institutional applications requiring integrated information technology (Ajibade, 2018). To address these limitations, researchers suggest modifying existing models by adding or removing variables and incorporating moderators or mediators (Malatji et al., 2020). Furthermore, a shift from technology-push to strategy-pull models, facilitated by new "plug-and-play" technologies, may prove more effective in integrating knowledge management into organizational processes (Malhotra, 2005).

Although SAMR is an adaptable and beneficial framework for integrating technology into teaching, it has some limitations. The SAMR model's design is a hierarchical taxonomy. The model has received criticism because its design does not consider the complex elements of teaching with technology (Gillespie, 2022). It defines and arranges teachers' uses of technology in very narrow ways (Hamilton et al., 2016). The SAMR model strongly emphasizes the levels of technology integration teachers should attain to progress along the continuum. However, the importance of highlighting the use of technology in ways that indicate a change in pedagogy or daily classroom practice to improve teaching and learning is ignored (Hamilton et al., 2016).

A study conducted by Hrastinski (2019) found that blended learning models, such as the flipped classroom, have been successful in Australian universities, promoting active learning and fostering student-centered experiences. Another best practice is the use of authentic assessment methods supported by technology. Authentic assessments allow students to apply their knowledge and skills in real-world contexts. Technology can facilitate the creation and submission of multimedia projects, online portfolios, and collaborative group work. Accordingly, Kennedy *et* al. (2019) stated that the effectiveness of authentic assessment methods in Australian universities promotes deeper learning and prepares students for professional contexts.

Furthermore, successful models of technology integration in higher education include the establishment of learning communities and networks. These communities provide opportunities for collaboration, knowledge sharing, and peer support among faculty members, instructional designers, and educational technologists (Herrington et al., 2019). In addition to this, it emphasizes the importance of building strong learning communities to support technology integration efforts in Australian universities.

Additionally, the provision of ongoing professional development for faculty members is crucial for successful technology integration. Professional development programs can enhance faculty members' pedagogical skills, technological competencies, and understanding of effective instructional strategies. A study conducted by Olcott et al. (2020) highlighted the positive impact of faculty development initiatives on technology integration in Australian universities. The best practices and successful models of technology integration in Australian universities include blended learning approaches, authentic assessment methods, the establishment of learning communities, and ongoing faculty professional development. By using these strategies, universities effectively integrate technology into curriculums and instructional settings, enhance student engagement, and learning outcomes, and prepare students for the digital age.

Technology integration in higher education has become increasingly important to enhance teaching and learning practices. The integration of e-learning platforms, augmented reality, and virtual reality have shown a positive relationship with student engagement and academic achievement (Zulfikhar et al., 2024). Technology integration significantly impacts teacher learning, pedagogical strategies, and student engagement, with institutional support playing a crucial role (Panakaje et al., 2024). As the world rapidly moves into digital media, the importance of ICT integration in education will continue to grow in the 21st century (B. Alemu, 2015).

One best practice is the adoption of a blended learning approach. Blended learning combines face-to-face instruction with online learning activities, leveraging technology to enhance student engagement and learning outcomes (Garrison and Vaughan, 2018). Besides, blended learning models, such as the flipped classroom, have been successful in American universities, promoting active learning and fostering student-centered experiences.

Another best practice is the use of authentic assessment methods supported by technology. Authentic assessments allow students to apply their knowledge and skills in real-world contexts. Technology can facilitate the creation and submission of multimedia projects, online portfolios, and collaborative group work. A study conducted by Wiggins et al. (2017) highlighted the effectiveness of authentic assessment methods in American universities, promoting deeper learning and preparing students for professional contexts. Furthermore, successful models of technology integration in higher education include the establishment of learning communities and networks. These communities provide opportunities for collaboration, knowledge sharing, and peer support among faculty members, instructional designers, and educational technologists. Thus, Keengwe et al. (2019) emphasized the importance of building strong learning communities to support technology integration efforts in American universities.

Additionally, the provision of ongoing professional development for faculty members is crucial for successful technology integration. Professional development programs can enhance faculty members' pedagogical skills, technological competencies, and understanding of effective instructional strategies. Accordingly, Hsu et al. (2019) highlighted the positive impact of faculty development initiatives on technology integration in American universities. The best practices and successful models of technology integration in American universities include blended learning approaches, authentic assessment methods, the establishment of learning communities, and ongoing faculty professional development. By implementing these strategies, universities can effectively integrate technology into the curriculum and instructional settings, enhancing student engagement and learning outcomes, and preparing students for the digital age. Therefore, technology integration in higher education has become increasingly important to enhance teaching and learning practices. Blended learning combines face-to-face instruction with online learning activities, leveraging technology to enhance student engagement and learning outcomes. A study conducted by Garrison and Vaughan (2018) found that blended learning models, such as the flipped classroom, have been successful in American universities, promoting active learning and fostering student-centered experiences.

In addition, the use of authentic assessment methods supported by technology allows students to apply their knowledge and skills in real-world contexts. Technology can facilitate the creation and submission of multimedia projects, online portfolios, and collaborative group work. Wiggins et al. (2017) showed the effectiveness of authentic assessment methods in American universities, promoting deeper learning and preparing students for professional contexts. Successful models of technology integration in higher education include the establishment of learning communities and networks. These communities provide opportunities for collaboration, knowledge sharing, and peer support among faculty members, instructional designers, and educational technologists. Likewise, Keengwe et al. (2019) emphasized the importance of building strong learning communities to support technology integration efforts in American universities.

The provision of ongoing professional development for faculty members is crucial for successful technology integration. Professional development programs can enhance faculty members' pedagogical skills, technological competencies, and understanding of effective instructional strategies. Similarly, Hsu et al. (2019) highlighted the positive impact of faculty development initiatives on technology integration in American universities. The best practices and successful models of technology integration in American universities include blended learning approaches, authentic assessment methods, the establishment of learning communities, and ongoing faculty professional development. Thus, universities effectively integrate technology into the curriculum and instructional settings to enhance student engagement, achieve learning outcomes, and prepare students for the digital age.

2.7. The Roles of Technology in Curriculum and Instruction

Technology is an integral part of our everyday lives. Students are considered digital natives and have become accustomed to always being connected to their devices and the Internet (Harrell, & Bynum, 2018). Besides, in today's educational environments, incorporating technology is a crucial feature in influencing how students learn and ensuring that everyone has equal opportunities to access education (Eden et al., 2024). Likewise, technology integration augments student engagement improves practicality in teaching-learning processes, and allows for personalized learning (Raave et al., 2022; Gupta & Goel, 2024). Instructors integrate technology primarily to provide visuals for attention and interaction, manage time effectively, and meet individual student needs (Liu, 2016). Moreover, technology integration can enhance teaching methods, improve student-teacher interactions, and facilitate the tracking of learning processes (Chen et al., 2019).

Technology improves the dynamics between teachers and students, often leading to enhanced learning. This can include the use of interactive online platforms, educational apps, and digital resources that cater to different learning styles (Elsayed et al., 2017). Also, it allows for more personalized learning experiences, as it provides opportunities for adaptive learning and tailored feedback, ultimately contributing to improved student engagement and academic performance. Likewise, Perrotta (2013) argued that the potential benefits of teachers using digital technology are extensively documented in academic literature, often encompassing improved learning outcomes, heightened student engagement, and more effective management and organization of learning.

Since technology is so important to our lives, schools must now incorporate it into their curricula to help students develop the skills and careers of the twenty-first century (Cakir, 2012; Luterberbach & Brown, 2011). Furthermore, technological innovation is crucial for existence, and human learning is essential. Ensuring access to knowledge, interaction, and creation capabilities is urgent, and incorporating technology into curriculum and teacher education is crucial (Kaplan, 2017). Hence, technology integration in education has become increasingly important for enhancing teaching and learning processes. Curriculum mapping can help teachers understand their curriculum deeply, enabling meaningful technology integration and fostering student engagement through inquiry (Morehead & LaBeau, 2005).

Incorporating technology in instruction is crucial for preparing educators to facilitate classroom technology use (Kaplan, 2017). Education technology, which combines instructional and system approaches, systematizes scientific applications in education to improve the teaching-learning environment in conventional and distance learning settings (Ali & Equbal, 2020). The digital curriculum and accompanying technology offer new perspectives on student engagement and control over learning, particularly for students with disabilities accessing the general curriculum (Abell et al., 2005). Additionally, the role of the digital curriculum and accompanying technology is beginning to bring new perspectives to how students can be engaged and have more control over their learning. As explained by Morehead & LaBeau (2005) technology continues to reshape classrooms, teachers need to understand its benefits and find meaningful ways to integrate it into their instruction.

Technology plays a significant role in today's era, the scope of technology has expanded so much that it impacted the educational sector. This has revolutionized the entire educational field, making teacher-student interaction more enjoyable (Bhowmik *et* al., 2024). Therefore, the adoption and integration of ICT into the teaching and learning environment provide more opportunities for teachers and students to work better in a globalized digital age (Lawrence, & Tar, 2018). Thus, the integration of technology in higher education is crucial for enhancing teaching and learning processes. Virtual reality and e-learning platforms offer significant potential to improve instruction and student engagement (Estes et al., 2017; Zulfikhar et al., 2024). Furthermore, technology integration positively impacts teacher learning, pedagogical strategies, teacher performance, and student engagement (Panakaje et al., 2024). To maximize the benefits of technology in improving student academic achievement, institutions should focus on providing relevant curriculum design, accessibility, and continuous support for faculty development (Martínez-Martínez, 2006).

Information and communication technology refers to technology (ICT) that provides access to information using components. Some of the components of ICT include wireless networks, the internet, cell phones, and other communication media. The application of ICT is making changes in economic and social development worldwide (Johnston et al., 2019). Learners of today grow up with numerous technological tools, and therefore, the way of adjusting teaching to the possibilities of new modern technologies. Technology integration has reinforced the learning surroundings and classroom guidelines by allowing learners to complete their assignments using internet-enabled devices. The school curriculum entails the infusion of technology to heighten learning in multi-disciplinary settings. Technology integration equips the learners with a sense of power and allows for improved learning in broad topics. It encompasses all types of computer and communications equipment and software used to produce, design, store, transmit, interpret, and modify data in various formats (Chandler & Munday, 2020). In education, personal computers, laptops, tablets, and mobile phones are commonly used tools. In the modern society of the 21st century, it is not strange to see at least one computer in every classroom. A classroom computer is any electronic device that allows students to connect to the internet to study, create, and accomplish assignments and schoolwork. Teachers can use these computers to assign work to students and create study groups in a classroom. The use of computers has enabled the division of work and attention among students (Stockwell & Liu, 2015).

A study conducted by Johnston et al. (2019) proved the importance of technology in the learning environment. For instance, evidence supports the finding that ICT can serve different purposes if used effectively. It can provide a platform for professional development for both pre-service and in-service teachers. It can also aid in teaching and learning processes and increase teacher knowledge and skills. Similarly, it can improve educational management systems, and the steadiness and quality of instruction both for formal and non-formal education and for increasing prospects for more student-centered pedagogical methods. Equally, ICT can overcome gender disparity and language and disability obstacles, it can broaden sources of information and knowledge, nurture collaboration, promote creativity, and strengthen higher-order thinking skills. Finally, it can provide flexibility in delivery and reach learners outside the traditional educational systems. Because education is paramount for development, ICT enables interactive learning, supports change, improves students' skills, and prepares them for a global economy and the current knowledge-based society and technology plays an influential role in studying, communication, and flexibility (Dondanville et al., 2020).

2.7.1. Benefits of technology integration for students

Recent research highlights the numerous benefits of technological integration in education. It can enhance student learning outcomes, academic achievement, and engagement (Bhat, 2023). Technology integration facilitates personalized learning, encourages student responsibility, and transforms teachers into guides (Gupta & Goel, 2024). It supports collaborative and independent learning, improves language skills, and provides access to diverse resources (Rintaningrum, 2023). Additionally, it can reduce discipline issues, boost teacher confidence, and facilitate assessment (Ahmad & Hamad, 2020). However, challenges exist, including rapid technological changes, costs, time constraints, and varying abilities to use technology (Rintaningrum, 2023). Successful integration requires supporting existing student-centered practices, implementing organization-wide initiatives, and providing extensive professional development for teachers

(Gupta & Goel, 2024). Overall, technology integration in education offers significant potential to enhance the learning experience and outcomes for students across various subjects and settings.

Technology integration in curriculum and instructional settings strongly facilitates students understanding and fosters deep and higher-order thinking levels. Accordingly, Brown (2017) stated that the use of technology in teaching could have profound effects on students' learning regarding the development of higher cognitive capabilities. Regarding this, Hardman (2019) demonstrated that ICT increases students' achievements and supports their learning and attainment. The findings showed that students in technology integration classrooms perform 12% higher than do students in traditional settings. Additionally, studies have shown that technology can influence language acquisition, enhance literacy development, support learning, enhance self-esteem, and motivate students. If students exercise computers at the early stages of learning, they will be motivated to learn and have better learning outcomes than those who do not exercise computers.

2.7.2. Benefits of technology integration for instructors

The positive effect of interactive learning technologies is not limited to students but also benefits instructors because it causes more collaborative instructional strategies to occur among instructors. Technology integration in teaching offers numerous advantages for educators. Technology integration enhances student engagement, accessibility, and academic achievement (Torres, 2022; Zulfikhar et al., 2024). Instructors who integrate technology often demonstrate advanced techno-pedagogical competence and high ICT acceptance (Çalışkan et al., 2021). Using e-learning platforms, augmented reality, and virtual reality can positively impact student learning outcomes (Zulfikhar et al., 2024). Hence, technology integration in higher education teaching offers significant potential for improving the learning experience.

Technology integration enhances classroom management, boosts teacher confidence, and facilitates student assessment (Ahmad & Hamad, 2020). Integration of information and communication technologies (ICTs) makes learning more interactive and motivating for students (Akram et al., 2022). It also improves language teaching and learning by providing an effective environment for skill development (Iqbal et al., 2021). Successful integration requires proper planning, implementation, and evaluation phases (Kler, 2014). Thus, to maximize the benefits of technology in education, recommendations include optimizing digital pedagogies, modifying curricula, and providing ongoing professional development for instructors (Pelila et al., 2022; Gupta & Goel, 2024).

Teachers perceive increased student engagement as a primary advantage of classroom technology use (Carver, 2016; Rother, 2003). Technology can enhance teaching and learning dynamics, improve class discussions, and involve students more deeply in their education (Elsayed et al., 2017). Teachers also report that computers can be more effective than traditional methods for conveying certain educational materials (Rother, 2003). Importantly, teachers' perceptions of technology benefits are influenced more by institutional factors than individual characteristics (Perrotta, 2013). As technology becomes increasingly prevalent in education, teachers are developing their digital and pedagogical skills while preparing students for technology-driven careers (Elsayed et al., 2017). Furthermore, the integration of technology improves the teaching and learning of language skills, particularly English (Gilakjani, 2017; S. Iqbal et al., 2021). Teachers generally have positive perceptions regarding technology integration, recognizing its effectiveness in supporting classroom processes (Akram et al., 2022). Besides, technology integration is crucial in meeting global educational requirements and transforming traditional teaching methods to improve learning outcomes (Ghavifekr & Rosdy, 2015). The current generation of learners has been greatly influenced by technology. Instructors can engage learners in the learning process using online resources, tools, or apps tailored to the learners' level of interest (Khan, & Alamri, 2017).

2.7.3. Instructors’ willingness and abilities of technology integration

Teachers' self-efficacy beliefs positively correlate with their intention to integrate technology into teaching (Kamran et al., 2024). However, willingness and positive experiences with technology do not guarantee its comprehensive implementation in classrooms (Zhao, 2007). A study of Taiwanese teachers found a positive correlation between technology integration ability and usage frequency (Hsu, 2010). Additionally, distinct ability and usage scales were used to assess instructors' skills in technology integration to better understand the impact that ability and usage play in technology integration.

Perceived usefulness and ease of use positively influence instructors' attitudes toward technology adoption (Motshegwe & Batane, 2015). Interestingly, while some studies suggest self-efficacy as a predictor of technology integration (Kamran et al., 2024), others found no significant influence of self-efficacy on perceived usefulness, ease of use, or attitudes (Motshegwe & Batane, 2015). These findings highlight the complex interplay of factors affecting instructors' technology integration, emphasizing the need for further research into additional influences such as cultural background and teaching philosophy.

There are many obstacles to technology integration in the classroom, such as scarcity of funds, hardware, and software. However, the main obstacles are instructors' weak capabilities since teachers´ skills and attitudes determine the success of technology integration into the curriculum and teaching and learning process. Through research and observation, eight main areas of consideration were found to be important for instructors to integrate technology into curriculum and instruction. These areas are: 1) fear of change; 2) training in basics; 3) personal use; 4) teaching models; 5) learning base; 6) climate; 7) motivation; and 8) support. Thus, if higher education institutes contribute to enhancing some of these areas before students graduate, this would ease the pressure of employees on graduates, for instance, ease the pressure on schools once the pre-service teachers become in-service teachers. Therefore, enhancing the chance of successful technology integration in schools is required (Blackwell *et* al., 2016). The study stressed the requirements for preschool teachers and teacher trainers to understand the critical contextual factors about technology use within the preschool settings and respond to such factors.

2.7.4. Required knowledge and skills of instructors for technology integration

The successful integration of technology in education requires instructors to have specific knowledge and skills. While instructors generally have positive attitudes toward technology integration, they require proper training to enhance their proficiency (Smadi & Raman, 2020). Effective integration involves connecting technology with pedagogy in context-specific ways (Djoub, 2019). To facilitate the transfer of technology integration skills from training to classroom practice, it is important to develop instructional considerations based on knowledge transfer principles (Alemtairy, 2020). Assessing teachers' knowledge of technology integration is complex, but tools like the TPCK questionnaire can be used to evaluate perceived knowledge across different domains (Hosseini & Kamal, 2012). Continuous professional development and support are essential for successful technology integration in teaching practices across various educational contexts.

Education must create new pedagogical models for ICT integration and learning, as well as techniques to improve the teaching-learning process within higher education programs and ensure that all future instructors are well-prepared to use the new learning resources. In the traditional learning environment, the teacher has more control over the student, than teachers in technology-based learning environments. These are student-centered needs to have knowledge and skills on how to organize e-learning programs to assist students' learning (Mahini et al., 2012). The proper integration of ICT in education requires resources, rewards and incentives, the time factor, pedagogical factors, teacher attitudes, professional development, pedagogy, leadership, and attitudes of administrators (Sang et al., 2010).

The competencies of instructors' technology integration to make personal use of ICT in instruction; educational paradigms of making use of ICT in instruction; competency for teaching; and understanding policy dimensions (Hardman, 2019). The teaching competency matrix includes five separate competencies needed for teachers to integrate technology into their teaching. The five competency categories are community and netiquette; active teaching/facilitating; instructional design; tools and technology; and leadership and instruction. The integration of Information and Communication Technologies (ICT) in education is a complex process influenced by various factors. Teachers' technology competencies are crucial for successful implementation, encompassing both technological and pedagogical dimensions (Rodríguez et al., 2013; Cerveró et al., 2011). These competencies are affected by personal factors such as gender, age, and frequency of computer use, as well as contextual factors like educational institution type and access to resources (Suárez-Rodríguez et al., 2012). To effectively use technology for innovative teaching, instructors must develop basic technology skills. Successful integration of technology requires considering learners' expectations and their perceptions of how useful the system is (Assar, 2020).

2.7.5. Technology integration and instructors professional development practices

Technology integration in instructor development is crucial for effective teaching in higher education. Professional development programs focusing on technological, pedagogical, and content knowledge can help instructors meaningfully integrate technology into their teaching practices (Dysart & Weckerle, 2015). Evidence-based multimodal reflective training has been shown to improve technology integration and reflective practices among language instructors (Kaya & Adiguzel, 2021). A multifaceted model incorporating training, support, access, and incentives can lead to substantive changes in faculty expectations and increased technology integration in teacher preparation programs (Judge & O'Bannon, 2008). However, instructors face numerous challenges in integrating technology into instruction, necessitating the development of evaluation tools to assess and stimulate instructor's performance in technology integration (Favero & Hinson, 2007). Thus, to put it nutshell, the aforementioned approaches collectively emphasize the importance of providing continuous, centralized support and development opportunities for instructors to effectively integrate technology into their teaching methods.

In today's digital age, education helps students get the relevant knowledge, mindset, and abilities needed to comprehend and successfully navigate their digitally dominated surroundings (Yusuf et al., 2022). Hence, for technology integration to achieve intended instructional objectives, professional development is of paramount importance for in-service instructors. Technology-enhanced reflection providing multimodality and evidence-based data has the potential to help instructors achieve technology integration in their teaching (Kaya, & Adiguzel, 2021). Various models and frameworks, such as TPACK and SAMR, have been implemented to guide technology integration, though instructors may require more specific, step-by-step guidance (Bajracharya, 2021). Exemplary lecturers in Ghana have developed technology integration competencies through individual learning, peer support, and online resources, emphasizing the need for institutional support (Yusuf et al., 2022). However, while instructors may initially feel optimistic about their skills following training, they often experience decreased satisfaction and recognize the need for ongoing support after implementing online teaching (Brinkley-Etzkorn, 2019). These findings underscore the importance of continuous professional development and institutional support to ensure successful technology integration in education.

Technology integration into teacher pre-service and in-service professional development programs contributes to the quality of teachers regarding effective utilization of technology in the teaching-learning process. The rise of technology in the 1980s has shown extensive improvements by schools and educators to create strategies to use technology for the advancement of learning and teaching. However, not been converted into practical implementation, which has brought more attention to developing pre-service teachers´ education programs before these students join the teaching profession (Haines, 2016). This shows that technology integration into teacher training develops and maintains ICT capabilities and prevents capabilities and competencies from underutilization. The constant developments in technology are imperative for in-service and pre-service teachers to continue learning about new technological tools, their capabilities, and applications in learning and teaching (Tondeur, 2019). Hence, this is important to train teachers, not just in the use and application of technology but also to constantly upgrade their capabilities to keep up to date with the latest developments in technology applied in teaching.

Furthermore, teachers are ongoing learners of ICT. Therefore, by accepting and adjusting ICT as an essential component of their employment, professionals will increase their ICT comprehension, leading to pedagogical benefits. Therefore, it is vital to offer teachers training and professional development on both the technical and pedagogical aspects of ICT use across the curriculum (Heitink *et* al., 2016). The results highlighted that most of the technology used to enhance and improve either pedagogy and subject matter or just pedagogy singly. The reasons addressed transformed learning into a more attractive activity, achieving goals of education and assisting the process of learning where technology tools assist educational activities.

2.8. Roles of instructors in technology integration into curriculum and instructional settings

The integration of technology into curriculum and instruction requires a shift in instructors' roles and competencies. Instructors need to develop skills to effectively incorporate technology into instruction (Karimah & Muslim, 2019; Çevik et al., 2015). Moreover, preservice teacher education should focus on developing prospective teachers' perceptions of technology integration and their roles in this process (Çevik et al., 2015). Ultimately, effective technology integration has the potential to improve learning outcomes and problem-solving skills. However, teachers face challenges in this process, including their own beliefs and knowledge about technology (Najdabbasi & Pedaste, 2014).

As technology becomes increasingly prevalent in 21st-century classrooms, instructors must adapt their methodologies and take on new responsibilities (Faig, 2023). These include facilitating students' acquisition of technology-related knowledge, motivating them to use technology, and creating situations that require technology integration in learning (Najdabbasi & Pedaste, 2014). However, for successful technology integration, instructors must maintain a prominent role within the classroom format (Chaparro et al., 2004). Preservice teachers' perceptions of technology integration and their roles in this process are crucial, and efforts should be made to develop these perceptions during teacher training programs (Çevik et al., 2015). Technology integration enhances student engagement, accessibility, and academic achievement (Torres, 2022; Zulfikhar et al., 2024). Instructors who integrate technology often demonstrate advanced techno-pedagogical competence and high ICT acceptance (Çalışkan et al., 2021). Using e-learning platforms, augmented reality, and virtual reality can positively impact student learning outcomes (Zulfikhar et al., 2024). Hence, technology integration in higher education teaching offers significant potential for improving the learning experience.

Teachers' conceptions of technology and school policies influence their use of technology, with roles including learners, leaders, collaborators, and designers (Obara et al., 2018). In hybrid courses, instructors' roles shift from teacher-centered to student-centered, becoming more interactive and initiative-taking (Beck & Ferdig, 2008). In online environments, instructors typically perform four key roles: managing, pedagogical, social, and technical (Singh & Engeness, 2021). Therefore, these roles are valid in virtual world education but with different emphases compared to traditional or online classrooms (Berge, 2008). The transition from in-person to online and virtual world teaching has led to a transformation in instructors' roles, emphasizing facilitation, collaboration, and problem-solving approaches. This shift reflects the changing nature of education in technology-rich environments and the need for instructors to adapt their teaching strategies accordingly.

The integration of technology in the curriculum and instructional settings in higher education requires the active involvement of instructors in designing, implementing, and evaluating technology-based educational programs. According to a study conducted by Alemayehu and colleagues (2021), instructors' roles are essential to ensure the successful integration of technology in higher education in Ethiopia.

One of the roles of instructors in technology integration is to design technology-based educational programs that align with the learning objectives and instructional strategies. Instructors should have a clear understanding of the available technological tools and how they can be used to enhance the learning experience. They should also ensure that the technology-based educational programs are accessible to all students, regardless of their backgrounds or learning needs. A study carried out by Gebrehiwot and colleagues (2020) emphasized the importance of instructors' involvement in designing technology-based educational programs that meet the diverse learning needs of students.

Another role of instructors in technology integration is to facilitate student engagement and participation. Instructors should use technology-based tools to promote active learning, collaboration, and critical thinking. They should also provide students with feedback on their progress and encourage them to reflect on their learning experiences. A study by Tadesse and colleagues (2019) found that instructors who actively engage students in technology-based educational programs promote student motivation and achievement.

Instructors also play a critical role in providing technical support and training for students. They should ensure that students have access to the necessary technological tools and resources to participate in technology-based educational programs. Moreover, instructors should provide training on how to use these tools effectively to enhance the learning experience. A study by Mekonnen and colleagues (2018) highlighted the importance of instructors' providing technical support and training for students to ensure the successful integration of technology in higher education.

Furthermore, instructors should evaluate the effectiveness of technology-based educational programs regularly. They should collect data on student performance, engagement, and satisfaction with technology-based educational programs. Based on this data, instructors can make necessary adjustments to improve the quality of education. A study by Gebre and colleagues (2018) emphasized the importance of instructors' evaluating the effectiveness of technology-based educational programs to ensure continuous improvement.

The integration of technology into the curriculum and instructional settings in higher education requires the active involvement of instructors. Instructors' roles include designing technology-based educational programs, facilitating student engagement and participation, providing technical support and training for students, and evaluating the effectiveness of technology-based educational programs. The successful integration of technology in higher education depends on instructors' commitment to promoting student-centered learning experiences that leverage technological tools effectively.

Technology by itself will not and cannot change colleges. It is only when reflective and flexible educators integrate technology into effective learning environments, that the restructuring of classroom practices will benefit all learners (Gibson, 2001 cited in Chrysostomou & Mousoulides, 2010). However, as reported by the British Educational Communications and Technology Agency (2004), only a few teachers succeed in integrating technology into the subject teaching– instructional process, fruitfully and constructively that can promote students' conceptual understandings and stimulate higher-level thinking and reasoning. However, in most cases, teachers just use technology to do what they have always done, although they often claim to have changed their teaching practices.

When teachers and students have sufficient access to educational technologies and adequate technology training use confidence in their abilities to apply the technology integration into instruction (Choy, Wong, & Gao, 2009; Bauer & Kenton, 2005; Overbaugh& Lu, 2008; Shapley, Sheehan, Maloney, & Caranikas-Walker, 2010; Van Dam, Becker & Simpson, 2007; Woolfe, 2010; Zhao, 2007; cited in Davies, 2013). Reformulation in this sense means the extension of the curriculum adopting new and useful instructional strategies, content, products, and processes that were not possible in the past. However, teachers who perceive educational technologies as minimal or of no practical value will ignore these technologies, including those who are computer literate (Spektor-Levy *et* al., 2005*)*.

The mandates for universities and colleges to utilize educational technologies in classrooms are based on the belief that technology can improve instruction and facilitate learning. Another widely held belief is that students need to develop technology literacy and skills to become productive members of society in a competitive global economy (Davies, 2013). There is an increasing trend for technology integration in the classroom, requiring teachers to incorporate technology into their pedagogy (Kopcha, 2012). Teachers' progress through various stages of technology adoption, beginning with being alert to the possibilities of technology implementation for personal purposes and letting students acquire information technology literacy in their everyday learning. This awareness eventually brings about routine utilization of technology, and with appropriate training and support, they advance the creative usage of technology for teaching and learning. On the bright side, recent research has reported teachers' competence and confidence in providing instruction by using technology (Ismail et al., 2011; Kopcha, 2012).

Nevertheless, teachers who have admitted facing barriers to technology integration over the years are commonly found to be lacking in access to hardware and software, training, and support, and they often have little trust or belief in technology (Bhalla, 2012; Ertmer *et* al., 2012) although access to hardware and software is the basic criterion for technology utilization at school. Technology infrastructure available to teachers has to be reliable and useful to serve their purposes. If technology usage is time-consuming, teachers will be inclined not to use it. Similarly, if the hardware or software provided for teaching and learning is insufficient, it is difficult to fulfill the need to facilitate student-centered learning (Kopcha, 2012). Furthermore, compared to the past, when teachers had to request the installation of computers in the classrooms, technology is now readily available for teaching and learning.

The availability of technology infrastructure to teachers also boosts their confidence in using information technology professionally, for example, in using word processing software, and saving and accessing shared files (Ismail *et* al., 2011). Teachers' beliefs in information technology and confidence in their information technology skills are two prime attitudinal obstacles toward effective technology integration in their teaching (Bhalla, 2012; Kopcha, 2012; Ottenbreit-leftwich *et* al., 2010). Additionally, when teachers feel uncomfortable with the use of technological tools or are apprehensive that they may not be qualified to teach using information technology, they are less likely to incorporate technology into their teaching, resulting in less interaction between students and technology.

2.9. Factors affecting technology integration in curriculum and instructional settings

While the integration of technology in the curriculum and instructional settings in higher education offers numerous benefits, several factors can hinder its successful implementation. Understanding these factors is crucial for addressing the challenges and ensuring effective technology integration. Hence, this section explores some key factors affecting technology integration.

Although instructors understand the necessity of incorporating technology into the everyday process of teaching and learning, they often confront several hindrances when it comes to effectively integrating technology into their curricula. While some factors are resource-related, others derive from fundamental attitudes and practices (Su, 2009). Accordingly, technology integration in curriculum and instruction is influenced by various factors, both internal and external. Teacher-related factors, such as perception, self-confidence, and technological awareness, play a crucial role (Ince-Muslu & Erduran, 2021). External factors include infrastructure, budget, and administrative support (Pelila et al., 2022; Harrell & Bynum, 2018; Hur et al., 2016).

On top of this, technology integration in curriculum and instruction is influenced by various factors. These teacher-related factors, including attitudes, self-efficacy, technological awareness, and pedagogical knowledge, play a crucial role (Ince-Muslu & Erduran, 2020; Harrell & Bynum, 2018; Amaniampong & Hartmann, 2023). Non-teacher factors such as administrative support, student readiness, and curriculum approach also impact integration (Ince-Muslu & Erduran, 2020). Common barriers include inadequate infrastructure, insufficient technological resources, and low internet access (Amaniampong & Hartmann, 2023). Professional development and training are essential for successful integration (Harrell & Bynum, 2018). To improve technology integration, recommendations include optimizing digital pedagogies, modifying curricula, and conducting ICT workshops (Pelila et al., 2022). However, despite these challenges, technology integration remains crucial for preparing students for 21st-century skills and careers (Harrell & Bynum, 2018).

The integration of technology into higher education curricula is influenced by various factors.

Personal, institutional, and technological factors affect teachers' adoption of technology in teaching (Buabeng-Andoh, 2012). Factors such as access, training, and context significantly influence the quality of technology use in education (Martínez-Martínez, 2006). Moreover, other barriers to technology adoption include insufficient infrastructure, limited ICT skills, and inadequate technical support (Çalışkan et al., 2021). Besides, some instructors hesitate due to security concerns and perceptions of classroom disruption (Torres, 2022). Technology integration in higher education faces numerous barriers, both external and internal. Hence, external barriers include lack of funding, insufficient infrastructure, poor internet access, inadequate hardware and software, poor professional development, and limited ongoing support (Pelila et al., 2022; Dinç, 2019; Ryan & Bagley, 2015; Buabeng-Andoh, 2012; Schoepp, 2005). Similarly, other external factors such as infrastructure, resources, and professional development, along with internal factors like teacher self-efficacy and perceptions, technical issues, and time investment hinder integration (Chen et al., 2019; Harrell & Bynum, 2018). Besides, factors affecting technology integration are the digital divide, and instructors' reluctance (Yue et al., 2024). On the other hand, internal barriers encompass personal beliefs, perceptions, awareness, self-efficacy, competence, planning, and confidence levels regarding technology use (Seifu, 2020; Ince-Muslu & Erduran, 2020; Ryan & Bagley, 2015). Furthermore, teacher-related factors embrace attitudes towards technology, pedagogical knowledge, computer self-efficacy, and prior experience (Kaleli-Yilmaz, 2015; John, 2015).

Institutional support, availability of resources, and relevant policies also play crucial roles (Amaniampong & Hartmann, 2023). Schneckenberg (2009) argues that these visible barriers are symptoms of deeper structural and cultural issues within universities, including motivational traits of academic staff and long-standing academic values. The slow adoption of e-learning in European universities exemplifies these challenges. Additionally, the absence of exemplary integration models and difficulties in evaluating learning outcomes pose challenges (Izaham, 2009). Institutional factors such as curriculum overload and lack of in-service training further hinder integration (Amaniampong & Hartmann, 2023). Also, prospective teachers identify parental concerns and security issues as potential barriers (Dinç, 2019).

The effectiveness of technology integration varies between institutions, even when educational strategies are similar (Xakaza-Kumalo, 2018). To stimulate technology integration, institutions should focus on equipping educators with technological pedagogical content knowledge and addressing infrastructure issues (Chen et al., 2019). Moreover, to promote effective integration, institutions should focus on equipping educators with the necessary skills and providing adequate support (Amaniampong & Hartmann, 2023). To manage these challenges, educational institutions should allocate sufficient budgets for ICT infrastructure and provide professional development opportunities for teachers (Akram et al., 2022; Ghavifekr & Rosdy, 2015). To maximize the potential of technological tools in higher education, collaboration among educators, technologists, and curriculum designers, adequate technological infrastructure, teacher training, relevant curriculum design, and institutional support and institutional support are essential (Yue et al., 2024; Panakaje et al., 2024; Zulfikhar et al., 2024). Equally, enablers for information communication technology integration in tertiary institutions include proper infrastructure, managerial support, peer support, positive modeling, and emphasizing the impact on student satisfaction can be effective (McCabe & Oakley, 2020; Nzuki & Kyalo, 2014). As a final point, to alleviate these hindering factors, university leaders must tailor technology integration efforts to address the real learning needs and motivations of faculty members (Schneckenberg, 2009).

Some of the factors specifically addressed in this review include support for teachers' technology integration in the form of training, the availability of technology, barriers to technology integration, and technology anxiety. Prevalent factors hindering technology integration in curriculum and instructional settings revealed that they held the most promise for explaining teachers' technology integration (Karkouti, 2021). The most prevalent barriers to successful integration include organizational support, teacher attitudes and expectations, and technology itself (Moeller & Reitzes, 2011). Thus, teachers' attitudes towards and expertise with technology have been identified as key factors associated with technology use in classrooms (Inan & Lowther, 2010) because teachers need to hold a positive attitude toward technology to use it effectively in their teaching.

Insufficient access to reliable internet connectivity, limited availability of computers or devices, and inadequate technical support can impede the effective use of technology in the curriculum. A study conducted by Alemayehu and colleagues (2021) found that the lack of infrastructure and resources, and resistance to change among instructors and educational stakeholders were significant barriers to technology integration in Ethiopian higher education. These occur because of a lack of familiarity or fear of disrupting established teaching practices. Moreover, Tadesse and colleagues (2019) highlighted the importance of addressing resistance to change through comprehensive training programs and support for instructors. These include short-term training and professional development opportunities for instructors to integrate technology into their teaching.

The digital divide, which refers to the unequal access to technology and digital resources among students, is another significant factor hindering technology integration. Inequitable access to devices, internet connectivity, and digital literacy skills can create disparities in students' ability to participate in technology-based learning activities. Mekonnen and colleagues (2018) emphasized the need for strategies that address the digital divide, such as providing access to devices and digital resources for all students. Institutional policies and administrative support can influence the successful integration of technology. Inadequate policies or lack of clear guidelines on technology integration can create ambiguity and hinder effective implementation. Furthermore, limited administrative support in terms of funding, technical assistance, and recognition of the importance of technology integration can impede progress. Gebrehiwot and colleagues (2020) emphasized the need for strong institutional leadership and support to overcome these challenges.

Cultural factors and attitudes towards technology can affect its integration into the curriculum. Societal beliefs, norms, and perceptions about the role of technology in education can influence its acceptance and adoption. It is crucial to address cultural barriers and promote a positive attitude toward technology integration among educational stakeholders. Regarding to this Gebre and colleagues (2018) highlighted the importance of creating a culture that values technology as a tool for enhancing learning. Teachers' pedagogical beliefs and existing teaching practices shape how they incorporate technology in classrooms *(*Honey & Moeller, 1990; Sandholtz *et* al., 1997). To use technology effectively for educational purposes, teachers must not only be familiar with how to operate the equipment but also understand how these tools are effectively used in the subjects they teach and how to incorporate resources into classroom activities that accomplish important learning goals (Karkouti, 2021).

Instructors need ongoing professional development to keep up with how professionals are using technology in the subjects they teach and to understand the essential role that technology plays in supporting the work and generating knowledge in those subjects. While teachers use technology in their private lives and know how to operate it, they lack some other knowledge and skills required to support teaching and learning (Karkouti, 2021). Technology itself has a potential barrier to technology integration. Low-band width technology can be unreliable and break down at any given moment, which can be an obstacle to accessing the Internet. Teachers may not feel comfortable spending valuable instructional time dealing with equipment failures or slow Internet access. Unless they have access to reliable support, they may opt not to use technology in the classroom. Moreover, continual changes and innovations can make it difficult for teachers to keep up with the latest technology (Zhao & Frank, 2003; Lemke *et* al., 2009).

One could also readily think that the problems of educational technology integration into any curriculum with the provision of sufficient hardware, software, and in-service training, together with a reduction in the number of children per class and the inclusion of Information and Communication Technologies in the national curriculum (Spektor-Levy et al., 2005*)*. Nonetheless, issues that hinder technology use in schools include social and moral ethics, like the question of inequitable access to technology for all students, which causes some teachers to avoid requiring students to use technology to do assignments at home. Many schools also find it necessary to restrict the use of various technologies due to potential negative consequences and ethical dilemmas, considering it a moral imperative to monitor internet use and limit student access to this technology (Davies, 2013).

The support for teachers' use of technology has evolved over the last decade from minimal or non-existent support in many schools to a wider acceptance by administrators and communities and the belief that technology is now a necessity. This support comes in many different forms including public support, availability of technology for both teacher and student use, teacher training, release time for planning and learning, technical support, administrative support, and availability of appropriate instructional materials. The barriers encountered by teachers and learners regarding technology integration are the lack of funding, lack of training, lack of time, lack of access to technology, resistance to change, teachers' attitudes, and the organizational structure of schools (Karkouti, 2021).

In conclusion, several factors can hinder the integration of technology in the curriculum and instructional settings in higher education. These include inadequate infrastructure and resources, resistance to change among instructors, the digital divide, institutional policies, and administrative support, as well as cultural factors and attitudes toward technology. Addressing these factors through targeted interventions, such as providing adequate resources, comprehensive training programs for instructors, addressing the digital divide, establishing supportive institutional policies, and promoting a positive culture towards technology integration, is crucial for successful implementation.

2.10. Learning Theories

These days, modern technology has completely changed the way we communicate, live, and learn. Thus, fundamental social contexts should be reflected in learning requirements and theories that outline learning concepts and procedures (Siemens, 2006). Learning theories have evolved over the past 150 years, with four major approaches emerging: behaviorism, cognitivism, constructivism, and connectivism (Mechlová & Malčík, 2012). These theories guide the learning process and help educators create optimal learning environments (Dilshad, 2017). Behaviorism, cognitivism, and constructivism have long been established, but connectivism has been proposed as a new framework for understanding networked learning in the digital age (Jung, 2019). Connectivism emphasizes that knowledge exists in the world rather than solely in an individual's mind (Mechlová & Malčík, 2012). Recent studies have examined how these theories are implemented in technology-enhanced learning environments, with connectivism offering the widest opportunities for learner autonomy, interactivity, and diversity (Lamtara, 2023).

As technology use in education continues to grow, especially in the wake of the COVID-19 pandemic, there is an increasing need for faculty to align their pedagogy with technology-supported learning methods (Lamtara, 2023). When designing learning environments, the broad learning theories of constructivism, cognitivism, and behaviorism are most frequently applied. But they were created when technology did not affect education (Siemens, 2006). From the point of view of information and communication technology four learning theories have been often utilized in the creation of instructional environments: behaviourism, cognitivism, constructivism, and connectivism as a learning theory for the digital age. Connectivism was introduced as a theory of learning based on the premise that knowledge exists in the world rather than in the head of an individual (Mechlova & Malcik, 2012).

2.10.1. Constructivism Learning Theory and Technology Integration

Constructivism is a prominent theory of learning that has had a big impact on how technology is used in schools. Constructivism's central claim is that through experiences and reflection, students actively create their knowledge and understanding of the world (Vygotsky & Cole, 1978). Within the framework of integrating technology, constructivism highlights the significance of employing digital instruments and materials to promote dynamic, student-focused education. One of the key principles of constructivism is that learning is a social process, where learners collaborate and interact with their peers, teachers, and the learning environment (Vygotsky & Cole, 1978). Technology can play a crucial role in enabling and enhancing these social interactions. For instance, online discussion forums, collaborative document editing tools, and video conferencing platforms allow students to engage in meaningful discussions, share ideas, and co-construct knowledge (Garrison & Arbaugh, 2007; Scardamalia & Bereiter, 2006). Thus, technology offers learners diverse digital resources like interactive simulations, educational games, and multimedia content, stimulating curiosity and promoting active exploration.

Technology can enable the creation of authentic learning environments by providing access to primary sources, virtual field trips, and collaborative projects that connect learners with experts and professionals in their field of study (Lombardi, & Oblinger, 2007; Reeves et al., 2002). Technology can be leveraged to offer personalized and adaptive learning experiences, where digital tools and platforms can provide just-in-time support, feedback, and guidance to learners based on their individual needs and progress (Pea, 2018; Quintana et al., 2018). The integration of technology in the classroom has been greatly shaped by constructivist principles. Constructivist-inspired technology integration encourages students to use digital tools to explore, experiment, and create their understanding of concepts (Ertmer & Ottenbreit-Leftwich, 2013). For example, students may use simulation software to visualize and interact with scientific phenomena, engage in online collaborative projects, or utilize digital storytelling tools to express their learning in multimodal ways.

Research has shown that when technology is integrated in a constructivist manner, it can foster deeper learning, critical thinking, and problem-solving skills (Tondeur et al., 2017). Technology can provide learners with opportunities to engage in authentic, meaningful tasks, collaborate with peers, and receive immediate feedback, all of which align with constructivist principles (Ertmer & Ottenbreit-Leftwich, 2010). However, the successful integration of technology in a constructivist learning environment requires a shift in the role of the teacher. Teachers must move from being the sole provider of knowledge to becoming facilitators who guide and support students in their learning process (Ertmer & Ottenbreit-Leftwich, 2013). This shift can be challenging, as it often requires teachers to develop new pedagogical skills and beliefs about the role of technology in the classroom. The constructivist learning theory has been a driving force behind the integration of technology in education. By aligning technology use with constructivist principles, educators can create engaging, learner-centered environments that foster deep understanding, critical thinking, and collaborative learning.

2.10.2. Connectivism Learning Theory and Technology Integration

Connectivism is a relatively new learning theory that has emerged in the digital age, addressing the changing nature of learning in the 21st century. Proposed by George Siemens (2005), connectivism emphasizes the importance of technology and digital networks in the learning process. This theory posits that learning occurs through the connections formed between individuals, information, and technology, rather than solely within the individual. In the connectivist view, knowledge is distributed across a network of connections, and the ability to learn and grow is dependent on the ability to access and navigate these networks (Siemens, 2005). This is particularly relevant in the current digital landscape, where information is constantly being created, shared, and updated at an unprecedented rate. The integration of technology in education has been strongly influenced by the principles of connectivism. Connectivist-inspired technology integration encourages learners to use digital tools to access, connect, and create knowledge within a networked environment (Dunaway, 2011). This can involve the use of social media, online forums, blogs, and other digital platforms that facilitate the exchange of information and the formation of connections between learners.

Research has shown that when technology is integrated in a connectivist manner, it can foster the development of critical 21st-century skills, such as digital literacy, collaboration, and the ability to navigate and evaluate information from diverse sources (Trust, 2017). Furthermore, connectivist-inspired technology integration can promote lifelong learning, as learners develop the skills to continuously adapt and learn in a rapidly changing digital landscape. However, the successful integration of technology in a connectivist learning environment requires a shift in the role of the teacher. Educators must move from being the sole provider of knowledge to becoming facilitators who guide learners in navigating and connecting within digital networks (Dunaway, 2011). This shift can be challenging, as it often requires teachers to develop new pedagogical skills and beliefs about the role of technology in the classroom. Overall, the connectivist learning theory has significantly influenced the integration of technology in education. By aligning technology use with connectivist principles, educators can create dynamic, networked learning environments that prepare students for the demands of the digital age. Connectivism, a relatively new learning theory proposed by George Siemens (2005), has gained significant attention in the digital age due to its emphasis on the role of technology in learning. Connectivism posits that learning occurs through the connections formed between individuals, information, and technology, rather than solely within the individual (Siemens, 2005).

In the digital age, where information is constantly evolving and readily available, the ability to navigate, connect, and make sense of this information has become crucial. Connectivism recognizes that learning is not just about acquiring knowledge but also about the ability to access, filter, and synthesize information from various sources (Dunaway, 2011). The integration of technology in education has been closely aligned with the principles of connectivism. Digital tools and platforms, such as social media, online forums, and collaborative platforms, enable learners to connect with a vast network of information, resources, and peers, facilitating the creation of knowledge through these connections (Goldie, 2016).

Researchers have found that when technology is integrated with a connectivist approach, it can foster the development of critical thinking, problem-solving, and collaborative skills (Goldie, 2016; Tondeur et al., 2017). For example, students may use online discussion forums to engage in dialogue with peers and experts, or they may utilize social media to curate and share information related to their learning goals. However, the successful integration of technology in a connectivist learning environment requires a shift in the role of the teacher. Educators must move from being the sole providers of knowledge to becoming facilitators who guide students in navigating and making sense of the vast network of information available (Dunaway, 2011). This shift can be challenging, as it often requires teachers to develop new pedagogical skills and beliefs about the role of technology in the classroom.

Moreover, the integration of technology in a connectivist learning environment must be carefully designed to ensure that learners develop the necessary skills to critically evaluate and synthesize information, rather than simply consuming it (Goldie, 2016). This requires a focus on developing digital literacy and information management skills among learners. With the current emphasis on technology and education, the theory of connectivism is a popular topic. Proponents of this educational theory say that technology has changed so dramatically over the last several decades that earlier learning theories must be reviewed to ensure that they fit new processes enabled by technology (Guder 2010). Thus, connectivism is currently challenging existing learning theories and differs from behaviorism, cognitivism, and constructivism, which place learning at the core of the learner's cognitive growth (Hendricks, 2019). Hence, this theory differs from traditional learning theories like cognitivism (where learning is an active, constructive process), behaviorism (a theory of learning based on the idea that all behaviors are acquired through conditioning), and constructivism (the theory that humans construct knowledge and meaning from their experiences) in that it defines learning through connections to a network of knowledge which can include any form of interaction (Hendricks, 2019).

Connectivism is a learning theory for the digital age that emphasizes the role of technology in facilitating knowledge acquisition and meaningful learning (Baque et al., 2020; Darrow, 2009). It promotes active connections, intelligent social networking, and student-generated curricula, helping learners stay current in rapidly evolving fields (Darrow, 2009). While traditional learning theories like behaviorism, constructivism, and cognitivism remain foundational, connectivism is considered more suitable for 21st-century education due to the influence of mobile tools and new technologies (Masethe et al., 2016). Thus, it is recommended as an appropriate theory for teaching and learning with technology, offering an optimistic perspective on educational outcomes. Consequently, connectivism has emerged as a relevant learning theory for the digital age, addressing the limitations of traditional theories in explaining technology-enabled learning (Mampota et al., 2023).

Above and beyond, it emphasizes networked learning and the integration of technology in education, which aligns with modern curriculum reforms. Furthermore, Connectivism contributes to competency-based learning by promoting the use of technology to discover, transform, and apply knowledge in real-world scenarios (Baque et al., 2020). Further, today this learning theory has been adopted by institutions of learning and has created the Massive Open Online Courses (MOOC) movement. Many institutions of learning that understand the changing landscape of how people learn, where they learn, and what they want to learn, have created websites like Edx, https://www.edx.org/, where anyone can take a course and/or engage in public discourse around a given topic (Utecht, & Keller, 2019). So, Connectivism's presence in massive open online courses (MOOCs) has made it influential in practice (Bell, 2011). This theory depends on the intervention's scope, available resources, and researchers' philosophical stances when addressing educational challenges in the digital age. This theory emphasizes learning in various networks, with the learner playing a crucial role in knowledge creation, allowing students to plug into the network and create their own learning experiences (Hendricks, 2019).

The connectivist learning theory has significantly influenced the integration of technology in education. By aligning technology use with connectivist principles, educators can create learning environments that foster the development of essential skills for the digital age, such as critical thinking, collaboration, and information management. A connectivist understanding of educational systems of the future shows Siemen’s, Downes, and Cormier when they constructed the first massive open online course (MOOC), partly to explain and partly to model a connectivist approach to learning. They supposed that MOOC courses (Downe’s, 2014) will help participants make sense of the transformative impact of technology in teaching and learning and that is a good example of the application of connectivism. MOOC (massive - networks grow; open networks have no edges; online- creates the first teal networks for learning; course-creating temporary networks) involving instructors, libraries, and others, presumes in short: a course, an event, an open action, an interactive activity, a distributed learning and lifelong-networked learning (Bates, 2015; Downes, 2014). Therefore, connectivism is the first theoretical attempt to radically examine the implications for learning of the internet and the explosion of new communications technologies.

2.10.3 Exponential development of Connectivism theory for and against technology integration

Connectivism or distributed learning is a new and important theory, including its pedagogical view and practice in massive open online courses (MOOCs). Educational scholars positioned connectivism as a new philosophy of education for the digital age, making Vygotsky's concept of a zone of proximal development (ZPD) more flexible and stretching it to include learning that lies outside the learner, in social networks and technological tools (Mattar, 2017). The development of knowledge, relentless research in artificial intelligence and neuroscience as well as new paradigms of educational sciences require the creation of a new theory of learning that meets the socio-economic evolution compatible with individual learning and educating. Instead of boring courses or seminars for forming and developing learners' professional and transversal competencies for careers, there is an obligation to create a learning ecology (environment) where learners can shape their meaning (Simen, 2005). Several studies predicted that learning theories are less relevant than the practical application of theories in the learning process in educational sciences. This was the mobile, for instance not to tell students about the new learning theory and its concepts, but to try it, partly into the learning activities and well for students. Students learn actively, and conscientiously, with satisfaction of its involvement as part of their everyday life, fulfilling the outcomes, embodied in the marks of appropriate disciplines. Educators are reflecting on how learning has changed and the accompanying implications to how we design the spaces and structures of learning today (Siemen, 2006, p. 39).

2.11. Technology Integration Practices into Curriculum and Instructional Settings in Ethiopian Context

The instructional settings play a crucial role in the overall effectiveness of the curricula practices in Ethiopian public universities. Technology integration into curricula and instructional settings has become increasingly important to enhance the quality of education and promote student engagement. According to a study conducted by Alemu and colleagues (2021), the integration of technology in higher education in Ethiopia is essential to creating effective instructional settings that foster active learning and critical thinking.

One aspect of integrating instructional settings is the use of blended learning, which combines traditional face-to-face instruction with online learning. Blended learning provides students with the opportunity to engage in interactive and collaborative learning experiences both in the physical classroom and through online platforms. Regarding this, Tadesse and colleagues (2019) found that blended learning enhances instructional settings in Ethiopian universities by promoting student participation and fostering a learner-centered approach. Another aspect of integrating the instructional settings is the incorporation of mobile learning. Mobile devices such as smartphones and tablets can be used to deliver educational content and facilitate learning activities. This approach is particularly beneficial for students in Ethiopian public universities, as it allows them to access educational resources anytime and anywhere (Mekonnen and colleagues, 2018). This shows that mobile learning creates flexible and inclusive instructional settings that accommodate diverse learning needs.

Online learning is another component of integrating instructional settings through platforms such as Moodle or Blackboard; students can access course materials, participate in discussions, and submit an assignment, which promotes a collaborative and interactive learning environment (Gebrehiwot and colleagues, 2020). This creates an inclusive instructional setting that supports self-directed learning and encourages active student engagement. Besides, Gebre and colleagues (2018) stated that E-learning contributes to the integration of the instructional settings by leveraging electronic devices such as computers or laptops. The E-learning enables the delivery of multimedia content, such as videos, simulations, and interactive modules. This enhances the instructional settings by providing students with engaging and interactive learning experiences. Therefore, the potential of e-learning in Ethiopian universities to create innovative and dynamic instructional settings promotes student creativity and critical thinking.

The integration of technology into the curriculum has become increasingly important in today's digital age. In Ethiopian public universities, there is a growing need to integrate technology into the curriculum to enhance the quality of education and prepare students for the demands of a digital world. According to a study conducted by Tamrat, (2022), the integration of technology in higher education in Ethiopia is essential to improve access to educational resources and promote student engagement. One approach to integrating technology into the curriculum is blended learning, which combines traditional face-to-face instruction with online learning. Blended learning provides students with the flexibility to learn at their own pace while still having access to the guidance and support of their instructors. With references to this, Adugna *et* al.(2023) found that blended learning is an effective approach to teaching in Ethiopian universities, as it provides students with a more interactive and engaging learning experience.

Mobile learning is another approach to integrating technology into the curriculum. It involves the use of mobile devices such as smartphones and tablets to deliver educational content to students. This approach is particularly useful for reaching students in remote areas who may not have access to traditional classroom settings (Astatke et al., 2016). Hence, mobile learning has the potential to improve access to education in Ethiopia, especially in rural areas. Online learning is important for integrating technology into the curriculum. It involves delivering educational content through online platforms such as Moodle or Blackboard, which allows students to access educational materials from anywhere at any time. A study conducted by Endris and Molla (2023) found that online learning is an effective approach to teaching in Ethiopian universities, as it provides students with greater access to educational resources and promotes self-directed learning. E-learning is yet another approach that uses electronic devices such as computers or laptops to deliver educational content. E-learning is particularly useful for delivering multimedia content such as videos, animations, and simulations.

According to a study carried out by Zelelew et al. (2023), e-learning has the potential to improve the quality of education in Ethiopia by providing students with a more interactive and engaging learning experience. The integration of instructional settings in the Ethiopian public universities' curriculum is essential to enhance the quality of education and promote student engagement. The incorporation of blended learning, mobile learning, online learning, and e-learning contributes to creating effective instructional settings that foster active learning, collaboration, and critical thinking among students. Therefore, the most common pedagogical application of wikis in education is to support writing instruction, provide a low-cost but effective communication and collaboration tool to promote the close reading, revision, and tracking of drafts; and ease students into writing for public consumption.

Technology integration in education has become increasingly important in global universities as they strive to enhance teaching and learning practices. In Ethiopia, public universities have been exploring ways to integrate technology into their curriculum and instructional settings to improve student engagement and learning outcomes (Abate & Tilahun, 2021).

According to a recent study carried out by Abate & Tilahun (2021), there has been a growing interest in technology integration in Ethiopian public universities. The study found that while there are challenges to implementing technology integration, such as lack of infrastructure and training, there are also many benefits, such as increased student engagement and improved learning outcomes. One approach to technology integration is the use of educational technology tools, such as learning management systems (LMS) and online resources. For example, a study carried out by Alemu and Mulugeta (2020) found that the use of LMS in Ethiopian public universities had a positive impact on student learning outcomes and engagement. Another approach is the use of blended learning, which combines traditional classroom instruction with online learning activities. A study conducted by Fenta and Molla (2020) found that blended learning was an effective way to integrate technology into the curriculum of Ethiopian public universities.

However, there is still much work to be done in terms of technology integration in Ethiopian public universities. A study undertaken by Yitbarek and Tadesse (2021) identified several challenges, including limited access to technology, lack of digital literacy among faculty and students, and inadequate infrastructure. These challenges must be addressed for successful technology integration to occur. According to a recent study conducted by Abate and Tilahun (2021), there has been a growing interest in technology integration in Ethiopian public universities. The study found that while there are challenges to implementing technology integration, such as lack of infrastructure and training, there are also many benefits, such as increased student engagement and improved learning outcomes. One approach to technology integration is the use of educational technology tools, such as learning management systems (LMS) and online resources. For example, a study undertaken by Alemu and Mulugeta (2020) found that the use of LMS in Ethiopian public universities had a positive impact on student learning outcomes and engagement.

Another approach is the use of blended learning, which combines traditional classroom instruction with online learning activities. A study undertaken by Fenta and Molla (2020) found that blended learning was an effective way to integrate technology into the curriculum of Ethiopian public universities. There is still much work to be done in terms of technology integration in Ethiopian public universities. Pertaining to this, Yitbarek and Tadesse (2021) identified several challenges, including limited access to technology, lack of digital literacy among faculty and students, and inadequate infrastructure. These challenges must be addressed for successful technology integration to occur.

Therefore, technology integration in global universities has become increasingly important in recent years. While Ethiopian public universities have shown a growing interest in technology integration, there are still challenges to be addressed. By leveraging educational technology tools and blended learning approaches, universities can improve student engagement and learning outcomes. Institutions must address the challenges of infrastructure and training to implement technology integration.

2.12. Conceptual Framework

A conceptual framework is an analytical tool with several variations and contexts under which the researcher's thoughts and wisdom practically operate in the particular study. Conceptual frameworks are derived from theories, models, or best practices, and provide a way of thinking about problems or complex systems (Bordage, 2009). As stated by Zackoff et al. (2019) conceptual frameworks offer a lens through which educators can develop research questions, design interventions, and evaluate outcomes. To this end, Almadi (2019) and Guntur (2019) stress the importance of conceptual frameworks in enhancing the quality and rigor of educational research, ultimately contributing to more effective educational methods and improved patient outcomes.

The conceptual framework is the researcher's idea of how the research problem will have to be explained and explored, why the topic one wishes to study matters, and why the means proposed to study it are appropriate and rigorous (Ravitch and Riggan, 2016). In this regard, Crawford (2019) suggested three sources for a conceptual framework of a particular study. These include the experiences of the researcher, synthesized literature, and theoretical framework.

In order to optimize student learning, curriculum and instruction must coexist together and have a close working relationship (Flake, 2017). The curriculum and instruction are two different phenomena that are both independent and interdependent. Although they are perceived as separate entities, instructional decisions are made after curricular decisions, and after instructional decisions are implemented and evaluated (Subandi, 2014). The relationship between curriculum and instruction is viewed as continuous, cyclical, ongoing, and never-ending, and they cannot function in isolation from one another (Lederman, & Niess, 2001; Saban, 2021). The relationship between curriculum and instruction is described based on Oliva's (1982) four types of models, such as dualistic, interlocking, concentric, and cyclical model (Saban, 2021). Therefore, the researcher found the cyclical model of curriculum and instruction was appropriate for developing the conceptual framework of the present study. This choice holds significant implications for the study's methodologies and findings, reflecting a deliberate and well-considered approach to the research.

The conceptual framework of the study addresses the independent variables related to instructional inputs and processes incorporating smart learning environments and instructors' professional competencies and skills that contributed to the practices of technology integration into undergraduate curricula and instructional settings (outcome variable). This synthesis resulted in the development of a conceptual framework that represents an integrated way of looking at the problem. Concerning technology integration into curriculum and instructional settings, the model considered the relationships between curriculum and instruction as interdependent and having significant impacts on each other. The researcher studied technology integration at two levels- program level (macro level) and course level (micro level) (Akcil et al. 2021). At the macro level, the researcher studied the curriculum from the technology integration perspective. The study addressed major components of the formal curricula- technology integration areas such as learning outcomes, contents, teaching strategies, and assessment techniques. Similarly, at the micro level, technology integration occurs in the instructional settings at the course level in the classroom, which includes learning objectives, contents, teaching strategies, and assessment techniques. Thus, unless new teaching methods, curriculum, assessment, and school organization are introduced at the same time, the use of instructional technology may not lead to significant improvements in educational outcomes (Alemu, 2015).

Through the lenses of theories of constructivism and connectives, this conceptual framework brings several related concepts together as predictive variables and outcome variables. This includes

Technology integration rationale, extent, and roles: Technology integration rationales refer to the understanding of the specified rationale dimension, and targets towards technology integration into undergraduate curriculums and instructional settings. The researcher believed that the extent to which key stakeholders such as Ministry of Education curriculum experts, academic leaders (quality assurance and academic program directorates), instructors, and students understand these dimensions for technology integration into undergraduate curriculums and instructional settings.

In addition, the roles of technology integration concern responsibilities taken and accountabilities shared by instructors during technology integration into undergraduate curricula and instructional settings. The extent to which instructors identify and play their roles, as facilitators, designers, learners, and leaders ensure the effectiveness of technology integration into undergraduate curricula and instructional settings.

Furthermore, technology integration practices target managing and realizing actual actions and implementation strategies in the areas of technology integration into curriculum and instructional settings. These areas include contents, learning outcomes/objectives, learning experiences, teaching and learning/strategies, assessment, and feedback systems. Therefore technology integration practice encompasses proficiencies in using various technological tools, lesson planning, learning management systems, modeling technology use in teaching practice, professional development opportunities, creating collaboration, sharing best practices, enhancing student-centered practices, knowledge generation, and promoting assessment and feedback systems.

Technology integration into curricula: The researcher attested that technologically mediated/supported curricula/ documents /course modules/syllabus/ framework of a given discipline are easily understood by learners, and help them achieve specified learning outcomes. Accordingly, the researcher investigated technology integration at the macro/program/policy document level in the areas of integration such as contents, learning outcomes/objectives, learning experiences, methods of teaching and learning/strategies, assessment, and feedback system.

Technology integration into instructional settings: The researcher assumed that the technology-mediated/assisted teaching-learning process assisted the learners and helped them achieve specified learning outcomes through well-exercised student-centered opportunities of learning in classrooms. Accordingly, the researcher investigated technological tools integration and application in classrooms at the micro/course level in the areas of integration such as contents, learning outcomes/objectives, learning experiences, teaching and learning strategies, assessment, and feedback system.

Factors affecting technology integration into undergraduate curricula and instructional settings: The researcher identified five distinct and overlapping major factors affecting technology integration into undergraduate curricula and instructional settings. This section analyzed and interpreted the influences of the following major factors. Firstly, the researcher explored the influences of inadequate infrastructure-smart learning environments that include infrastructure and resources. Secondly, barriers related to integrating technology into curriculum contents and activities and pedagogical practices. Thirdly, barriers related to the digital divide, connectivity, and internet access. Fourthly, the inertia to digital literacy and competencies includes sociocultural values and relative resistance to changes. Fifthly, barriers related to policy, administrative & technical support barriers.

Technology integration into undergraduate curriculums and instructional settings: Based on the theories of constructivism and connectivism, the researcher looked into multi-dimensional directional and examined TIUCIS in Ethiopian public universities. The combination of technology integration rationales, roles, practices, and appropriateness of technology integration into the areas of curriculum and instructional settings, and major factors contributing to or affecting an outcome variable (TIUCIS) of the study.

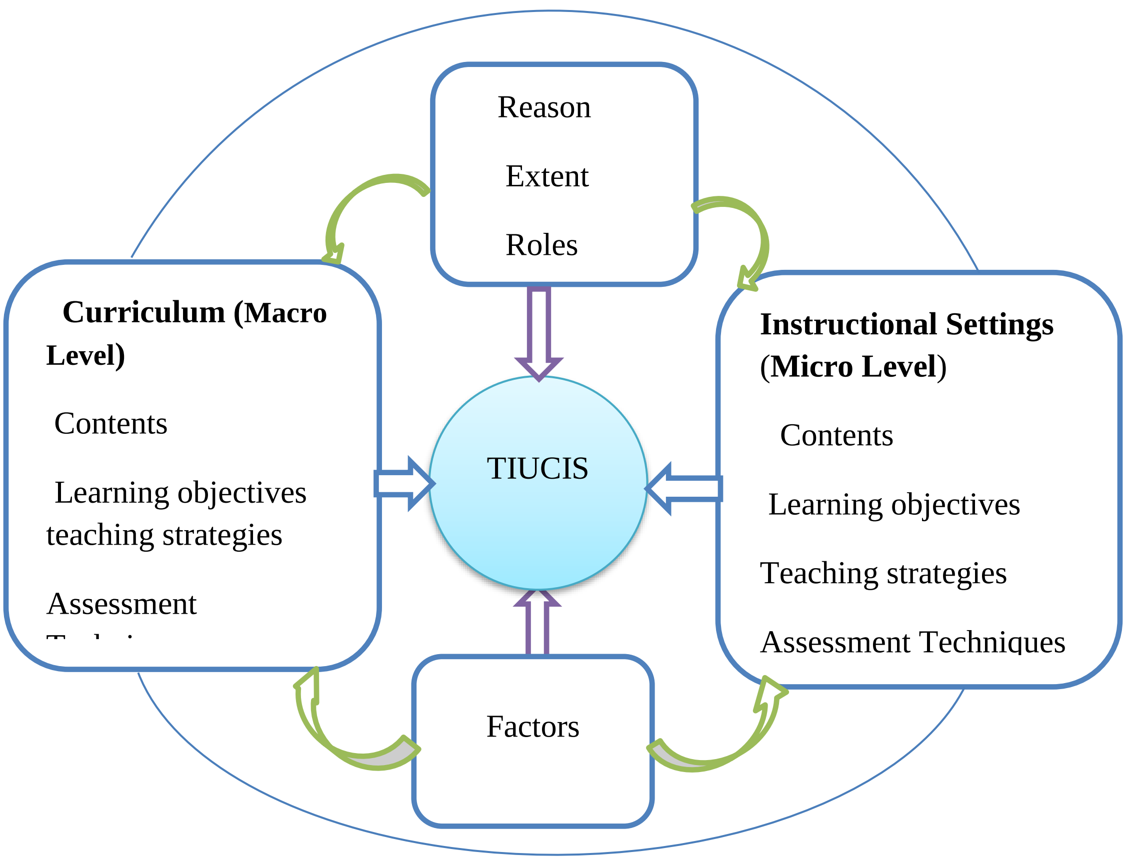


Figure 2.1: Conceptual framework, developed from literature by the author (2022-2024)

3. RESEARCH DESIGN AND METHODOLOGY

This chapter highlights the research design and methodology which incorporates the following subtopics: description of the study area, research paradigm, research design both quantitative and qualitative approaches which include sources of data, population, sample size, sampling techniques, data collection procedures, data collection instruments, validity, and reliability, trustworthiness, and methods of data analysis. Finally, it discusses the ethical considerations of the study.

3.1. Description of Research Settings

The study settings were determined based on the Ethiopian university differentiation structure. Accordingly, the researcher carefully selected seven sample Universities based on Ethiopian Universities' differentiation criteria. Accordingly, from the Research Universities, Jimma University, from Applied Universities; Assosa University & Dire Dawa University, from Comprehensive Universities-Wachamo University, Meda Welabu University & Oda Bultum University, and from specialized Universities-Adama Science & Technology Universities were samples of the study.

Adama is a central city located in the East Shewa Zone, Oromia regional state of government. The city is 99 km southeast of the capital of Ethiopia, Addis Ababa. Besides, Adama City sits between the base of an escarpment to the west and the Great Rift Valley to the east. Thus, Adama Science and Technology University (ASTU), where the researcher conducted the study, was first established in 1993 as Nazareth Technical College (NTC), offering degree and diploma-level education in technology fields. Later, the institution was renamed Nazareth College of

Technical Teacher Education (NCTTE), a self-explanatory label that describes what the institution used to train candidates who would become technical teachers for TVET colleges/Schools across the country. Although it is an institution with a history of only two decades, ASTU is known for its dynamic past. It has always been responsive to the realization of national policies: training of technologists at its infant stage, and later shifting to training of technical trainers, as well as business educators, to fill the gap in TVETs. Following its inauguration in May 2006 as Adama University, the full-fledged university started opening other academic programs in other areas extension of its original mission. The Ministry of Education nominated it as the Center of Excellence in Technology in 2008 and it opened various programs in applied engineering and technology. For its realization, it became a university modeled after the German paradigm: it not only became the only technical university in the nation but also the only one led by a German professor. Before 2008, the university had stratified faculties, and ASTU's reach was limited to its only campus in Adama town. The faculties ASTU include the School of Business, School of Engineering and Information Technologies, School of Humanities and Law, School of Natural Sciences, and School.

Oda Bultum University (OBU) is one of the public higher learning institutions in Ethiopia, established in November 2015 by decree No.322/2014 of the Council of Ministers of the Federal Democratic Republic of Ethiopia. The University is located in Chiro town in the West Hararghe zone of Oromia Regional State. It is located 325 km southeast of Addis Ababa, the capital city of Ethiopia. The area is known for its high-quality agricultural products; coffee, honey, and meat that fetch the highest prices at local and international markets; and its charitable society. As a public higher learning institution, Oda Bultum University has set itself core responsibilities with a focus on producing ethical, competent qualified graduates, conducting problem-solving research, and giving demand-driven community services. The University has now six Colleges, two institutes, and one school; it has regular, extension, and Special Bega undergraduate programs. At present, there are 32 regular, 5 extension, and 3 Special Bega undergraduate programs in the university. The University has more than 300 academic and 500 administrative staff members. Oda Bultum University is undertaking research and community service activities in various fields to make its contribution to the sustainable economic, social, and political development of the country. The University is planning and working on initiating relevant postgraduate (M.Sc /MA) programs.

Assosa University is located in Benishangul Gumuz Regional State of Ethiopia, in Assosa town at a distance of 477 km from Addis Ababa. Assosa University (ASU) is one of the third generation Public Universities established in May 2011 by the Council of Ministers decree number 215/2011. The University produces a qualified and dedicated workforce that the country needs. The qualified and dedicated workforce would participate in conducting scientific research, and providing community service to the community, they have come from. All the activities of the University aim at strengthening and realizing the growth and transformation plan. The University is located in Assosa, the capital city of Benishangul Gumuz Regional State. The town is located at a distance of 660 kilometers away from Addis Ababa, 210 kilometers south of the Grand Ethiopian Renaissance Dam/GERD/ and 96 km East of the Ethio-Sudanese border. The University officially embarked on its service in June 2011 G.C. The university began the teaching-learning program at Assosa Agricultural College. The university had taught for two years at Assosa Agricultural College. Since 2013 G.C, the University has moved to its main campus which, granted by the Assosa Town Administration. The academic wing launched with 100 teachers, and 5 faculties consisting of 17 undergraduate fields of studies. The University started teaching-learning with 1043 students in a regular program in December 2011. The intake capacity of the University grows from time to time. Up to the 2019 academic year, 8153 students graduated.

Madda Walabu University (MWU) is one of the higher educational institutions. The name Madda Walabu University was given to the university based on the place name, located 227 Km away from the zonal town of Robe to the southwest. Historically the place is where the Oromo people are the brainchild of the culture of the “Gada” system as has been recurrently indicated by elders and researchers. This place has deep-rooted value for the Oromo people. Madda Walabu University is among the recently founded (2007 G.C) institutions of public higher education in the country. However, despite it being a new the university. It is a rapidly changing institution in terms of student admission, and expansion of programs and campuses. Currently, the University has one institute five colleges, and three schools. It has also 974 academic staff, 1187 administrative staff as well as 23693 students. The University is running 46 undergraduate and 5 graduate programs.

Dire Dawa University is located in the industrial and commercial city of Dire Dawa, which is located 515 km east of Addis Ababa. The university is a young higher education institution that established and started its teaching and learning activities in the 2007 academic year. The university was established with the Ethiopian government's willingness and determination to expand higher education coverage and ensure its equitable distribution across the country to produce competent human resources and research outputs to meet the national development target through a poverty reduction strategy. The actual operation of the university began by enrolling 754 regular students in three faculties (Faculty of Natural Science and Mathematics, Faculty of Social Science and Language, and Faculty of Business and Economics), in 13 different undergraduate academic programs with 90 academic staff and 103 administrative support staff operating with limited facilities. Thus, the university has one Institute (Institute of Technology) and Five Colleges (College of Natural & Computational Science, College of Business & Economics, College of Social Sciences & Humanities, College of Law, and College of Medicine and Health Science) with 47 undergraduate and 46 graduate programs. The current enrollment has reached more than 21,159 students in undergraduate and graduate programs via regular and non-regular admission modalities. Institute of Technology is one of the ten institutes started in Ethiopia to support the realization of the transition towards the industry-led economy.

Jimma University is located in Oromia Regional State 352 kilometers southwest of Addis Ababa, founded on the amalgamation of the Jimma Institute of Health Science and the Jimma College of Agriculture in the 1980's. Both institutions had been national leaders in their respective fields, and with the merger, the development of a new, multifaceted, and development-oriented institution was able to emerge from the two former specialty institutions. Jimma University has become a hub of intellectual and academic activity that attracts thought leaders, innovators, educators, and leaders from around the country. Jimma University is one of the top-ranked public institutions in the nation, and this comes from the quality of each academic program. Jimma University has a history of international collaboration, which has set the groundwork for it to be a truly global institution. With international partners from the University of Oklahoma in the United States, Jimma University's parent institution the Jimma College of Agriculture addresses matters of agriculture in the 1960's. Jimma University has hosted partners from all around the world for decades. Such long-term partners include foreign teaching staff from India and the Philippines, Cuban doctors and development professionals, American and European doctors and public health professionals, and Asian development partners from South Korea, Japan, and China. Foreign partners often regard Jimma University as a unique, yet little-known major institution of research and higher education. A variety of foreign partners, scholars, and researchers have successfully published articles, engaged in globally relevant scientific research, and worked on Ph.D. dissertations at Jimma University. Currently, Jimma University is in a critical development stage and with the physical and programmatic development of the institution, the goal of become a globally collaborative and competitive university that produces the highest quality academic and research outputs. It has more than 2722 (1322 academic and 1400 support) staff members. The university is operating on four campuses and it is in the phase of establishing its fifth campus. The university provides education for more than 43,000 students in 69 undergraduate and 103 postgraduate programs in regular, summer, and distance education with more enrollments in the years to come.

Wachemo University (WCU) is one of the public higher educational institutions founded in 2009 G.C. It is located 230 km southwest of Addis Ababa, at Hosanna town in an area of over 200 hectares. The University commenced its function in 2012 admitting 538 students in 12 departments under 4 colleges. Currently, the University has admitted over 18,400 students in regular and continuing education programs in 48 departments under 6 Colleges, namely 1) Engineering and Technology, 2) Natural and Computational Sciences, 3) Medicine and Health Sciences, 4) Agricultural Sciences, 5) Business and Economics, and 6) Social Sciences and Humanities. In addition to these, the university is going to launch 10 new programs at the undergraduate level and 6 programs at the MSc level in the next academic year. The University has 1047 academic staff (from these 36 are expatriate academic staff) 39 technical support staff and 1448 administrative support staff totaling 2495. Finally, all the community members of WCU with their profundity and commitment are playing an immense role in achieving the national growth and transformation plan via the university’s vision, mission, and goals. The University has been working hard in teaching, research, and community services for the last five years. It was one of the awarded the prize of “Best Achieving University” for three successive years, from 2013-15 academic years, among the newly established third generation Universities of Ethiopia.

3.2. Research Philosophy

Research philosophy in education is a critical aspect of educational inquiry, emphasizing the importance of philosophical reflection in research practices (Koetting & Malisa, 2013). Assumptions underpin the social science researcher's decision to conduct research (Gay et al, 2012). Moreover, philosophy is about our beliefs on the nature of knowledge and reality spastically,educational research has been increasingly informed by diverse philosophical worldviews which in turn underlie the choice of methodologies and approaches to educational inquiry (Cohen et al., 2018; Creswell & Creswell, 2018). Research philosophy encompasses ontological, epistemological, methodological, and axiological components, which form the foundation of educational research paradigms (Khatri, 2020). In addition to this, research philosophy refers to the underlying assumptions and beliefs that guide the research process. It is a fundamental aspect of research, as it shapes the researcher's approach to knowledge acquisition, data collection, and analysis (Saunders et al., 2015). Accordingly, philosophical assumptions address issues related to the nature of reality (ontology), how researchers know what they know (epistemology), and the methods used to study a particular phenomenon (methodology) (Creswell, 2014; Sorensen, 2010).

3.3. Research Paradigm

Paradigm is the philosophical intent for understanding a study (Cohen et al., 2018). A paradigm is a framework that structures research practice based on those beliefs. According to the principle of philosophical worldviews, pragmatism is the founding epistemological ground of a mixed method where what is important from both positivism and constructivism are considered. The mixed method is the pragmatic movement that moves past the paradigm wars proposing logical and practical alternatives (Creswell & Creswell, 2018). Research paradigms are fundamental philosophical frameworks that guide educational and scientific research (Khatri, 2020; Yong et al., 2021). These paradigms encompass key components such as ontology, epistemology, methodology, and axiology, which shape researchers' worldviews and study designs (Shah & Al-Bargi, 2013). The main paradigms identified in the literature include positivism, interpretivism, critical theory, and realism (Yong et al., 2021). By exploring the connections between ontology, epistemology, methodology, and methods within each paradigm, researchers can better align their theoretical frameworks with appropriate study designs (Shah & Al-Bargi, 2013).

Pragmatism has emerged as a valuable research paradigm in social sciences, offering a flexible approach that bridges quantitative and qualitative methods. It supports methodological pluralism and the production of socially useful knowledge (Shah et al., 2018). Pragmatism provides a philosophical framework for mixed-methods research, allowing researchers to adapt their approach based on the research question and context (Feilzer, 2010). In design research, pragmatism offers a foundation for creating actionable knowledge and design theories (Goldkuhl, 2012).

Specifically, pragmatism is a research philosophy that focuses on the practical applications of knowledge and the use of research findings (Creswell & Creswell, 2018). Unlike positivism and interpretivism, which focus on the nature of reality and the researcher-subject connection, pragmatism is concerned with the practical application of research and its potential to solve real-world problems (Saunders et al., 2015). Pragmatists believe that the choice of research methods should be based on their ability to address the research question effectively, rather than on adherence to a particular philosophical stance (Tashakkori & Teddlie, 2010). This approach allows researchers to use a combination of quantitative and qualitative methods, known as mixed methods research, to gain a more comprehensive understanding of the research problem (Creswell & Plano Clark, 2018). Also, (Biesta, 2020; Huff, 2018) explored the role and use of pragmatism in educational research, emphasizing its potential to inform policy and practice and highlighting its potential to inform decision-making and solve problems.

3.3.1. Post-positivism paradigm

Post-positivism represents the thinking after positivism, challenging the traditional notion of the absolute truth of knowledge (Phillips & Burbules, 2000) and recognizing that we cannot be positive about our claims of knowledge when studying the behavior and actions of humans. According to Phillips and Burbules (2000), you can gain a sense of the key assumptions of this position such as the following: (1). Knowledge is conjectural (anti-foundational)-absolute truth cannot exist. (2). Research is the process of making claims and then refining or abandoning some of them for other claims more strongly warranted. Most quantitative research, for example, starts with the test of a theory. (3). Data, evidence, and rational considerations shape knowledge. (4). Research seeks to develop relevant, true statements, ones that can serve to explain the situation of concern or that describe the causal relationships of interest. In quantitative studies, researchers advance the relationship among variables and pose this in terms of questions or hypotheses. (5). Being objective is an essential aspect of competent inquiry; researchers must examine methods and conclusions for bias. For example, standards of validity and reliability are important in quantitative research.

3.3.2. Constructivism or social constructivism paradigm

Constructivism or social constructivism (often combined with interpretivism) perspective is typically, an approach to qualitative research that believes that individuals seek understanding of the world in which they live and work. Individuals develop subjective meanings of their experiences directed toward certain objects or things. These meanings are varied and multiple, leading the researcher to look for the complexity of views rather than narrowing meanings into a few categories or ideas (Creswell, 2014).

3.3.3. The Transformative paradigm

This position arose during the 1980s and 1990s from individuals who felt that the post-positivist assumptions imposed structural laws and theories that did not fit marginalized individuals in our society or issues of power and social justice, discrimination, and oppression. In the main, these inquirers felt that the constructivist stance did not go far enough in advocating for an action agenda to help marginalized peoples. A transformative worldview holds research inquiry intertwined with politics and a political change agenda to confront social oppression at whatever levels it occurs (Martin, 2010). Therefore, transformative researchers use both qualitative and quantitative techniques to understand disparities that occur in community relationships, support social justice, and ultimately ensure transformative change.

3.3.4. Pragmatist paradigm

In the present study, pragmatic philosophical assumptions, suggest the use of multiple approaches to investigate or derive knowledge about a problem (Creswell, 2014). Pragmatism has emerged as a prominent philosophical paradigm for mixed methods research, offering a rationale for combining quantitative and qualitative approaches (Shaw et al., 2010). Thus, it supports the integration of diverse research methods and modes of analysis to produce socially useful knowledge (Feilzer, 2010). Pragmatism focuses on practical and useful works to solve problems (Patton, 2002). Besides, the pragmatism paradigm is widely considered the philosophical foundation for mixed methods research, offering a flexible approach that combines quantitative and qualitative paradigms (Maarouf, 2019). It allows researchers to select methods best suited to address complex social problems (Allemang et al., 2021). This applies to mixed methods research in that inquirers draw liberally from both quantitative and qualitative assumptions when he/she engages in research, individual researcher has freedom of choice. In this way, the researcher is free to choose the methods, techniques, and procedures of research that best meet his needs and purposes (Morgan, 2007). Therefore, pragmatists believe that reality is continually changing amid the flow of constantly changing situations.

In the present study, the researcher used the pragmatic mixed approach whose logic of inquiry includes the use of induction (discovery of patterns), deduction (testing of theories and hypotheses), and abduction (uncovering and relying on the best set of explanations for understanding one's results). The pragmatist approach also attempts to legitimate the use of multiple approaches in answering research questions rather than constraining researchers' choices in that it rejects dogmatism (Creswell & Creswell, 2018). This mixed method is inclusive, pluralistic, and complementary in suggesting researchers take an eclectic approach to method selection by thinking about the research problem and how to conduct the research including techniques and procedures. Therefore, the researcher preferred pragmatism as a paradigm to examine technology integration into undergraduate curricula and instructional settings in Ethiopian Public Universities.

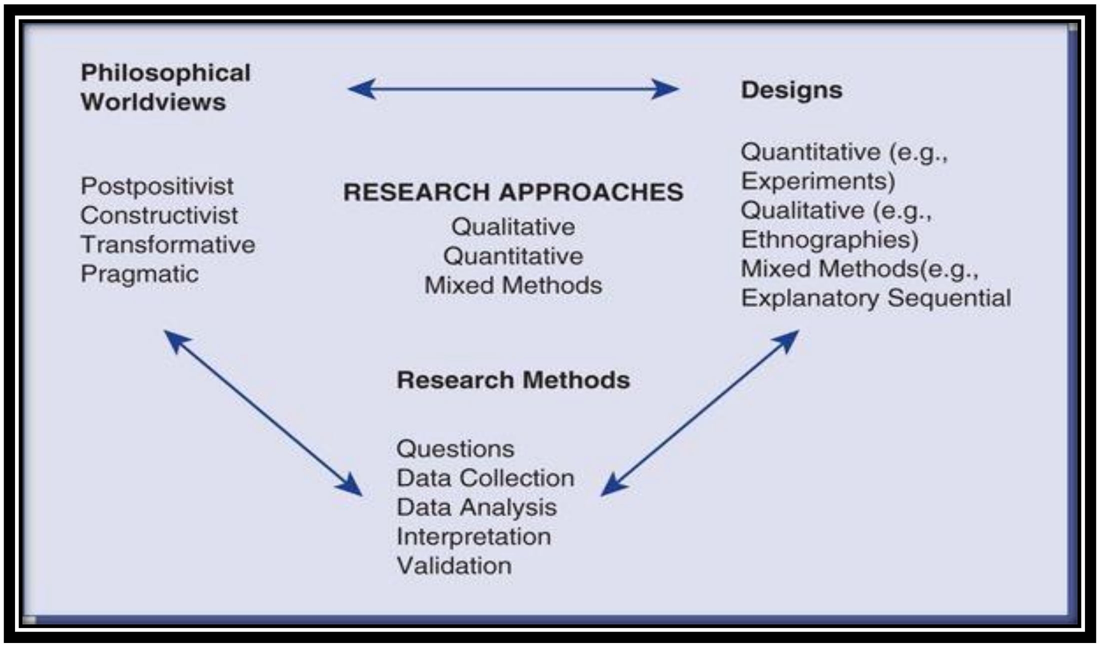


Figure 3.1: A summary of interconnections of philosophical worldviews, research designs, and methods

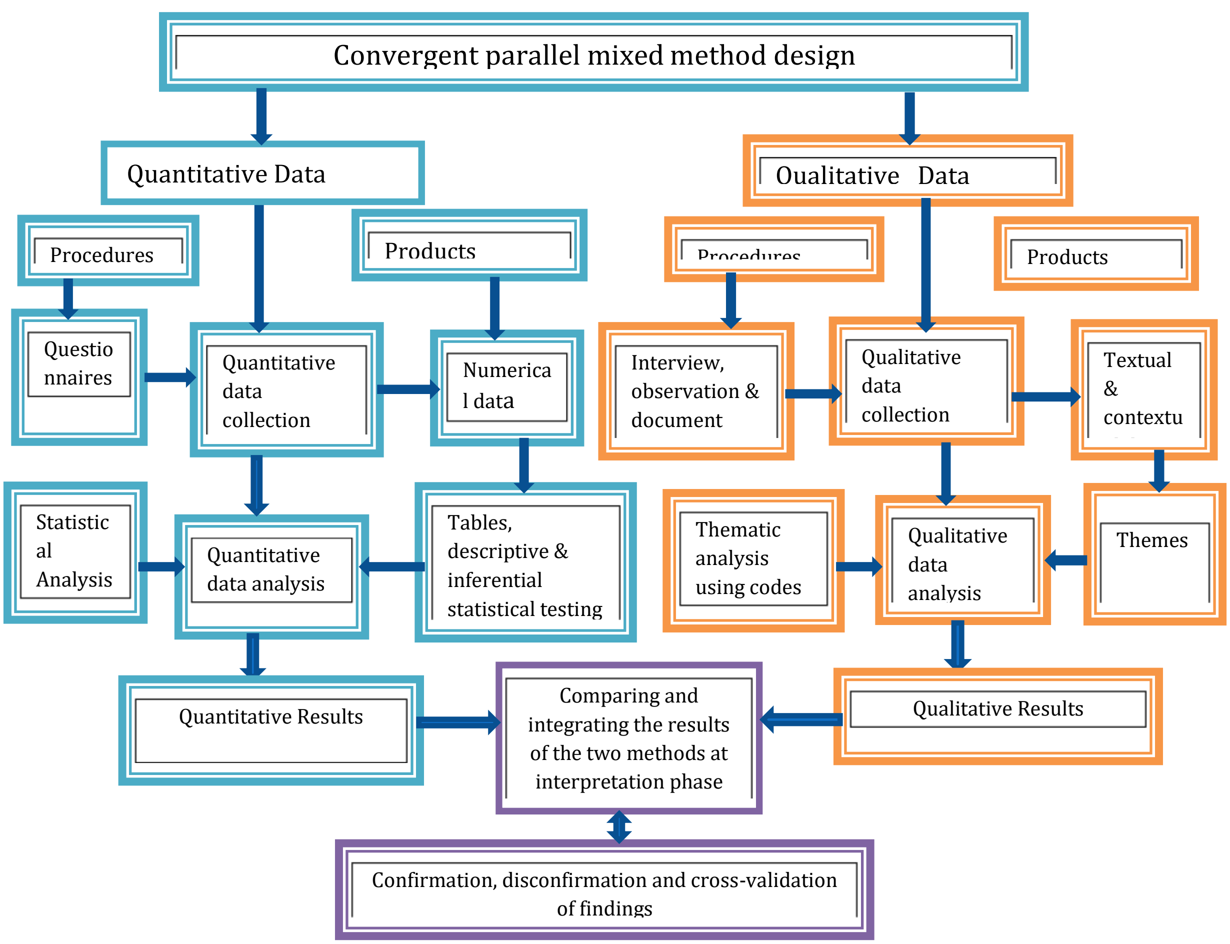
Source: Adapted from Creswell and Creswell (2018)

3.4. Research Design

Mixed methods research combines quantitative and qualitative approaches to provide a comprehensive understanding of complex phenomena (Tashakkori et al., 2012; Sharma et al., 2023). Based on the philosophical assumption chosen, the researcher employed a mixed approach with a mixed convergent parallel (QUAN+QUAL) design. This design helps to obtain valid and reliable scientific outputs, outcomes, and impacts (Creswell & Creswell, 2018; CIvankova & Wingo, 2018). This approach is useful for investigating complex practical problems connected to technology integration into undergraduate curricula and instructional settings in Ethiopian public universities by collecting both qualitative and quantitative data at the same time and analyzing them simultaneously (Creswell, 2014). The researcher integrated both qualitative and quantitative results at the interpretation and discussion stages. The researcher used mixed model research in which the mixing of qualitative and quantitative approaches occurs across all stages of a study (Creswell & Creswell, 2018). Each approach brings different kinds of cognizance, which helps to balance out the strengths and weaknesses of each (Johnson & Christensen, 2017). The convergent-parallel mixed design involves the simultaneous collection of qualitative and quantitative data (usually both QUAL and QUAN are the emphasis), followed by the combination and comparisons of these multiple data sources (Edmonds, and Kennedy, 2017). Thus, in this design, the researcher converges or merges quantitative and qualitative data to provide a comprehensive analysis of the research problem (Creswell, and Clark, 2018). Besides, the investigator typically collects both forms of data at roughly the same time and then integrates the information into the interpretation of the overall results (Creswell, 2014). On top of this, the design gathers the qualitative and quantitative data at the same time but analyzes them separately; it is not sequential (Privitera, and Ahlgrim-Delzell, 2019).

The convergent parallel mixed design method enables the researcher "to gain a more vigorous understanding of quantitative results by integrating qualitative findings to triangulate the findings and explore divergent findings" (Hesse-Biber, 2010). Equal priorities were given between the two methods, and finally, both results were integrated at the interpretation and discussion phases following explicit procedures of theorization. The researcher used both quantitative data collected through surveys, and qualitative data collected through interviews, observation, and document reviews based on methodological principles to check their validation.

Mixed methods designs are commonly identified as convergent parallel, sequential, embedded, and triangulation (Almeida, 2018). The convergent parallel design involves collecting and analyzing quantitative and qualitative data simultaneously (Baran, 2016). Within the convergent parallel mixed design method, the quantitative method helped the researcher to test theories, whereas the qualitative method helped the researcher to construct knowledge from the contexts of sample public universities in line with TIUCIS through deductive reasoning and inductive reasoning respectively. In addition, convergent parallel mixed design is less time-consuming because both qualitative and quantitative data were collected during the same visit to the field and analyzed simultaneously (Creswell & Creswell, 2018). It further helps the researcher compare the two databases at the interpretation stage. This comparison refers to confirmation, disconfirmation, cross-validation, and corroboration (Morgan, 2007). This model uses separate qualitative and quantitative methods as means to offset the weaknesses inherent within one method or conversely, the strength of one adds to the strength of the other (Creswell, 2014). This shows that the convergent parallel mixed design method counterbalances the limitations, and supports the strengths of quantitative and qualitative research methods.



Source: Adopted and modified from Creswell and Creswell (2018)

Figure 3.2: Convergent parallel mixed design

3.5. Sources of Data

The researcher collected both primary and secondary data from sources to obtain sufficient information concerning the study (Creswell, 2014). The primary data were collected using surveys, interviews, and direct classroom observation from primary sources of the data such as instructors, quality assurance directorates, academic program directorates, students' council presidents, MoE curriculum experts, and classroom settings. In addition, the researcher collected secondary data from secondary sources such as policy documents of MoE, and sample undergraduate program curricula (English language, economics, civil engineering, nursing, physics, and plant science).

3.6. Target Population, Sample Size, and Sampling Techniques

The researcher conducted the present study in Ethiopian public universities following the differentiation policy document (MoSHE, 2020) according to their mission accomplishment. According to the previous Ministry of Science and Higher Education (MoSHE), now merged into the Ministry of Education, in Ethiopia, there were 50 public universities at the time of data collection. These universities were categorized based on their years of establishment as 1st, 2nd, 3rd, 4^{th,} and 5th generation universities (MoE, 2018). Then, MoSHE (2020) differentiated them into research universities, comprehensive universities, applied universities, and special technology universities. However, because of security reasons, 15 universities and to keep anonymity, 11 universities found in the Amhara region, 4 universities found in the Tigray region, and one pilot testing university were not part of the main study. The researcher used multi-stage sampling techniques and selected appropriate participants at universities, colleges, and department levels from the target population of the study. The researcher selected seven universities from 35 public universities using a simple random sampling technique to provide equal and independent chances for each university to be selected as a sample of the study.

The FDRE (2023) suggested that among the various areas identified in the roadmap policy document for intervention, the need to differentiate public universities was an urgent policy shift.

Accordingly, the entire sample selected Ethiopian public universities were (1) research universities, which undertake research and teaching with a special focus on graduate programs (2) universities of applied sciences, which undertake teaching and research in equal proportion, and (3) comprehensive universities, who undertake professional, practice-oriented teaching and research (4) Special universities (FDRE 2023, p. 90). Therefore, the seven sample universities were selected as follows: from 8 eight research universities: Jimma University, from 15 applied universities: Assosa University and Dire Dawa University, from 21 comprehensive universities: Wachamo University, Meda Walabu University, and Oda Bultum University), and from 2 specialized universities Adama Science and Technology University were selected using simple random sampling (lottery system) technique. The sample size of each target population was determined believing that the ideal sample size is large enough economically in terms of both time and complexity and small enough and manageable and specific for analysis (Best & Kahn, 2016). Accordingly, a representative sample size of instructors for the present study was determined using the following formula:

$n = [(N)\,(p)\,(1 - p)] / [(N - 1)\,(B/C)^2 + (p)\,(1 - p)]$ (Biemer & Lyberg, 2003).

$$\text{Hence, } n = \frac{[(7161)\,(0.5)\,(1\text{-}0.5)]}{[(7161\text{-}1)\,(0.05/1.96)^2 + (0.5)\,(1\text{-}0.5)]} = 364.648 = 365$$

Then, the sample size of each university is determined proportionally in the following way.

nu= Nu ×nT, NT, Where, nu = sample size of a university, Nu= population of a university, nT= the total sample size is 365, NT= total population of the seven universities.

Table 3.1: Target population and sample size of instructors

S.N	Sample universities	Population of Instructors	Sample size
1	Adama Science and Technology University	1230	63
2	Mada Walabu University	974	50
3	Assosa University	853	44
4	Oda Bultum University	439	22
5	Jimma University	1322	67

6	Dire Dawa University	1296	66
7	Wachamo University	1047	53
Total		7161	365

Source: survey (2024)

Table 3.1 shows that the researcher collected quantitative data through a self-constructed questionnaire from 365 instructors selected from seven sample universities using a stratified random sampling technique followed by a simple random sampling technique after allocating proportionality of sample size in each sample university (Table 3.1). After proportionality allocation, the sample instructors were further selected from the selected departments (English language, economics, civil engineering, nursing, physics, and plant science) from each sample university's colleges and schools using a simple random sampling technique. Accordingly, the researcher distributed 365 questionnaires to the selected instructors. From this figure, 331 (91%) instructors actively filled out and returned the questionnaires that the researcher quantitatively analyzed.

For qualitative data collection, the researcher developed semi-structured interview guiding questions and explored key interview informants' perspectives, experiences, and insights concerning technology integration into undergraduate programs curricula and instructional settings in Ethiopian public universities. In-depth qualitative data were collected from 24 key informant interviewees (KII). These include, 7 quality assurance directorates, 7 academic program directorates, 7 students' council presidents, from sample universities, and 3 curriculum experts at the MoE level were selected using purposive sampling technique based on their expertise, unique perspectives on the subject of interest, positions as directorates with specialized knowledge and responsibilities, lived experience, and exposure.

Moreover, the researcher undertook document examination (the curricula of undergraduate programs such as English language, economics, civil engineering, nursing, physics, and plant science) and classroom observation of the perspective curricula to enrich the data collected about technology integration into undergraduate programs curricula and instructional settings in Ethiopian public universities.

3.7. Instruments of Data Collection

The researchers prepared and used different data collection tools such as self-constructed closed-ended Likert scale, open-ended questionnaires, semi-structured interview guiding questions, observation checklists, and document analysis coded sheets. Regarding this, Creswell (2014) suggested that employing multiple data collection tools helps the researcher to strengthen inadequacies and ensure triangulation of data. The researchers prepared and applied different data-gathering instruments such as self-constructed questionnaires, semi-structured interviews, and document review coded sheets. Concerning this, Creswell and Creswell (2018) suggested that employing multiple data collection instruments helped the researchers to combine and strengthen the inadequacies and triangulation of data.

3.7.1. Questionnaire

In educational research, quantitative investigators often use a combination of categorical and continuous scales. Interval scales provide the most variation of responses and lend themselves to stronger statistical analysis. The best rule of thumb is that if you do not know in advance what statistical analysis you will use and create continuous scales (Creswell, 2014). The continuous scales can always be converted into ordinal or nominal scales (Tuckman, 1999) when necessary but not vice-versa (Creswell, 2014). Ordinal data includes items such as rating scales and Likert rating scales frequently used to ask for opinions and attitudes (Cohen et al., 2018). This is an appropriate technique to use rating scales to survey the opinions of large participants.
Based on the rationalizations stated behind the importance of rating scales, the researcher prepared 5-point Likert rating scales closed-ended question questionnaires, and open-ended question questionnaires, for instructors in English to collect their perceptions about technology integration practice into undergraduate curricula and instruction in Ethiopian public Universities.

The researcher preferred questionnaires because it is easier to handle and simple for respondents to answer within a short period (Koul, 2008). It is economical in the sense that it can supply a considerable amount of research data for a relatively low cost in terms of materials, money, and time, and it is easier to arrange (Denscombe, 2007). Thus, the questionnaire is cheaper than other tools, has wider coverage, is pre-coded, and reduces the effects of personal interactions with a researcher during the data collection process. Accordingly, 19 items of the questionnaire were used to assess the rationale underpinning technology integration, 26 items of the questionnaire were used to survey extent of technology integration, 24 items were used to survey instructors' roles in technology integration, and 30 items were regarding prevailing factors or variables affecting TICUIS in Ethiopian public universities. 99 close-ended self-developed and one open-ended item of a questionnaire was prepared and administered to instructors for the main study after carefully validated and reliability was tested via pilot study.

3.7.2. Interviews

Interviews are a popular method of qualitative data collection, offering insights into social and emotional phenomena (Minhat, 2015). Various interview types exist, including structured, unstructured, and semi-structured formats (Aborisade, 2013). Thus, interviews remain crucial for extracting rich insights, granting researchers close access to participants' perspectives and experiences (Benlahcene, & Ramdani 2020). The quality of data collected depends on the interviewer's skills and the chosen data collection mode (Adhabi & Anozie, 2017). Hence, proper planning and consideration of ethical dimensions are essential for successful interviews (Dursun, 2023).

An in-depth interview enables interviewers and interviewees or key informants to discuss their interpretation of the world they live in and to articulate how they view the situations from their point of view (Cohen *et* al., 2018). The protocols and semi-structured interview guiding questions are useful when a researcher needs to gain new insights into respondents' feelings, opinions, emotions, and experiences (Denscombe, 2007; Yin, 2018). Thus, an interview enabled a researcher to deduce implied information from respondents' feelings, actions, expressions, and intended responses. The researcher conducted interviews in English with 24 participants selected purposively namely, with 7 academic program directorates, 7 quality assurance directors, 7 students' councils' presidents, and 3 MoE curriculum experts based on seven after communicating with them. Then, the researcher coded 24 participants and retained their anonymity. The researcher made audio-recorded interviews transcribed the data, and read the transcriptions to discern the main lines of reasoning, then made analytical coding to the main themes, subthemes, and verbatim.

3.7.3. Classroom Observation

Recent studies highlight the importance of observation as a data collection instrument in educational research. Hence, observational methods are valuable tools in educational research, providing direct insights into student behavior and educational events (Cotton et al., 2010). Observation allows researchers to interpret social worlds by immersing themselves in particular settings, providing insights into the experiences of teachers, students, and administrators (LaGarry, 2019). While observation has been used for a long time, it is relatively underutilized in special education research, with researchers often failing to report specifics of their observational methods (Ferreira & Francisco, 2020).

An observation is an appropriate tool for collecting data on naturally occurring behaviors and offers a good opportunity for the researcher to collect factual data from naturally occurring social settings through his or her senses (O'Leary, 2004; Yin, 2018). It is an appropriate tool for collecting data on naturally occurring behaviors in their usual contexts. It offers a good opportunity for the researcher to collect factual data from naturally occurring social settings. By using classroom observation coded as (Ob1-Ob7), it is possible to study all observable public phenomena if they are accessible to the study (Sarantakos, 2005).

The researcher made seven direct observations (one observation in each sample university) on issues related to the practical implementation of TIUCIS. The observations were made for one hour in each sample university following instructors facilitating different courses and designated as Ob1-Ob7. The researcher observed how much technology was integrated into instructors' instructional settings. Most commonly instructors were using PPT presentations using LCD throughout the lesson time. Yet, in two universities instructors were using smart whiteboards on top of using PPT presentations using LCD. Throughout the researchers' observations of seven presentations, the majority of students were following the shared PPT presentations using their smart mobile phones.

3.7.4. Documents Reviews

Document review for data collection is a critical process in research methodology and it involves analyzing various forms of documents, including text, images, and artifacts (Nilamsari, 2017).

To ensure high-quality data abstraction in systematic reviews, researchers should use standardized data extraction forms, pilot-test the process, and develop outlines of tables and figures in advance (Li et al., 2015). In addition, document review can help researchers efficiently collect the right amount of data, minimize errors, and produce accurate and comprehensive reviews of existing literature across different fields of study (Bowen, 2009). This method is often combined with other data collection techniques such as interviews, observations, and focus groups to enhance the validity and comprehensiveness of research findings (Dewi, 2021).

Documents are important to corroborate evidence from other data sources and help the researcher develop a broader perspective of the context under study (Yin, 2018). The researcher made a document review of policy documents of MoE and MoSHE, and sample undergraduate programs curriculum. Therefore, document reviews and analyses are important in yielding relevant sources of data (Best & Kahn, 2016; Yin, 2018). A researcher read the collected documents to structure the data, and to differentiate between different meaningful segments of it. Then, the researcher identified meaningful segments, coded, and categorized them based on a particular focus (Schreier, 2012).

The researcher reviewed seven curricula from the sampled universities and policy documents. Coded sheet checklists were prepared by the researcher and reviewed the extent of technology integration into curriculum and instruction setting areas as criteria for selection. This focuses on objectives, contents, activities, learning experiences, methods of teaching, and assessment). Then, the researcher coded and analyzed the data in themes. Finally, the findings were found relevant to the research questions and conceptual framework of the study and integrated with quantitative findings at the discussion phase.

3.8. Data Collection Procedures

This study employed a mixed method approach, specifically the convergent Parallel Mixed Method, and data were collected concurrently. Data collection procedures in research require careful planning and execution to obtain valid and reliable data in research. Data collection procedures include observations, interviews, surveys, focus groups, and participatory techniques (Nelson & Cohn, 2015). The selected approach should align with the research objectives and provide high-quality data to answer the research questions effectively. The data collection procedures are crucial elements of a research study because they provide the foundation for the analysis and findings. It is important to carefully design and implement data collection methods to ensure the accuracy and reliability of the data gathered. By paying close attention to data collection procedures, researchers can enhance the quality and validity of their study's results. To achieve this, the researcher used various methods including survey questionnaires, interviews, document reviews, and classroom observation. The data collection instruments were designed based on the basic research questions of the study to ensure that the collected data would serve the intended purpose of the research. Therefore, the procedures for collecting the two data sets were outlined as follows:

3.8.1. Quantitative Data Collection Procedure

Before administering the questionnaire to collect quantitative data, the researcher received a letter of support from Haramaya University, College of Education and Behavioral Science, Department of Adult Education and Community Development, which was distributed to all seven sample universities, the Ministry of Education, and one university for a pilot study. After obtaining permission, the researcher requested the selected sample of instructors for their approval to participate in the study. After getting participants' consent, the researcher distributed questionnaires, promising them that their information would not be shared with a third party and would be kept strictly confidential. Each participant had enough time to read and answer questions. The researcher also supplied clarifications requested by the participants.

Then after, the researcher contacted the selected sample respondents in person at their respective departments. Hence, the sets of questionnaires were distributed to a total of 365 respondents in the seven sample universities. Out of the distributed questionnaire, the response rate from the seven universities was 331 which was 90.7%. This demonstrates that the research attained the highest level of response rate when compared to the existing literature in this particular field. Accordingly, in research on questionnaire response rates in education and psychology, a minimum response rate of 70% is recommended, while 50% is considered acceptable for business surveys (Green & Boser, 2001). Hence, this implies that a high response rate (90.7%) helps to minimize potential bias and ensures that the findings accurately reflect the views of the target population.

Table 3.2. Respondents' sample size and response rate

S.N.	University	Sample size	Response rate	percentage
1	ASTU	63	59	93,7%
2	ASU	44	39	88.6%
3	DDU	66	59	89.4%
4	JMU	67	61	91%
5	MWU	50	46	92%
6	ODB	22	20	90.9%
7	WCU	53	47	88.7%
		365	331	90.7%

Source: Survey (2024)

The researcher's efforts led to an increase in response rates. For instance, the researcher discussed the nature and format of the questionnaire with the respondents before and during filling it out in person, through phone conversations, and encouraging them. In addition to this, the researcher replaced the questionnaire papers in case they became lost.

3.8.2. Qualitative Data Collection Procedure

Formally, before the interview began, ethical issues were addressed. To commence the interview and observation, the researcher carefully considered potential ethical issues. All participants selected for the study were personally contacted and provided with a brief explanation of the research topic, their involvement, and its potential impact. Additionally, the researcher emphasized the voluntary nature of participation, ensuring that individuals could withdraw and withhold their data from being made public at any time.

All selected participants were personally contacted and briefed on the research topic and objectives and their participation. Furthermore, the researcher made it clear that participation is voluntary, and participants can withdraw at any time and withhold their data before it is made public. Then the interviewees were asked whether they wanted to participate or not. In the rare event that individuals refused to participate in the study, particularly to be recorded, the researcher was forced to take notes in writing. Most of the interviews were conducted at their offices. To improve data quality, noise, and other interruptions were kept to a minimum during the interview. In this manner, all of the twenty-four interviews were carried out successfully by using a smartphone and converted all the audio to verbatim. During the classroom observation, the researcher obtained consent from the instructors before observing each classroom for one period. The main focus was on assessing the extent of technology integration into the instructional process.

The procedure for classroom observations was conducted after permission was given from department heads and instructors. Then seven classroom observations were conducted for a period at each sample university. Before directing the document review, the researcher carefully selected the relevant policy documents. These included the Ethiopian education development roadmap, the ICT policy for Higher Education, and TVET, as well as the differentiation of the higher education system of Ethiopia. All documents were meticulously examined, and the review process was conducted in alignment with the implications of technology integration. To this end, the review's themes were incorporated into the data analysis.

3.9. Validity and Reliability of Data Collection Tools

Prolonged fieldwork, reflexivity, methodological triangulation, and using multiple sources of data as vital to maximize qualitative validity and quantitative reliabilities of data collection tools (Creswell, 2014).

3.9.1. Validity of data collection tools

Validity in research assesses how well a measure represents its intended concept. Four main types of validity are identified: construct, content, face, and criterion validity (Diamond, 2021; Lim, 2024). As indicated by these authors, content validity evaluates whether a measure captures the full range of a concept, while face validity assesses its apparent suitability. Therefore, the face, content, and construct validity of the data collection instrument were verified by advisors, experts in the field of two curricula, and a computer science instructor.

Procedurally, after developing instruments of data collection, the face/content validity data collection tools were maintained to measure what it intended to measure. Five education expert reviewers whose qualifications are PhD and above have made between-line reading and commented on some items of tools for improvement. The researcher then discussed the issues with them, agreed on comments, incorporated them into data collection instruments and cleaned them, and made them ready for a pilot study.

3.9.2. Reliability of data collection tools

The researcher made a pilot test in Addis Ababa University targeted at addressing the following points based on reliability results. (1). Check the appropriateness of instruments through customization or standardization in the development of TIUCIS scales. (2). Confirm the reliability of data collection tools. (3). Evaluate the sample adequacy in study sites. Accordingly, the reliability of quantitative results was preserved by avoiding ambiguous questions. The researcher conducted a pilot test on 38 instructors and checked the data collection instruments before the main data collection process. The reliability of the survey instrument is crucial for ensuring credible results. Even though the reliability of an instrument could be tested in various ways, the internal consistency of items was used in this study. To do this, a pilot study was conducted at Addis Ababa University, which was not considered in the main study for survey data collection. Hence, a questionnaire was distributed to 38 respondents for this pilot study. Based on this, the reliability test was conducted and the result was as follows. Since the questionnaire had different dimensions for each construct, the internal consistency value was calculated for each dimension. Based on this, the value of Cronbach's Alpha (α) of .95 was for the rationale of technology integration, .98 for the extent of technology integration, .96 for the roles of instructors, and .97 for factors affecting technology integration. Therefore, it is evident that the survey instrument demonstrates high reliability across these dimensions. This implies that each item of the questionnaire measures each dimension. Then, the researcher proceeded to the main data collection process after making some modifications to the items of the questionnaire.

3.10. Trustworthiness of the Qualitative Data

Trustworthiness in qualitative research is crucial for establishing the credibility and reliability of findings (Ahmed, 2024). As stated by Kakar et al. (2023) trustworthiness embraces key criteria such as credibility, transferability, dependability, and confirmability. Credibility is achieved through extended involvement, persistent observation, and triangulation, while transferability requires comprehensive explanations (Ahmed, 2024). Dependability is ensured through rigorous documentation and audit trails, and confirmability through peer debriefing and reflexive (Curtin & Fossey, 2007). Based on this, the researcher triangulated both the method of the data collection and the source of the data. First of all, the researcher used a combination of interviews, classroom observations, and document reviews for the qualitative data collection. This approach allowed for a comprehensive understanding of the research topic by gathering information from multiple perspectives and sources. The use of interviews facilitated in-depth insights from participants, while classroom observations provided real-time data on behaviors and interactions. Additionally, document reviews enabled the researcher to analyze existing records and materials relevant to the study. This multi-faceted approach enhanced the credibility and reliability of the collected data, contributing to a more robust research outcome.

The analysis of the data also followed rigorous procedures of qualitative data analysis. The dense explanation provided in this research may enable anybody who wants to compare and contrast the results with other contexts for transferability. This ensures that the findings are robust and can be applied to similar situations in other settings. In qualitative research, rigorous procedures were used to ensure the credibility, confirmability, transferability, and dependability of the study. By addressing these aspects, the researcher enhances the trustworthiness and rigor of the qualitative study, ultimately contributing to its quality and validity.

3.11. Methods of Data Analysis

The researcher used both quantitative and qualitative methods to analyze data. According to Creswell (2014; Cohen *et* al., 2018), mixed-method helps to achieve what is termed triangulation where a comparison between different databases for better effects. The researcher analyzed both qualitative and quantitative data side-by-side and mixed at the interpretation stage. Thus, the data collected through closed-ended questionnaires were tallied, tabulated, and analyzed using appropriate descriptive and inferential statistical techniques such as average mean, and standard deviation, to check the distribution of data around the central tendency. Likewise, the researcher used a one-sample t-test to compare the mean of a single sample (instructors) to an expected ideal mean value (3.00) to determine if the mean calculated from sample data collected from a single group is statistically different from an expected ideal mean value specified by the researcher.

Furthermore, the researcher used Pearson correlation to examine the relations between variables. Factorial analysis was used to calculate average means along the scales and variances. The stepwise multiple regression analysis was made to examine the predictive effects of prevailing factors affecting the practices of TIUCIS in Ethiopian public universities. The researcher used rank order to compare the mean differences among the seven sample universities concerning the extent of TIUCIS in Ethiopian universities. The researcher used one-way ANOVA and checked the effect size among the seven sample universities using SPSS version-26. Moreover, the researcher analyzed qualitative textual and contextual data collected through open-ended items of questionnaires, interviews, observation, and document review through thematic narration using statements based on word-for-word/verbatim. Thus, the researcher decided to analyze both quantitative and qualitative data depending on the nature of the data, number of groups compared, and types of data collection tools.

3.12. Ethical Considerations

It is essential to consider ethics in educational research at every stage of the research process (Abed, 2015). Accordingly, ethical considerations in educational research have gained significant importance in recent years, focusing on trust, dignity, privacy, and confidentiality of participants (González et al., 2020). Researchers must adhere to ethical guidelines during data collection, address human subject concerns, and follow proper reporting practices to ensure trustworthy and valid findings (Kessio & Chang'ach, 2020). Researchers need to protect participants from physical, social, and psychological harm, although some argue that harm may be inevitable in qualitative research due to intrusive inquiry (Jena, 2020). Therefore, addressing these ethical and legal considerations is essential for conducting responsible and impactful educational research.

When researching technology integration in education and curriculum, ethical considerations are paramount to ensure the integrity and credibility of the study. First, it is crucial to obtain informed consent from all participants involved in the research, including educators, students, and administrators. Participants should be fully aware of the research objectives, procedures, and any potential risks or benefits. Additionally, their consent should be voluntarily given without any form of coercion. Confidentiality and anonymity are also vital, protecting participants' identities and personal information from being disclosed without permission.

Secondly, researchers must be mindful of the potential impact of technology on educational equity and access. Ethical research should address and mitigate any disparities that technology integration might exacerbate, such as differences in access to resources among various student populations. It is important to consider how the findings and recommendations of the study could influence policy and practice in a way that promotes fairness and inclusivity. By thoughtfully addressing these ethical considerations, the research can contribute to meaningful and equitable advancements in technology integration in education.

4. RESULTS AND DISCUSSION

4.1 Results of the Study

This chapter presents the findings of the study. Firstly, the data obtained quantitatively and qualitatively were analyzed simultaneously. The researcher integrated the findings obtained from quantitative and qualitative data analysis at the interpretation stage. The researcher presented the major findings of the study following their respective objectives and research questions.

Table 4.1: Analysis framework(Research Ends, Research Tools, Methods of Analysis)

N	Research questions	Research tools	Methods of Analyses
1	What are the reasons for integrating technology into undergraduate curricula and instructional settings in Ethiopian public universities?	Questionnaire, interview	Frequency, mean, SD, one sample t-test, narration
2	To what extent is technology integrated into undergraduate curricula and instructional settings in Ethiopian public universities?	Questionnaire, interview, classroom observation, document review checklist	Frequency, average mean, SD, one sample t-test, and narration
3	What roles do instructors play in integrating	Questionnaire, interview,	Frequency, average

	technology into undergraduate curricula and instructional settings in Ethiopian public universities?	observation checklist, document review checklist	mean, SD, one sample t-test, and narration
4	To what extent are the prevailing factors affecting technology integration into curricula and instructional settings in Ethiopian public universities?	Questionnaire, interview, document review checklist	Frequency, average mean, person moment product correlation, factorial analysis, stepwise multiple regression and narration
5	How do technology integration practices differ among Ethiopian public universities in the context of undergraduate curricula and instructional settings?	Questionnaire, interview, observation checklist, document review checklist	Frequency, percentage, mean, rank order Pearson correlation, one-way ANOVA and narration

Source: researcher (2024)

4.1.1 Demographic Characteristics of the Respondents

Table 4.2 shows that a total of 355 respondents gender-wise (Male = 317; 89.29%, Female = 38; 10.71%) selected from seven Ethiopian public universities participated in quantitative and qualitative investigation in the present study. Accordingly, the researcher collected data from 331 instructors (Table 4.2) via a self-constructed questionnaire and 24 key informant interviewees (KII) (Table 4.3) including academic program directorates, quality assurance directorates, students' council presidents, and curriculum experts selected from Ministry of Education by semi-structured interviews. Therefore, the researcher analyzed both qualitative and quantitative data at the same time and mixed them at the interpretation stage.

Table 4.2: Demographic Characteristics of Academic Staff

Demographic Variable	Categories	Frequency	Percent
Name of Sample University	Adama Science & Technology University	59	17.82
	Madda Walabu University	46	13.90
	Assosa University	39	11.78
	Oda Bultum University	20	6.04
	Jimma Univsrsity	61	18.43
	Dire Dawa University	59	17.82
	Wachamo University	47	14.20
	Total	331	100.0
College	Engineering and Technology	93	28.10
	Natural and Computational Science	41	12.39

	Medicine and Health Science	39	11.78
	Agricultural and Life Science	6	1.81
	Business and Economics	83	25.08
	Social Science and Humanities	69	20.85
	Total	331	100
Gender	Male	295	89.12
	Female	36	10.88
	Total	331	100.0
	Graduate Assistant	6	1.81
Academic rank	Assistant Lecturer	16	4.83
	Lecturer	240	72.51
	Assistant Professor	52	15.71
	Associate professor	15	4.53
	Professor	2	.60
	Total	331	100.0
Work experience in years	1-5 years	160	48.34
	6-10 years	113	34.14
	11-15 years	45	13.60
	Above 15 years	13	3.93
	Total	331	100.0

Source: Survey (2024)

Table 4.2 above shows that the majority of instructors were selected from Engineering and Technology (N= 93; 28.10%) followed by the College of Business and Economics (N=83; 25.08%), Social Science and Humanities (N = 69; 20.85%), Natural and Computational Science (N = 41; 12.39%), and Medicine and Health Science (N=39; 11.78%), Agricultural and Life Science (N= 6; 1.8%). Table 4.2 further showed that the majority of instructors were lecturer/second-degree holders (N = 240; 72.51%) followed by Assistant Professors (N= 52%; 15.71%). In addition, the majority of instructors' work experience ranged from 1 to 5 years (N = 160; 48.34%) followed by 6 to 10 years (N = 113; 34.14%), and 11 to 15 years (N=45; 13.60).

This indicates that the majority of the participating instructors were relatively inexperienced in the teaching profession, highlighting a potential need for mentorship and professional development. As novices, these instructors may benefit significantly from guidance and support from more experienced colleagues, particularly in navigating the complexities of teaching and integrating technology into their instructional practices.

Mentorship programs could play a crucial role in helping these instructors develop their pedagogical skills, adapt to evolving educational technologies, and enhance their overall effectiveness in the classroom. Additionally, providing targeted training and resources could empower them to implement best practices and innovative teaching strategies, ultimately leading to improved educational outcomes for their students. Recognizing and addressing this need for mentorship and support is essential for fostering a more capable and confident teaching workforce.

Table 4.3: Demographic Characteristics of Academic Leaders and Analytical Codes

Demographic Variable	Categories	Gender		Codes of participants	No. coded
		M	F		
Academic leaders	Quality assurance directorates	7		QA1- QA7	7
	Academic Program directorates	7		APD8 - APD14	7
	MoE experts	2	1	ME15 -ME17	3
	Students' council presidents	6	1	SCP18-SCP24	7
	Total	22	2		24

Source: Survey (2024)

Table 4.3 shows that 24 KII whose qualifications and work experiences are PhD and above, and above 15 years of work experience respectively, for quality assurance directorates and academic program directorates, and experts from MoE except those student councils' presidents. Gender-wise, 22 interviewees were males and 2 of them were females. In addition, the analytical code of each participant is in place for the qualitative investigation to maintain the anonymity of respondents.

Table 4.4: Gender-wise mean difference regarding overall TIUCIS

Respondents	Gender	N	%
Instructors	Male	317	89.29
	Female	38	10.71
	Total	355	100.00

Source: Survey (2024)

Table 4.4 illustrates that the total mean of male participants in technology integration, 317 (89.29%), was significantly higher than that of female participants (M=10.71%). This disparity is attributed to the larger number of male instructors compared to female instructors working in the sampled public universities. The data suggests a notable proportional difference between male and female participants in the study, reflecting the gender imbalance in the source population within the colleges and departments of the sample universities.

4.1.2. Reasons for Underpinning Technology Integration into Curricula and Instructional Settings

The rationales of technology integration into undergraduate curricula and instructional settings address the preparative, pedagogical, catalytic, accessibility, motivational, and administrative aspects. The side-by-side convergent parallel mixed methods analysis was made based on the responses of 355 respondents, 331 instructors (quantitatively), and the responses of 24 KII (qualitatively) which include academic program directorates, quality assurance directorates, students' councils' presidents, and MoE curriculum experts.

Table 4.5: Reasons for Underpin Technology Integration into Curricula

Dimensions	Items	N	M	SD	t-test	Df	Sig.
Preparative	Prepares students for their future occupation	331	3.625	.649	1.692	330	.271
	Teaches students the value of technology	331	2.941	.720	6.405	330	.000
	Assists students' cooperation in their learning	331	3.252	.870	1.459	330	.278
	Supports students' concerns about using technology	331	2.789	.908	12.357	330	.000
	Strengthen students' problem-solving skills	331	2.908	.873	7.729	330	.000
	Total average mean		3.323	.868			
Pedagogic	Assists students' engagement in the learning process	331	3.063	.695	1.293	330	.318
	Assists in adapting education to fit students' needs	331	2.881	.872	6.831	330	.000
	Offer authentic learning environments	331	3.121	.825	1.786	330	.245
	Improve interactions b/n instructors & students	331	2.897	.717	10.358	330	.000
	Total Average Mean		2.991	.675		330	
Catalytic	Assists in realizing a planned educational reform	331	3.069	.732	1.238	330	.341
	Assists in expressing educational mission	331	3.215	.549	1.727	330	.294
	Total Average Mean		3.142	.539			
Accessibility	Access education for learners with difficulties	331	2.810	.872	11.219	330	.000
	Reduces inequalities among groups	331	2.662	.857	8.835	330	.000

	of students						
	Assists to realize distance education	331	3.211	.756	1.481	330	.291
	Realizes education is limitless of the session hours	331	3.132	.815	1.897	330	.196
	Total Average Mean		2.954	.828			
Motivational	Inspiring students to learn	331	3.085	.927	2.187	330	.266
	Monitoring students' learning progress	331	2.912	.824	7.039	330	.000
	Total Average Mean		2.998	.345			
Administrative	Align education & students' living environment	331	2.794	.792	11.442	330	.000
	Assists in managing educational process	331	2.812	.849	9.547	330	.000
	Total Average Mean		2.803	.840			
	Grand Mean		3.124	.749			

Source: Survey (2024)

Cutoff points: mean score from 1.00 -1.99 is (completely not important); from 2.00 - 2.99 (barely important); 3.00 (expected ideal mean); from 3.01 - 3.99 (important); from 4.00 - 5.00 is (very important), and p is significant at 0.05.

4.1.2.1. Preparative Dimensions

Table 4.5 item 1 depicts that the preparative dimensions of underpinning technology integration into undergraduate curricula and instructional settings average mean of respondents was found to be (M=3.625, t (1.692)=.271, p >.05). The one-sample t-test confirmed there was no a statistically significant difference between the average means of instructors and expected ideal mean regarding instructors' perception of the importance of technology integration in preparing students for their future occupation. However, item 2 of the same Table summarizes that the average mean of the respondents was (M=2.941, t (6.405) =.000, p <.05). The one sample t-test confirmed that there was a statistically significant difference between the means of instructors and expected ideal mean. However, item 3 of Table 4.5 demonstrates that the average mean of instructors was (M=3.252, t (1.459) =.278, p >.05). This suggests the average mean of instructors was greater than the expected ideal mean value. The one-sample t-test revealed that there was no statistically significant difference between the average mean of instructors and the expected ideal mean. On the other hand, item 4 of the same Table reflected that the average mean of respondents was (M = 2.789, t (12.357) =.000, p <.05). The one sample t-test confirmed that there was a statistically significant difference between the average mean of instructors and expected ideal mean. The last item 5 regarding preparative dimensions of technology integration shows whether/not technology strengthens students' problem-solving skills. The mean of instructors was found to be (M=2.908, t (7.729) = .000, p <.05). The one sample t-test confirmed that there was a statistically significant difference between the average mean of instructors and the expected ideal mean.

Therefore, the total average of preparative dimensions of technology integration practice mean was (M=3.323) which is greater than an ideal mean (3.00). This indicates that instructors have an understanding of the importance of rationales rated as with requirements for technology integration practices into undergraduate programs curricula and instructional settings.

4.1.2.2. Pedagogical Dimension

About the educational dimension of technology integration into undergraduate curricula and instructional settings, Table 4.5 item 1 showed that the average mean of instructors was (M = 3.063, t (1.293) = .318, p >.05). This indicated the average mean of instructors was greater than the expected ideal mean value. The one sample t-test revealed that there was no statistically significant difference in opinion among instructors while rating whether technology integration assists students' engagement in the learning process. On the other hand, item 2 of the same Table depicted that the average means of instructors regarding whether or not technology assists instructors in adapting education to fit students' needs was (M = 2.881, t (6.831) = .000, p <.05) indicating that the average mean lies below the expected ideal mean value. The one sample t-test showed that there was a statistically significant difference between the calculated average mean of instructors and the expected ideal mean. Yet, item 3 recommended that the mean of instructors regarding whether technology integration offers authentic learning environments for learners was (M = 3.121, t (1.786) = .245, p >.05). The one sample t-test confirmed that there was no a statistically significant difference of perceptions between the means of instructors and expected ideal mean. Table 5 item 4 showed that the mean of instructors regarding whether or not technology integration improves interactions between instructors and students was (M = 2.897, t (10.358) =.000, p <.05). The one sample t-test assured that there was a statistically significant difference between the mean of instructors and an expected ideal mean.

Therefore, the total average mean of pedagogical dimensions of technology integration practice mean was (M= 2.991) which is a little bit less than an ideal mean. This indicates that the awareness of instructors on the pedagogic dimension of rationale requires improvements in technology integration into undergraduate curricula and instructional settings.

4.1.2.3. Catalystic Dimension

Regarding the catalystic dimension of technology integration into undergraduate curricula and instructional settings, Table 4.5 item 1 showed that the average mean of instructors was (M = 3.069, t (1.238) =.341, p >.05). This suggested that the average mean of instructors was greater than the expected ideal mean value. The one-sample t-test revealed that there was no statistically significant difference between the average mean of instructors and the expected ideal mean. Similarly, item 2 showed whether or not technology integration assists in realizing planned educational reforms, and expressing educational mission (M = 3.215, t (1.727) =.294, p>.05). The one sample t-test examined that there was no statistically significant difference between the average means of instructors and expected ideal mean. Therefore, the total average of catalytic dimensions of technology integration practice mean was (M = 3.142) which was greater than an ideal mean value (3.00). This indicates that the awareness of instructors on the catalytic dimension of rationales requires acceleration of technology integration practices into undergraduate programs' curricula and instructional settings.

4.1.2.4. Accessibility Dimension

The accessibility dimension of technology integration into undergraduate curricula and instructional settings is important. Accordingly, Table 4.5 items 1 and 2 demonstrated that the average mean of instructors was [(M=2.810, t (11.219) =.000; M=2.662, t (8.835) =.000, p <.05)] respectively. This suggested the average mean of instructors was less than the expected ideal mean value. The one sample t-test revealed that there was a statistically significant difference between the average mean of instructors and the expected ideal mean regarding instructors' access to education for learners with learning difficulties and reduced inequalities among groups of students respectively was less. Yet, item 3 revealed that the average mean of instructors regarding whether/not technology integration assists in realizing distance education was (M=3.211, t (1.481) =.291, p >.05). The one sample t-test confirmed that there was no a statistically significant difference between the mean of instructors and the expected ideal mean. Likewise, item 4 showed that the mean of instructors regarding whether or not technology integration realizes education to be limitless of the session hours was (M=3.132, t (1.897) =.196, p >. 05). The one sample t-test assured that there were no statistically significant differences between the mean of instructors and expected ideal mean.

Therefore, the total average accessibility dimension of the rationale of technology integration mean was (M= 2.954) which is less than the expected ideal mean. This indicates that the perception of instructors on the accessibility dimension of rationale requires improvements in integrating technology into undergraduate curricula and instructional settings.

4.1.2.5. Motivational dimension

The motivational dimension of technology integration into undergraduate curricula and instructional settings was rated as follows. Table 4.5 item 1 showed that the average mean of instructors was (M=3.085, t (2.187) =.266, p>.05). This suggested the average mean of instructors was greater than the expected ideal mean value. The one-sample t-test revealed that there was no statistically significant difference between the mean of instructors and the expected ideal mean indicating that technology enhances students' inspiration of learning. Whereas, item 2 showed instructors rated (M=2.912, t (7.039) =.000, p <.05) whether or not technology monitors students' learning progress. The average mean of instructors was less than the ideal mean, and the one sample t-test examined that there was a statistically significant difference.

Therefore, the total average mean of motivational dimensions of rationale regarding technology integration practice total average mean was (M= 2.998) which was approximately equal to an ideal mean value. This indicates that the awareness of instructors on the motivational dimension rationale of technology integration requires additional efforts in undergraduate curricula and instructional settings.

4.1.2.6. Administrative Dimension

The administrative dimension summarized in Table 4.5 item 1 showed that the average mean of instructors was (M=2.794, t (11.442) =.000, p<.05). This shows that the average mean of instructors was less than the expected ideal mean value. The one sample t-test revealed that there was a statistically significant difference in perceptions among instructors regarding whether/not technology aligns education with students' living environment. Similarly, item 2 of the same

Table reflected that the average mean of instructors whether/not technology assists in managing educational processes was (M = 2.812, t (9.547) = .000, p <.05). The one sample t-test examined that there was a statistically significant difference of perceptions between the average mean of instructors and expected mean.

Therefore, the total average of the administrative dimension of technology integration practice mean was (M= 2.803). This indicates that the awareness of instructors on the administrative dimension of rationales whether technology integration practices support/aid administrative tasks in undergraduate curricula and instructional settings.

The overall grand mean of preparative, pedagogic, catalytic, accessibility, motivational, and administrative dimensions of rationales of technology integration into undergraduate curricula and instructional settings(M=3.124). Therefore, the grand mean of respondents revealed that the awareness of instructors was found reasonably important although it requires further work to create positive attitudes among key stakeholders in public universities.

According to the qualitative exploration of the study, one of the KII from MoE expressed:

> ‘The Ethiopian Ministry of Education is actively working to integrate technology into curricula and instructional settings. The goal is to ensure that educational policies are designed to effectively incorporate technology in both synchronous and asynchronous learning environments. This integration is crucial for several reasons: it enhances the quality and relevance of education, optimizes cost and time management, improves student achievement, and boosts students' interest and motivation by fostering confidence in innovation. As a result, instructors, college deans, and higher education leaders are increasingly recognizing the importance of embedding technology into curriculum and instruction’ (ME15, April 16, 2024).

In addition, one of the quality assurance directorates revealed:

> ‘At present, it is more accurate to describe the issue as one of perception rather than awareness when it comes to instructors' understanding of technology integration. It is evident that both instructors and students recognize the pedagogical and motivational benefits of technology in education. However, the successful design and utilization of technology-integrated curricula and instructional processes are contingent upon the availability of adequate infrastructure. If universities invest in technological infrastructure and provide

> comprehensive training for instructors, both faculty and students would be well-equipped to integrate technology effectively into the educational environment. These efforts would lead to more effective teaching methods and enhanced learning experiences for students, thereby significantly improving the overall educational outcomes’ (QA5, February 19, 2024).

Similarly one of the interviewees discussed the reason for using technology in curriculum and instruction

> ‘The Ethiopian Government and the Ministry of Education have recognized the importance of technology as a key driver for economic and social development. In particular, the education sector is seen as a crucial area for using technology for education, especially in curriculum implementation and teaching methods. Therefore, instructors and university leaders must prioritize the integration of technology into educational practices. In this context, the use of technology in education is not just a choice but a necessity. It is essential to adapt to technological advancements to stay relevant and competitive in the rapidly evolving educational landscape. Therefore, the approach to technology in education can be likened to the adage "do it, or lose it, and swim or sink", emphasizing the mandatory nature of embracing technology rather than considering it as an optional component of education’ (QA7, February 2024).

An academic program director discussed:

> ‘Nowadays, technology plays a crucial role not only in education but also in our daily lives. In the realm of education, the influence of technology is profound as it has the potential to enhance the teaching and learning process, empowering students to gain comprehensive knowledge. For example, the integration of e-learning platforms significantly facilitates the teaching and learning process by providing a wide range of resources and interactive tools that cater to diverse learning styles. The accessibility and flexibility offered by e-learning contribute to a more personalized and effective learning experience for students’ (APD11, 15 January 2024).

Similarly, one of the students' council presidents stated:

> ‘The integration of technology into the curriculum and instructional process is essential for making learning easier and more effective. Technology allows teachers to deliver instruction that engages multiple senses, making abstract concepts more concrete and practical. This is expected to be achieved with various tools such as videos, animations, pictures, figures, diagrams, and specialized software. By incorporating these technological tools, students can grasp complex concepts more easily and apply them in real-life scenarios’ (SCP20, 22 January 2024).

In addition, one of the academic program directors explained in such a way:

> 'The potential benefits of technology integration in education are clear. It is essential to address the aforementioned challenges and barriers to facilitate a more seamless and widespread adoption of technology in educational settings. This would require the development of supportive learning environments that embrace technological advancements, increased recognition of the value of technology in education for both educators and students, and the enhancement of educators' professional competencies in integrating technology into their teaching practices. Efforts to create a more tech-integrated educational landscape should also focus on providing adequate resources and support for both educators and students, fostering a culture of innovation and adaptability, and ensuring equitable access to technology across all levels of education' (APD8, 02 April 2024).

…The review of the Ethiopian education development roadmap (MoE, 2018) reveals that universities did not seem to have strategies and tactics to prepare programs requiring intensive use of information technology for learning purposes. This policy document clearly outlines the existing challenges and gaps. However, it doesn't indicate direction on how to integrate technology into the curricula and instruction process in higher education institutions.

Although the roadmap policy document didn't show the direction of using technology in the education system, the ICT policy for HE and TVET in Ethiopia (MoSHE, 2020) identified its mission and objective to ensure that all HE and TVET educators, administrators, and learners take full advantage of the opportunities offered by digital technology. Since, technology is a central concern in curriculum design, instruction settings, and assessment delivery to promote students' access to digital knowledge using ICT resource materials. This improves the efficiency and effectiveness of education and training systems using technology (Document review, April 2024).

…The MoE policy document review (differentiation of universities) deals with Ethiopian university differentiation discourages uniformity of curriculum across universities, and encourages universities to design their curriculum assisted by ICT, digital technologies, asynchronous and synchronous instruction, flipped classroom instruction, blended learning, and online learning. On top of designing course planning, the policy encourages the application of innovative pedagogies supported by digital technologies such as smart boards, data mining processes, video conferencing, and mobile phones (Document review, February 2024).

…The review of the MoSHE policy document (differentiation of universities) showed regarded technology as knowledge, process, and tools for curriculum implementation in face-to-face interaction, online/virtual, and blended learning because technology motivates learners and facilitates their individual and collaborative learning potential. The document encourages teachers' technology integration practices at content, activities, learning experiences, and learning outcomes levels during instructional planning and in classrooms (Document review, February 2024).

The rationale for integrating technology into undergraduate curricula and instructional settings in Ethiopian higher education institutions is multifaceted, encompassing preparative, pedagogical, catalytic, accessible, and motivational aspects. These elements underscore the importance of technology integration in classrooms, independent of the professional and pedagogical competencies of curriculum designers and subject matter instructors. Despite challenges such as a lack of instructor motivation, commitment, and professional competencies, higher education institutions in Ethiopia demonstrate a growing awareness of the need for technology integration and its potential benefits in enhancing educational outcomes.

4.1.3. Dimensions of the Extent of Technology Integration into Curricula and Instructional Settings

The side-by-side convergent parallel mixed methods analysis was made based on responses of 355 participants, 331 instructors (quantitatively), and 24 KII (qualitatively) which include academic program directorates, quality assurance directorates, students council's presidents, and MoE curriculum experts.

Table 4.6: Technological Infrastructures and their Application in TIUCIS

Dimensions	Items	N	M	SD	t-test	Df	Sig.
Availability of technological infrastructure	Computer labs are equipped with up-to-date hardware	331	3.136	.884	3.017	330	.087
	Computer labs are equipped with up-to-date	331	3.024	.872	2.381	330	.162

	software.						
	There is reliable internet connectivity in the college.	331	2.062	.996	17.026	330	.000
	There are multimedia facilities in classrooms.	331	2.363	.929	14.942	330	.000
	Total average mean		2.646	.923			
Integration of technology into course materials	Digital resources are incorporated into the curriculum	331	3.000	.881	2.900	330	.050
	There are online learning management systems/ platforms used for course delivery and interaction	331	2.822	.971	9.117	330	.000
	Instructors and students use digital learning materials	331	2.970	.890	6.085	330	.000
	Total average mean		2.931	.821			
Application of technology in instructional delivery	Instructors use multimedia presentations during lectures.	331	2.864	.779	9.459	330	.000
	Online discussions, forums, or virtual classrooms are utilized for student engagement.		2.562	.984	14.247	330	.000
	Instructors employ educational apps or software for interactive learning experiences.	331	2.764	.740	10.821	330	.000
	Total average mean	331	2.730	.786			
Accessibility and inclusivity	Accommodations are provided for students with disabilities using assistive technologies.	331	2.719	.891	11.181	330	.000
	There is attention that technology integration does not create barriers for certain students.	331	2.888	.454	9.728	330	.000
	Resources and materials are available in different formats to accommodate diverse learning needs.	331	2.984	.934	8.571	330	.000
	Total average mean		2.858	.739			
	Grand Mean		2.791	.828			

Source: Survey (2024)

Cutoff points: mean score from 1.00 -1.99 is (very poor); from 2.00 - 2.99 (poor); 3.00(expected ideal mean); from 3.01 - 3.99 (good); from 4.00 - 5.00 is (very good), and p is significant at 0.05.

4.1.3.1. Availability of Technological Infrastructure Dimension

According to Table 4.6 items 1, 2, and 3, the average means of instructors about the availability of technological infrastructures such as equipping computer labs with up-to-date hardware, up-to-date software, and internet connectivity were [(M = 3.136, t (3.017) =.087; 3.024, t (2.381=.162 and 2.062, t (17.026) = .000, p >.05)] respectively. The one-sample t-test of all three items indicated that there were no statistically significant differences between the average means of instructors and the expected ideal mean, respectively. On the contrary, the availability of multimedia facilities in classrooms (M=2.363, t (14.942) =.000, p. 05) was less than the expected ideal mean value. The one-sample t-test shows that there was a statistically significant difference between the mean of respondents and the expected ideal mean.

As a result, the total average mean of availability of technological infrastructure (M=2.646) was less than an ideal mean value. This indicates that the availability of technology infrastructure is not worth mentioning and requires additional effort for technology integration.

4.1.3.2. Integration of Technology into Course Materials

Table 4.6 items 1, 2, and 3 illustrated that the states of integration of technology into course materials were not successful in instructional quality. For instance, digital resources were moderately incorporated into curriculum (M=3.00, t (2.900) =.050), although the online platforms used for course delivery and interaction were not encouraging (M=2.822, t (9.117) =.000). In addition, instructors and students did not use digital learning materials as much as expected in higher institutions (M=2.971, t (6.085), p=.000). The one sample t-test shows that there were statistically significant differences between mean of respondents and expected ideal mean.

The total average mean of integration of technology into course materials (M = 2.931) was less than the ideal mean value. This indicates poor practices of instructors on the integration of technology into course materials.

4.1.3.3. Application of Technology for Instructional Delivery

Table 4.6 items 1, 2, and 3 showed that the status of instructors' application technology integration in their instructional system is below expectation. The majority of instructors could not use multimedia presentations or videos during lectures because of a lack of preparation (M=2.864, t (9.459) =.000). In addition, they were not capable of using online discussions, forums, or virtual classrooms utilized for student engagement (M=2.562, t (14.247) =.000). Also, instructors do not employ educational apps or software for interactive learning experiences effectively (M=2.764, t (10.821) =.000). The one sample t-test shows that there was a statistically significant difference between the mean of respondents and expected ideal mean.

The total average mean of application of technology for instructional delivery was not supported by digital pedagogical practices in Ethiopian public universities (2.730) less than an ideal mean value (3.00). This indicates that extent of integration of technology applications in the instructional settings were poor.

Regarding the application of technology for instructional delivery, one of the interviewees highlighted:

> ‘I have noticed that some instructors have attempted to integrate various technological tools into the classroom but have encountered challenges in operating them effectively. During highway construction, for example, there are different types of software available. While instructors are familiar with older software like Eagle Point, which was released in 2008, many of them lack knowledge about how to use the latest software such as Civil 3D, which was manufactured in 2022. As a result, I have observed a deficiency in the instructors' proficiency in applying different technological tools, whether in classroom settings or practical field work’ (SCP20, 22 January 2024).

4.1.3.4 Accessibility and Inclusivity

Table 4.6 items 1, 2, & 3 demonstrated that the contribution of technology integration practices to curriculums and instruction accessibility and inclusivity was not as powerful in ensuring the quality of learning in higher education institutions as the average means of practices predicted. Accordingly, the provisions of accommodations for students with disabilities using assistive technologies were rated below the ideal mean (M=2.719, t (11.181) =.000, p<.05). Similarly, the lack of barriers to technology integration for some students was not recognized (M=2.888, t (9.728) =.000). In addition, there was lack of resources and material to accommodate diverse learning needs (M=2.918, t (8.571) =.000). Therefore, the total average mean of accessibility and inclusivity (M=2.858) was less than an ideal mean value. This indicates that the extent of making technology accessible and inclusive to all students were less than the ideal mean. As the one-sample t-values were less than the p-value, there were significant differences between the average mean of instructors and the expected ideal mean.

The grand mean of technological infrastructures and their application (M=2.791) was less than the ideal mean (M=3.00). Therefore, it is less than the ideal means and it requires further improvements in technological infrastructures and their application in public universities.

Furthermore, one of the interviewees suggested:

> ‘It can be challenging to integrate technology into undergraduate curricula and instructional systems in Ethiopia for various reasons. One of the main obstacles is the

> lack of resources such as infrastructure (whiteboards, smart boards, internet connection, video cassettes, computers, tablets, cassettes, and smart mobile phones). Additionally, there is a deficiency in instructors' competency and willingness to improve instructional practices by incorporating technology. It appears that there is a lack of skilled professionals capable of effectively integrating technology into the curriculum and pedagogy. Technology integration practices in Ethiopian public higher education institutions are still in their early stages of development or at common sense. This indicates that there is significant potential for growth and improvement in leveraging technology for educational purposes within these institutions' (ME17, 16 April 2024).

On the contrary, one of the academic program directors suggested:

> 'Sure, let's discuss the technological aspects of our university further. At the university I work in, technology plays a crucial role in our teaching and learning activities. We prioritize the integration of ICT (Information and Communication Technology) into our infrastructure and educational practices. For example, our instructors are actively involved in developing and utilizing e-learning resources for their courses. Additionally, we are striving to align our programs with various technological tools to seek accreditation. Despite our emphasis on technology, we currently lack a separate institutional policy specifically addressing technology integration. However, we possess the capability to seamlessly incorporate various technological tools into our curriculum and instructional processes. It is important to note that our university has recently introduced a new position, namely the e-learning coordinator. This signifies our commitment to transitioning several courses into an online learning management system. Ministry of Education places a strong emphasis on the integration of technology into the academic environment' (APD11, 15 January 2024).

…Furthermore, the researcher witnessed that some classroom instruction was teacher-centered dominated by PowerPoint slide presentations and it was difficult to see the stage at which technologies were integrated into instruction where there was no student interaction (the majority of students were reading from their mobile phones). This attempt shows the best paths toward the application of digital technologies in instructional settings (Ob1, Ob4 & Ob7, April 2024).

4.1.3.5. Professional Competency and Activities Related to the Extent of Technology Integration

Table 4.7: Professional Competency and Activities for Technology Integration

Dimensions	Items	N	M	SD	t-test	Df	Sig.
Skills development	Training to enhance students' digital literacy skills	331	2.858	.817	7.491	330	.000
	Professional development to improve technology proficiency	331	2.903	.756	9.325	330	.000
	Effective support for instructors using	331	2.915	.7168	10.001	330	.000

	technology						
	Effective support for students using technology	331	2.925	.752	9.824	330	.000
	Total average mean		2.900	.898			
Research & innovation with technology	Encouraging students to use technology for research	331	3.112	.635	2.223	330	.098
	Instructors utilize technology for research activities	331	3.096	.540	.978	330	.417
	Innovation and entrepreneurship among students	331	3.063	.570	.829	330	.569
	Total average mean		3.089	.687			
Collaborative and blended learning	As online collaboration tools for team-based learning	331	2.767	.715	7.108	330	.000
	Blended & online leanings are integrated	331	2.837	.864	5.585	330	.000
	Facilitating virtual meetings for academic purposes	331	3.109	.796	1.904	330	.271
	Total average mean		2.904	.901			
Assessment and feedback through technology	Conducting online assessments via digital platforms	331	2.462	.998	13.219	330	.000
	Using plagiarism detection software for evaluation	331	2.535	.768	12.865	330	.000
	Technology is used to provide timely feedback to students on their performance	331	2.879	.699	6.671	330	.000
	Total average mean		2.625	.9618			
	Grand Mean		2.880	.895			

Source: Survey (2024)

Cutoff points: mean score from 1.00 -1.99 is (very poor); from 2.00 - 2.99 (poor); 3.00(expected ideal mean); from 3.01 - 3.99 (good); from 4.00 - 5.00 is (very good), and p is significant at 0.05.

4.1.3.6. Skills Development Dimension of Technology Integration

Table 4.7 items 1, 2, 3, and 4 demonstrated that the contribution of technology integration practices to the skills development dimension was poor. Accordingly, training provided to instructors to enhance students' digital literacy skills (M=2.858, t (7.491) =.000), professional development/learning opportunities for improving technological proficiency (M=2.903, t (9.325) =.000), effective support for instructors using technology (2.915, t (10.001) =.000), effective support for students using technology (M=2.921, t (9.824) =.000), p <.05. This indicates that the skills development dimensions of technology integration practices were below the ideal mean. As the one-sample t-values were less than the p-value, there were significant differences between the average mean of instructors and the expected ideal mean.

Therefore, the total average mean of skills development activities of technology integration practices (M=2.900) was less than an ideal mean value. This indicates that the skills development dimensions of technology integration extent were below the ideal mean.

In addition, one of the interviewee student council presidents explained:

> ‘I have noticed that despite the availability of various technological tools at our university, their usage doesn't align with my expectations. The predominant method of instruction seems to heavily rely on PowerPoint presentations, and there seems to be a lack of encouragement for us to explore and utilize other technological resources for learning. Given that our generation is highly adept at using and relying on a wide range of technological tools, it would be beneficial if our instructors provided more support in leveraging these resources to enhance our learning experience’ (SCP20, 22 January 2024)

4.1.3.7. Instructors’ Technology Integration in Research and Innovation

Table 4.7 items 1, 2, and 3 stated that the efforts of working research and innovation with technology integration practices were rated by instructors showing mean values [(M = 3.112, t (2.223) =.098; 3.096, t (.978=.417 & 3.063, t (.829) = .568, p >.05)] respectively. The one sample t-test of all three items indicated that there were no statistically significant differences in means of instructors realizing that instructors utilize technology for research activities and initiatives for technological innovation and entrepreneurship among students respectively.

The total average mean of research and innovation with technology integration practice (M=3.089) was greater than an ideal mean value. The one-sample t-test confirmed that there were no statistical differences between the average means of instructors and the expected ideal mean.

Furthermore, one of the interviewees suggested:

> ‘I think, some instructors in my respective university are capacitating themselves using technology applications in the teaching-learning process, research and innovation, and community services. However, the majority of instructors do not worry about technology applications although the 21st century requires up-to-date competencies and skills to satisfy their students in classrooms. I dare say that familiarizing oneself with technology and effectively using technology improves the life of instructors, society, families, and the performance of tomorrow’s workforce to graduate from the university. Incorporating technological tools and approaches into teaching can enhance student engagement, provide access to a

> wide range of resources, and prepare students for success in an increasingly digital world. Moreover, leveraging technology in research and innovation can lead to groundbreaking discoveries and advancements in various fields. Embracing technology also allows for greater outreach and impact in community services, benefiting society at large. Therefore, instructors need to recognize the significance of technology and equip themselves with the necessary skills to better fulfill their responsibilities and contribute to a more prosperous future' (QA4, 10 April 2024).

Regardless of the lack of information about the integration of technology into the curricula, one of the interviewees suggested:

> 'Our instructors are using technology as transformational tools to facilitate the teaching-learning process. For instance, my university has adjusted smart technology-based learning, whiteboards, LCD, and internet access….I am sure that my college's instructors have good feelings towards virtual learning and blended learning as that of 21^{st} century needs although we lack successive follow-up mechanisms whether/or not instructors are creating interactive instructional processes in and outside classrooms. I have to follow the status of technology integration practice in curriculum and instructional settings in collaboration with respective college deans and department heads' (APD10, 15 March 2024).

4.1.3.8. Extent of Collaborative and Blended Learning

Table 4.7 items 1, 2, and 3 demonstrated that the status of collaborative and blended learning practices through technology was poor and did not foster team-based learning (M= 2.767, t (7.108) =.000), blended and online learning are integrated with face to face instruction (M=2.837, t (5.585) =.000). The one sample t-test confirmed that there were significant differences between average means of instructors and expected ideal mean. On the contrary, technology facilitates virtual meetings for academic purposes (M=3.109, t = 1.904=.271). The one-sample t-test confirmed that there was no significant difference between the average mean of instructors and the expected ideal mean.

Therefore, the total average mean of collaborative and blended learning practices (M=2.904) was less than an ideal mean value. The findings of the study suggest that the extent of collaborative and blended learning among instructors fell short of the anticipated ideal average.

4.1.3.9. Assessment and Feedback through Technology

Table 4.7 items 1, 2, and 3 confirmed that the status of assessment and feedback through technology were not encouraging implying that online assessments were not effectively conducted through digital platforms (M=2.462, t (13.219) =.000, p <.05). Likewise, instructors were not effectively used for checking plagiarism software to evaluate students work (M=2.535, t (10.865) =.000). The instructors did not effectively use technology to provide timely feedback to students (M=2.879, t (6.671) =.000). The one-sample t-test values were less than the p-value indicating that there were significant differences between the average means of instructors and expected ideal mean.

The total average mean of assessment and feedback through technology (M=2.625) was less than an ideal mean value. This indicates that the practices of instructors in utilizing assessment and feedback systems were below the ideal mean. The grand mean of professional competency development activities for technology integration practice (M=2.880). Therefore, it is less than the expected ideal mean and it requires further improvements in technology integration into undergraduate curricula and instructional settings (TIUCS) in Ethiopian public universities.

Therefore, the overall grand mean of the extent of technology integration into undergraduate curricula and instructional settings (M=2.820). Therefore, it is less than the ideal mean.

Regarding the professional competencies and skills in technology integration practices, one of the quality assurance directorates stated:

> ‘I believe that a few instructors are investing their time in mastering the art of delivering synchronous and asynchronous instruction. However, there seems to be a lack of enthusiasm among some instructors towards these practices. Some argue that these methods make students lazy rather than nurturing deep learning and critical thinking skills. Additionally, I assume that some students may not prioritize their learning once they leave the classroom, even though the current educational paradigm emphasizes student center and continuous learning, regardless of time and location, as long as the content is relevant to the learners.’(QA3, 7 April, 2024).

… In addition to this, the researcher's observation revealed that although instructors in their daily lessons mainly use PowerPoint slides, there was a lack of clear integration of technology in the teaching-learning process. This lack of technology integration, particularly the instructors' insufficient use of various digital devices like laptops, smartboards, and smartphones, leads them to emphasize more on traditional teaching methods. These findings suggest that there may be inadequate practices in integrating technology into curriculum design and instructional settings. This information highlights the potential need for professional development and training to support educators in effectively incorporating technology into their teaching practices (Ob2, Ob5, and Ob7, 1-15 March 2024).

…On the other hand, based on the curricula review checklist, the researcher reviews each curriculum and summarizes the results as follows. The undergraduate curricula of Natural Resource Management, Nursing, Physics, Economics, English Language and Literature, and Civil Engineering were reviewed to check the status of technology integration. The intended technology integration areas such as learning outcomes, contents, teaching strategies, and assessment strategies were mainly focused on each curriculum (Curricula reviews, January – April, 2024).

Accordingly, the learning outcomes, contents, teaching strategies, and assessment strategies were not properly designed to integrate technology into the mentioned curricula. The issue of technology integration was not emphasized on practical implementation. Because, instructors were not supposed to use technology for teaching and learning purposes due to lack of integration in those areas. This means that technology in curriculum and instruction is not integrated into the Natural Resource Management, Nursing, Physics, Economics, English Language and Literature, and Civil Engineering curricula. So that, students may not be adequately prepared to utilize technology in their teaching and learning process. The respective departments miss out on the opportunities that technology can offer in terms of more engaging and effective teaching methods, as well as preparing students for academic achievement and future work. This lack of integration not only stuck innovation in pedagogical approaches but also creates a significant gap in students' technological usage for learning. Therefore, graduates find themselves at a disadvantage when competing for roles that require proficiency in technological tools and methods, which are now integrated across various sectors.

Since, technology is not integrated into the aforementioned curricula and instructional areas such as learning outcomes, contents, teaching strategies, and assessment strategies instructors may not develop their professional and technological skills, to effectively incorporate technology into their teaching. This in turn, can lead to a cycle of reluctance to adopt new methods, perpetuating a traditional approach to education that may no longer serve the needs of students or society. Collaborative learning, interactive simulations, and digital platforms that enhance the learning experience are overlooked opportunities that could transform the educational landscape within these departments. As a result, it becomes essential to revisit and revise the curriculum framework, ensuring it encapsulates technology integration holistically. Professional development initiatives should focus on equipping instructors with the skills to incorporate technology into their subject areas specifically into instructional settings effectively. Such an overhaul would not only benefit instructors by expanding their teaching practice but also foster a learning environment that prioritizes engagement and relevance, ultimately leading to enriched student outcomes.

Embracing technology in education holds the potential to create meaningful learning experiences that promote critical thinking, problem-solving, and creativity. If departments like Natural Resource Management, Nursing, Physics, Economics, English Language and Literature, and Civil Engineering do not make concerted efforts to integrate technology into their curricula, the risk of becoming obsolete, outpaced by institutions that are innovating and preparing their students for the futures they will face. Thus, the imperative for change is clear, and it calls for a strategic approach to curriculum design that places technology at its core.

From the reviewed curricula, civil engineering was relatively better in technology integration compared to others. For instance, the review reveals that its objective is to develop the fundamental capability of visual and graphical communications in the construction industry. It involves the interpretation and creation of graphical presentations using computer-aided drafting software. The teaching strategies include presentation of modules/courses is through lectures, tutorials, self-study (project works), problem-solving, class and group discussions, assignments, laboratory demonstrations, and hands-on exercises as well as quizzes and tests. Audiovisual aids and e-learning are also methods to be applied in supporting the lectures.

However, the aforementioned technological tools were simply to support the lecture methods. This suggests that the purpose of these tools is to aid in the delivery or enhancement of the lecture, rather than being the main focus or subject of it.

4.1.4 Instructors' Roles in TIUCIS in Ethiopian Public Universities

Table 4.8: Proficiency, selection, and utilization of technological tools

Dimensions	Items	N	M	SD	t-test	Df	Sig.
Familiarity with technology	Familiar with technological tools and resources	331	3.072	.954	2.162	330	.102
	Possess basic computer skills and digital proficiencies	331	2.912	.875	4.974	330	.000
	Knowledgeable on educational technologies	331	2.781	.909	8.961	330	.000
	Total average mean		2.922	.864			
Integration of technology in course/lesson plans	Incorporate technology in plans and activities	331	2.696	.990	13.263	330	.000
	Integrate learning objectives with apt technological tools	331	2.871	.982	7.244	330	.000
	Pedagogical aids of technology integration in lessons.	331	3.051	1.018	2.183	330	.087
	Total average mean		2.873	.961			
Selection and utilization of technological tools	Choose apt technological tools based on learning goals	331	2.569	.935	14.117	330	.000
	Aware of educational software, apps or online platforms	331	2.717	.800	9.267	330	.000
	Technology integration improves learning engagement	331	3.107	1.127	2.008	330	.138
	Modify teaching strategies using technology effectively	331	2.801	.997	8.210	330	.000
	Total average mean		2.799	.874			
	Grand Mean		2.865	.877			

Source: Survey (2024)

Cutoff points: mean score from 1.00 -1.99 is (strongly disagree); from 2.00 - 2.99 (disagree); 3.00 (expected ideal mean); from 3.01 - 3.99 (agree); from 4.00 - 5.00 is (Strongly agree), and p is significant at 0.05.

4.1.4.1. Instructors' Roles in Familiarizing with TIUCIS

In line with instructors' familiarity with TIUCIS, Table 4.8 item 1 showed that instructors were familiar with technological tools and resources (M = 3.072, t (2.162) =.102, p>.05). The calculated mean value is greater than the ideal mean (M=3.00) and the performed one sample t-test showed that there was no a statistically significant difference between the average mean of instructors and the expected ideal mean. However, items 2 and 3 of the same Table summarized that instructors' basic computer skills and digital proficiencies (M= 2.912, t (4.974), p <.000), and knowledge of educational technologies (M=2.781, t (8.961), p <.000) were below the expected ideal mean (M=3.00). The one-sample t-test values were less than the p-value indicating that there were significant differences between the average means of instructors and the expected ideal mean.

The total average mean of instructors' familiarity with TIUCIS (M=2.922) was less than an ideal mean value (M=3.00). This requires improvements regarding instructors' familiarity with basic computer skills, digital proficiencies, and knowledge of digital literacy in education to enhance the implementation of TIUCIS in Ethiopian public universities.

4.1.4.2. Instructors' roles of technology integration in lesson/course plans

Concerning technology integration roles of instructors in lesson/course plans, Table 4.8 items 1 and 2 illuminated that instructors did not incorporate technology into course/lesson plans and activities (M=2.696, t(13.263), p <.000), and did not integrate learning objectives with apt technological tools (M=2.871, t (7.244), p <.000). The mean values were less than the expected ideal mean (M=3.00) and the respective one sample t-tests indicates statistically significant differences between average means of instructors and expected ideal mean. However, item 3 of the same Table revealed that instructors' pedagogical aids of technology integration in lessons were found to be moderate (M= 3.051, t (2.183) =.087, p >.05). The calculated mean value is a little bit greater than the ideal mean (M=3.00) and the performed one sample t-test showed that there was no statistically significant difference between the average mean of instructors and expected ideal mean.

The total average mean of instructors' technology integration roles in lesson/course plans (M=2.873) was less than an ideal mean value (M=3.00). This indicates the negligence of TIUICS and requires improvements.

4.1.4.3. Instructors' Roles in the Selection and Utilization of Technological Tools

The roles of instructors associated with the selection and utilization of technological tools were surveyed and Table 4.8 items 1, 2, & 4 respectively showed that instructors' professional competencies of choosing apt based on learning goals/objectives (M= 2.569, t (14.117), p <.000), the awareness of instructors about educational software, apps or online platforms

(M=2.717, t (9.267), p <.000), and instructors effectiveness of modifying teaching strategies using technology (M=2.801, t (8.210), p <.000). The calculated average means of the three items were less than the expected ideal mean (M=3.00), and the one-sample t-test confirmed that there were statistically significant differences between average means of instructors and expected ideal mean.

However, Item 3 of the same Table showed that instructors rated their roles that technology integration improves learning engagement (M = 3.107, t (1.127) =.138, p >.05). This mean value was greater than the ideal mean indicating that instructors' roles are good in improving students' learning engagement. The performed one sample t-test showed that there was no statistically significant difference between the average mean of instructors and the expected ideal mean.

The total average mean of instructors' technology integration roles concerning the selection and utilization of technological tools in curriculum and instructional settings was (M=2.799) which was less than an ideal mean value (M=3.00). This indicates the selection and utilization of technological tools in curriculum and instruction require improvements.

The grand mean of instructors' roles in TIUCIS in Ethiopian public universities (M=2.865). Therefore, it is less than the ideal mean and it requires further improvements in the selection and utilization of technological tools.

4.1.4.4. Adapting Technology Integration-Based Instructional Strategies and Support System

Table 4.9: Adapting Technology-Based Instructional Strategies

Dimensions	Items	N	M	SD	t-test	Df	Sig.
Adaptation of teaching strategies	Integrate teaching methods with technology and create blended learning environments	331	2.749	.954	9.715	330	.000
	Use technology-integrated active learning methods for student participation	331	3.114	1.170	1.875	330	.298
	Advice and guide on using technology for learning	331	2.459	.909	16.182	330	.000
	Total average mean		2.774	.862			
Student support and	Assist students in the technical aspects of using educational tools	331	2.881	.990	5.179	330	.000

guidance	Offer resources/training to develop students digital literacy skills	331	3.196	1.019	2.116	330	.119
	Use technology for assessing student learning feedback	331	2.878	.942	6.986	330	.000
	Total average mean		2.985	.594			
	Online assessments, quizzes, assignments are integrated into the instructional process		2.897	.892	6.892	330	.000
Assessment and feedback through technology	Utilize digital tools for following student performance progress		2.428	.917	16.268	330	.000
	Self-learning & exploration of new technological tools		2.698	.992	11.718	330	.000
	Total average mean		2.741	.899			
	Grand Mean		2.883	.908			

Source: Survey (2024)

Cutoff points: mean score from 1.00 -1.99 is (strongly disagree); from 2.00 - 2.99 (disagree); 3.00 (expected ideal mean); from 3.01 - 3.99 (agree); from 4.00 - 5.00 is (Strongly agree), and p is significant at 0.05.

4.1.4.5. Adaptation of teaching strategies

Regarding the roles of instructors associated with the adaptation of teaching strategies integrated with technology, respondents rated in two extreme ways. Accordingly, Table 4.9 items 1 & 3 showed that instructors' integration of teaching methods with technology and efforts of creating blended learning environments and the advice and guiding services they give to students were not promising [(M=2.749, t(9.715), & M=2.459, t (16.182), p <.000)], respectively. The calculated average means of the two items were less than the expected ideal mean (M=3.00), and the one-sample t-test confirmed that there were statistically significant differences between the average means of instructors and the expected ideal mean.

However, item 2 of the same Table showed that the instructors' use of technology-integrated active learning method for student participation was relatively encouraging (M= 3.114, t (1.875) =.298, p >.05). This mean value was greater than the ideal mean indicating that instructor's role with this respect; it is good in improving student's participation. The one-sample t-test showed that there was no statistically significant difference between the average mean of instructors and the expected ideal mean. The total average mean of instructors' adaptation of teaching strategies (M=2.772) was less than the expected ideal mean (M = 3.00).

4.1.4.6. Student Support and Guidance

Table 4.9 items 1 and 3 suggested that regarding instructors' roles of student support; the guidance assisting students in technical aspects of using educational tools and technology utilization for assessing students' learning feedback [(M=2.881, t (5.179), & M=2.878, t (6.986), p <.000)], respectively. The calculated average means of the two items were less than the expected ideal mean (M=3.00), and the respective one sample t-tests confirmed that there were statistically significant differences between the average means of instructors and the expected ideal mean. However, item 2 of the same Table showed that instructors positively offer resources/training to develop students' digital literacy skills (M= 3.196, t (2.116) =.119, p >.05). This mean value was greater than the ideal mean indicating that instructor's roles of offering resources/training develop students' digital literacy skills is fine with no statistically significant difference between average mean of instructors and expected ideal mean.

The total average mean of instructors' roles of student support and guidance (M=2.985) was less than the ideal mean (M=3.000). Therefore, it is less than the ideal means and it requires further improvements roles of supporting and guiding students.

4.1.4.7. Students' assessment and feedback through technology

Regarding instructors' roles in students' assessment and feedback through technology; Table 4.9, items 1, 2, and 3 reflected that the average means of practices of technology integration in online assessments, quizzes, and assignments, utilization of digital tools for following students' performance progress, and self-learning and exploration of new technological tools [(M=2.897, t (6.892); M=2.428, t (16.268.); M=2.698, t (11.718); p <.000)], respectively. The calculated average means of the three items were less than the expected ideal mean (M=3.00), and the one sample t-tests confirmed that there were statistically significant differences between the average means of instructors and the expected ideal mean.

The total average mean of instructors' students' assessment and feedback through technology (M=2.741) was less than the ideal mean (M=3.00). Therefore, instructors are expected to use technology to assess learners' performance and give feedback.

The grand mean instructor roles in adapting technology integration-based instructional strategies and support systems (M= 2.883). Therefore, it was less than the expected ideal mean and it requires further improvement.

4.1.4.8 Professional Development Practice and Collaboration in TIUCIS

Table 4.10: Professional Development Practice and Collaboration in TIUCIS

Dimensions	Items	N	M	SD	t-test	Df	Sig.
Professional development practices and experiences	Professional development opportunities related to educational technology	331	2.392	.981	16.961	330	.000
	Support systems enhance instructor's technology integration skills	331	2.751	.870	9.847	330	.000
	Instructors share best technology integration practices	331	2.912	.506	5.371	330	.000
	Total average mean		2.652	.869			
Collaboration & collegiality in technology integration	Platforms or communities where instructors exchange ideas and experiences.	331	2.912	.691	6.328	330	.000
	Actively contribute to the improvement of technology integration at the institutional level	331	2.831	.848	9.968	330	.000
	Total average mean		2.872	.886			
	Grand Mean		2.762	.911			

Source: Survey (2024)

Cutoff points: mean score from 1.00 -1.99 is (strongly disagree); from 2.00 - 2.99 (disagree); 3.00 (expected ideal mean); from 3.01 - 3.99 (agree); from 4.00 - 5.00 is (strongly agree), and p is significant at 0.05.

4.1.4.9. Instructors' Professional Development Practices and Technology Integration Experiences

Table 4.10 items 1, 2, and 3 summarized that the average means of instructors' professional development opportunities related to educational technology, support systems enhance technology integration skills, and sharing best technology integration practices and experiences were [(M=2.392, t(16.961); M=2.751, t(9.847.); M=2.912, t (5.371); p <.000)], respectively. The calculated average means of the three items were less than the expected ideal mean (M=3.00), and the one sample t-tests confirmed that there were statistically significant differences between the average means of instructors and the expected ideal mean.

The total average mean of instructors' professional development opportunities to foster technology integration practices and experiences in curriculum and instruction (M=2.652) was less than the ideal mean (M=3.00). This needs further attention from the instructors.

4.1.4.10. Collaboration and Collegiality in Technology Integration Practices

Regarding collaboration and collegiality in integrating curriculum and instruction, Table 4.10 items 1 and 2 indicated that the way platforms or communities of practice or instructors exchange ideas and experiences, as well as the contribution of technology integration at the institutional level [(M=2.912, t (6.328); M=2.831, t (9.968.); p <.000)]. The one sample t-tests confirmed that there were statistically significant differences between average means of instructors and expected ideal mean.

The total average mean of instructors' collaboration and collegiality in technology integration practices was (M=2.872) which is less than the ideal mean (M=3.00). Thus, this requires further improvements in collaboration and collegiality in technology integration practices

The grand mean of the dimension of instructors' professional development practice and collaboration in TIUCIS (M=2.762). Therefore, it is less than the ideal means and requires further improvement in professional development practice, experiences, collaboration, and collegiality in technology integration.

Therefore, the overall grand mean of the roles of instructors in TIUCIS (M=2.832). Therefore, it is less than the ideal mean.

Regarding instructors' roles in technology integration at his university stated:

> 'In my university, there is a need for the learning communities of practices of technology to foster collaborations aiming to familiarize instructors with their roles, selection and utilization, adaptation, and transformative strategies of Information and Communication Technology (ICT). Currently, instructors often prefer ready-made course materials instead of preparing curriculums for blended, face-to-face, and virtual learning systems. Although instructors have positive perceptions about identifying their roles, they lack the commitment to pursuing

> online training, occupational motivation, and professional skills required to effectively integrate technology into curriculum and instruction at the appropriate time and place. This integration is essential for improving the quality and equity of higher education' (QA7, 25 March 2024)

Likwise, one of the interviews selected from the Ministry of Education ensured:

> 'while some instructors have an understanding of the goals of integrating technology into the curriculum and instruction, the majority of instructors lack proficiency in identifying and fulfilling appropriate roles in incorporating technology into curriculum materials. This shortfall is reflected in the failure of many instructors to utilize technology as a transformative tool and a means of knowledge transmission. Additionally, there seems to be a lack of practices for adapting, adopting, and infusing technology within instructional methods. It appears that instructors may be relying on the Ministry of Education to provide pre-made technology-integrated curriculums and course/lesson plans. The actual implementation of technology integration in curriculum and instruction appears to be at an understanding level or as common sense, rather than being backed by comprehensive strategies and practices on the ground' (MoE15, 12 February 2024).

In addition, one of the interviewees selected from academic program directors illuminated:

> 'In higher education, integrating technology into the curriculum and instruction presents a valuable opportunity to enhance the quality of graduates' skills and competencies in line with 21st-century knowledge-based requirements. The Ministry of Education (MoE) is currently collaborating with Arizona State University to implement the MasterCard foundation online/virtual learning aimed at building the capacity of instructors for developing courses and planning instruction suitable for blended learning. At my university, over 30 instructors participated in this training program, completing and obtaining certification. This achievement has paved the way for easy replication of the training at both college and department levels, contributing to the overall capacity development of our educational institution. The collaboration with Arizona State University has allowed us to introduce innovative teaching methodologies and has equipped our instructors with the skills required to effectively engage students in online and blended learning environments. This initiative has not only supported the roles of our instructors but has also set a precedent for future collaborative programs with other renowned institutions, ensuring that our graduates are well-prepared for the demands of the modern workforce' (APD12, 8 February 2024).

In addition, one of the interviewees suggested:

> 'Currently, we have access to technology everywhere and in every social aspect. To maintain quality education, technology is crucial. The roles of instructors are

> important to realize the integration by conducting their curriculum reviews, designing their courses, and guiding their students in using technology. Specifically, instructors' roles are to facilitate and support students and their instructional process in the classrooms with available technological tools. With the expansion of technology, instructors also need to stay updated on the latest educational technology trends and tools. They must understand how to effectively integrate technology into their teaching methods to enhance the learning experience for their students. Additionally, instructors need to provide guidance and support to students in using technology for academic purposes, ensuring that they have the necessary skills to navigate digital resources, conduct research, and collaborate with peers. Through the effective integration of technology in education, instructors can create engaging and interactive learning environments that cater to diverse learning styles. This can involve incorporating multimedia content, interactive simulations, online collaborative platforms, and other digital tools into their teaching strategies. By doing so, instructors should empower and work on students to be skillful users of technology and prepare them for success in a digitally driven world' (QA6, 07 February 2024).

To conclude the ideas of the above interviews, the integration of technology into curricula and instructional settings has been attempted by instructors as part of their roles. However, many of them lack the commitment to fully pursue this integration, and as a result, they have been left behind in actual practices. This indicate that there is gap between intention and implementation has hindered the effectiveness of technology integration.

4.1.5. Relationships among Variables Rationales, Practices, Roles, and TIUCIS

The rationales, instructors' roles, and integration practices show some relationships in technology integration into undergraduate curricula and instructional settings in Ethiopian public Universities. The high correlation between rationales, practices, and roles, and TIUICS indicates a good understanding of rationales, practices, and roles that instructors implement technology integration into curriculum and instructional settings. Therefore, as the correlation between the independent variables and the independent variable or outcome increases in the same direction, the prediction of the impacts of independent variables on the dependent variables increases.

Accordingly, in this particular investigation, understanding rationales, practices, and roles contributed to TIUCIS in Ethiopian public Universities.

Table 4.11: A summary of Pearson moment product correlations among variables

Variables	TIUCIS _Total	Rationales	Extent	Roles
TIUCIS _Total	1			
Rationales	.807**	1		
extent	.674**	.486**	1	
Roles	.772**	.452**	.505**	1

Source: Survey (2024)

N.B. Correlation ranges from -1.00 through +1.00 (Choen et al., 2018) and it is significant at the .05 level

Table 4.11 showed that the analysis of correlation revealed that there were significant positive relationships among rationales, extent, and roles of instructors and the total TIUCIS scale. Accordingly, the correlation coefficients between the total TIUCIS and rationales, (r= .807), extent (r =.674), and roles (r = .772). All correlation figures show that the independent variables and the dependent variable show statistically significant positive correlations in the same direction.

In addition, the horizontal correlation among the dimensions (rationale, extent, and roles) contributing to the effectiveness of TIUCIS indicated in Table 4.11 as the correlation between rationale and extent (r =.486), and rationale and roles (r=.452) are in the range of medium correlation, and practice and roles (r =.505) was found in the range of strong correlation. Therefore, according to Cohen et al (2018), the higher the correlation between the independent variables and the dependent variables (TIUCIS), the more the prediction will be. Thus, the correlation coefficients between the three independent variables (rationale, extents, and roles) and the practical application of TIUCIS were found to be strong, r=.807, .674, and .772 respectively. These variables contribute to the practical implementation of technology integration into undergraduate curricula and instructional settings.

4.1.6. Factors Affecting Practices of TIUCIS

4.1.6.1. Mean Values of Principal Components Factors Affecting TIUCIS

The major factors contributing to the application of TIUCIS in Ethiopian public universities were analyzed as follows:

Table 4.12: Descriptive Statistics of Principal Components of Factors Affecting TIUCIS

Category	Principal Components	N	Items	Item Mean	Scale Mean	SD	Variance
TIUCIS - dimensions	Infrastructures- smart learning environment	331	8	4.447	35.576	3.331	26.648
	Technology integration into curriculum contents and pedagogical practice	331	7	3.287	23.009	5.132	35.924
	Digital divide, connectivity, and internet access	331	6	3.631	21.786	3.883	23.298
	Digital literacy and instructors and students' digital competences	331	7	3.712	25.981	4.048	28.336
	Policy, administration and technical support	331	7	3.351	23.457	5.081	35.567
	Grand Mean	331	35	3.686	129.809	4.495	149.773

Source: Survey (2024)

Cutoff points: mean score from 1.00 -1.99 is (strongly disagree); from 2.00 - 2.99 (disagree); 3.00 (expected ideal mean); from 3.01 - 3.99 (agree); from 4.00 - 5.00 is (Strongly agree), and p is significant at 0. 05.

Table 4.12 shows that the rated item means for each item ranges from 1-5. The minimum expected scale mean for the 35 items was found to be 35 (35x1), and the maximum mean was expected to be 165 (35 x 5). Accordingly, the item mean about the inadequacy of infrastructure-smart learning environment for TIUCIS (4.447) was greater than the expected ideal mean (M >3.00). Along the 8-item scale, the minimum mean value was 8(8x1) and the maximum expected mean was 40 (8x5). This revealed that the mean about inadequacy of infrastructure-smart learning environment was as high as 33.98 along the scale from a maximum mean (M=40.00) indicating high inadequacy of infrastructures or resources of smart learning environment in

Ethiopian public research universities. Likewise, the item mean for technology integration of curriculum contents and pedagogical practice challenges (3.287) was greater than the ideal mean (M >3.00). Along the scale, its mean was as high as 23.009 from a maximum mean (M=35.00) showing that there were gaps in integrating technology into curriculum, contents, activities, and pedagogical practices.

In addition, the item means about the digital divide, connectivity, and internet access barriers of technology integration into curriculum and instructional settings (3.631) was greater than the ideal mean (M >3.00). Along the scale, its mean was as high as 21.786 from a maximum mean (M=30.00) indicating that there were challenges associated with the digital divide, connectivity, and internet access. Similarly, the item mean about inertia emanated from socio-cultural values and resistance to digital literacy and digital competencies in TIUCIS (M=3.712) was greater than the ideal mean (M >3.00). Along the scale, its mean was as high as 25.981 from a maximum mean (M=35.000) indicating that there was inertia or resistance that challenged the development of digital literacy in curriculums and digital competency in curriculum settings. Finally, the item mean value about policy, administrative, and technical support barriers in TIUCIS (3.351) was greater than the ideal mean (M >3.00). Along the scale, its mean was as high as 23.457 from a maximum mean (M=35.000) indicating that there were policy, administration, and technical support barriers in TIUCIS. Therefore, the grand mean of individual items and along the scale of factors affecting TIUCIS were 3.686 and 129.809, respectively.

4.1.6.2. Correlations and Reliabilities of Principal Components of TIUCIS

According to the main data analysis, the present study shows inter-item correlations and reliability coefficients among 35 questionnaire items in line with their corresponding principal components.

Table 4.13: Inter-Item Correlations and Reliabilities of Factors Affecting TIUCIS

Category	Principal components	Inter-item correlations	Reliabilities	Communality value
TIUCIS-dimensions	Infrastructures- smart learning environment	.704	.852	1.000
	Technology integration curriculum contents and pedagogical practices	.669	.828	1.000
	Digital divide, connectivity and	.642	.834	1.000

	internet access			
	Digital literacy and instructors and students' digital competences	.663	.827	1.000
	Policy, administrative & technical support	.689	.833	1.000
	Total	.672	.831	1.000

Source: Survey (2024)

Table 4.13 shows that the Cronbach's alpha is the most common measure of internal consistency that provides a coefficient of inter-item correlations ranging from 0.642 to 0.704. The correlation of each item with the sum of all other relevant items was (.672). This is a measure of the internal consistency among the items (Cohen et al., 2018). The reliability coefficients for the five factors/ dimensions were highly reliable in measuring TIUCIS in Ethiopian public universities. The analysis revealed the reliability coefficients of the inadequate infrastructure-smart learning environment, curriculum contents and pedagogical practice, the digital divide, connectivity, and internet access, inertia to digital literacy and instructors and students digital competencies and policy, administrative and technical supports (α = .852, .828, .834,.827 &.833), respectively. The average alpha value was (α =.831). This shows the high level of internal consistency among the findings of each dimension.

4.1.6.3. Effects of Factors on Technology Integration into Undergraduate Curriculum and Instructional Settings

This section analyzed and interpreted influences of inadequate infrastructure-smart learning environment, challenges related to technology integration in curriculum contents and pedagogical practice, digital divide, connectivity and internet access barriers, resistance/inertia to digital literacy and digital competencies, and policy, administration, and technical support barriers. Therefore, firstly, the study investigated the influences of inadequate infrastructure-smart learning environments that include infrastructure and resources. Secondly, barriers related to integrating technology in curriculum contents and activities and pedagogical practices. Thirdly, barriers related to the digital divide, connectivity, and internet access. Fourthly, the inertia to digital literacy and digital competencies includes sociocultural values and relative resistance to changes. Fifthly, barriers related to policy, administrative, and technical support barriers.

Therefore, TIUCIS includes five distinct and overlapping factors. In the process of doing multiple regression analysis, the associations between the five predictive variables(independent variable) and criterion variable/outcome or dependent variable (technology integration into curriculum and instructional settings) have been estimated using Pearson correlation coefficients (R). The correlations among the predictors' variables themselves were computed to check the multi-collinearity assumption.

Table 4.13 showed that infrastructure-smart learning environment, curriculum contents and pedagogical practices, digital divide, connectivity and internet access, digital literacy and competencies, and policy, administrative and technical support [R_1 =.405, R_2 = .291, R_3 =.287, R_4=.326, R_5 =.307, p .05], respectively. The application of regression analysis depends on the logic of Tabachnick and Fidell (2001) suggested that two independent variables with the absolute value of a bivariate correlation of .800 or more in the same analysis violate the multi-collinearity assumption. Hence, multiple regression analysis follows five assumptions in analyses of parametric data. This includes (1). Linear relationship. (2). Multivariate normality. (3). There is no or little multicollinearity (outliers). (4). There is no autocorrelation, and (5). Homoscedasticity. In the present study, the maximum correlation was (R_1 =.405) and less than .800. Therefore, all variables were fitting to five multi-collinearity assumptions and retained for further use in the study.

For the computation of predictive (independent variables) and criterion (outcome/dependent) variables in regression model analysis, the researcher symbolized all variables. This includes X_1 = Infrastructures-smart learning environment, X_2 = Technology integration into curriculum contents and pedagogical practice, X_3 = Digital divide, connectivity and internet access, X_4 = Digital literacy and competencies in TIUCIS, X5 = Policy, administrative and technical supports, Y = Technology integration into the undergraduate curriculum and instructional settings in Table 4.14 below:

Table 4.14: A summary of relationships between predictive and criterion variables

Variables	x_1	x_2	x_3	x_4	x_5	Y
x_1	1					

x_2	.268**	1				
sig.	.000					
x_3	.291**	.169**	1			
sig.	.000	.090				
x_4	.326**	.132**	.144**	1		
sig.	.000	.096	.099			
x_5	.307**	.125**	.109**	.125**	1	
sig.	.000	.085	.082	.087		
Y	.405	.291	.287	.326	. 307	1
Sig.	.000	.000	.000	.000	.000	

Source: Survey (2024)

Correlation(r) ranges from -1 through 0 to +1 (Cohen et al., 2018) *and it is significant at the .05 level*

This has paramount importance in detecting the combined effects of the predictor variables on the criterion variable using a multiple regression model. Table 4.14 shows that multiple regression analysis determined the contributions of each predictive variable. This includes inadequate infrastructure- smart learning environment; technology integration into curriculum contents and pedagogical practice challenges; digital divide, connectivity, and internet access barriers; inertia to digital literacy and competencies and policy, administrative and technical support barriers in TIUCIS combined to the outcome variable (technology integration in curriculum and instructional settings).

The regression model analysis was used by the researcher as follows: $\acute{Y} = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5$ where, a = constant, b_1 = regression coefficient of factors related to infrastructures- smart learning environment (x_1), b_2 = regression coefficient of factors related to technology integration into curriculum contents and pedagogical practices (x_2), b_3= regression coefficient of factors related to digital divide, connectivity and internet access (x_3), b_4 = regression coefficient of factors related to digital literacy and competences in TIUCIS (x_4), as well as b_5 = regression coefficient of policy, administrative and technical support related factors (x_5) as presented in Table 4.15 below.

Table 4.15: A Summary of Multiple Regressions on TIUCIS Prevailing Factors

Predictor variables	Unstandardized Coefficients		Standardized Coefficient	T	Sig.
	B	Std. error	Beta		
Constant	15.1494	1.218		16.298	.000
Infrastructure- smart learning environment(x_1)	.169	.034	.169	5.820	.000
Technology integration into curriculum contents and pedagogical practices(x_2)	.144	.046	.144	3.847	.003
Digital divide, connectivity, and internet access(x_3)	.125	.013	.125	6. 365	.000
Digital literacy and instructors' competences (x_4)	.132	.012	.132	4.007	.001
Policy, administrative and technical supports(x_5)	.109	.019	.109	5.188	.000

Source: Survey (2024)

* R is significant at α =.05

Table 4.15 showed the regression equation; Y (TIUCIS' improvement) = $15.1494 + .169x_1 + .144x_2 + .125x_3 + .132x_4 + .109x_5$ indicated that all predictor variables in the study explained 53.10% of the total variances in the criterion variable (Y). The F-test showed that it is statistically significant at [$F (5, 326) = 59.198$, $p <. 05$).

The measure of the relative contribution of each predictor variable (shown under the Beta column) revealed that the coefficients of all variables are statistically significant at the p.05 level indicating that the variables were the major contributors to the regression equation. Each predictor variable has possessed the maximum Beta coefficient (x_1 = .169, x_2 = .144, x_3 =.125, x_4 =.132, x_5=.109, $p <.05$). They have positive effects of variables in predicting outcome variable (TIUCIS) (Y) as rated by instructors.

Table 4.16 shows a statistically significance of variables predicting practical improvements of TIUCIS in sample public universities in Ethiopia.

Table 4.16: A Summary of Stepwise Multiple Regression for Addition of Predicting Variables

N	Predictive variables	R	R^2	ΔR^2	Adjusted R^2	B	Beta weight	F
1	Infrastructures- smart learning environment (x_1)	.405	.164	.164	.162	.169	.405	125.891**
2	Tech. int. in curriculum contents and pedagogical practices (x_2)	.291	.085	.085	.083	.144	.291	106.418**
						.090	.287	
3	Digital divide, connectivity & internet access (x_3)	.287	.082	.082	.080	.125	.287	83.294**
						.096	.326	
						.099	.090	
4	Digital literacy and instructors' competencies (x_4)	.326	.106	.106	.104	.132	.326	68.792**
						.089	.307	
						.085	.089	
						.090	.093	
5	Policy, administrative & technical supports	.307	.094	.094	.092	.108	.302	60.211**
						.089	.125	
						.099	.088	
						.089	.096	
						.085	.099	
All Variables Entered		.729	.531	.531	.529			

Source: Survey (2024)

* Significant at the p .05 level

Multiple correlations (R) = .729, $R^{2\,=}$ .531, Constant = 15.1494, Multiple Linear Regression F values (5,326) = 59.198 when all variances were added to the regression model. Regression Equation; $Y' = 15.1294 + .169x_1 + .144x_2 + .125x_3 + .132x_4 + .109x_5$

Table 4.16 showed that the stepwise multiple regression analysis confirmed that all the predictor variables retained in the equation as essential contributors to the variation in Y (TIUCIS). Firstly, Table 4.16 showed that the proportion of variance in TIUCIS practices accounted when factors related to the infrastructure-smart learning environment (x_1) was 16.40%, and statistically significant at [F (1, 330) = 125.891, p <.05]. This was relatively the most explaining/predictive variable. Secondly, when factors related to technology integration into curriculum contents and pedagogical practices (x_2) entered into the regression model, the explained variance was raised by 8.50% and reached 24.90 % and significant at [F (2,329) = 106.418, p <.05]. Thirdly, when factors related to the digital divide, connectivity, and internet access (x_3) were added to the regression model, the explained variance was raised by 8.20% and reached 33.10% and significant at [F (3, 328) = 83.294, p <.05]. Fourthly, when factors related to digital literacy and instructors' and students' digital competencies (x_4) entered to regression model it accounted for 10.60% of the explained variable and reached 43.70% and significant at [F(4,327 = 68.792, p <.05]. Fifthly, in the next step, the policy, administrative, and technical supports (x_5) were added to the regression model and accounted for 9.4% of the explained variable and significant [F (5,326= 60.211, p <.05]. The five dimensions or variables in combination accounted for about 53.10% of the proportion of outcome variance. Therefore, improving all variables significantly contributes to the improvement of TIUCIS in Ethiopian public universities.

Although the variables that were included in the equation of stepwise regression differ in their proportion to explain the variance in the criterion variable, they were significantly important to improve the prediction when used in combination [F (5, 326) = 60.211, p <.05] rather than separately. Thus, the actual contributions of factors affecting TIUCIS in Ethiopian public universities at the sum of R^2 =.531 (53.10%) of the total variance. The results of summaries of stepwise multiple regression analyses confirmed that all predictor variables contributed to the outcome variable. These are illustrated as follows: infrastructures/smart learning environment (R_1^2 =.164); factors related to technology integration in curriculum contents and pedagogical practices (R_2^2 =.085); factors related to the digital divide, connectivity, and internet access (R_3^2 =.082); factors related to digital literacy and competences in TIUCIS (R_4^2 =.106); and factors related to policy, administrative and technical supports (R_5^2 =.094), correlated to TIUCIS in Ethiopian public universities.

In addition, the interviewees suggested their views that various factors are affecting technology integration into curricula and instructional settings in Ethiopian public universities.

Accordingly, one of the University's educational leader interviewees stated:

> 'Upon analyzing the current state of technology integration into curricula and instructional settings, it becomes evident that while we understand the importance of incorporating technology into education, many instructors continue to face

significant resistance. This resistance can be attributed to several factors. Primarily, there is a lack of a smart learning environment equipped with the necessary resources which hinders the seamless integration of technology into educational practices. Furthermore, there is a prevailing undervaluing of the benefits of technology in instruction within socio-cultural contexts, which acts as a barrier to its incorporation in teaching and learning. In addition to these issues, there are limitations in the professional competencies required to effectively integrate technology into instruction. This means that instructors may lack the necessary skills and knowledge to leverage technology in their teaching practices, further contributing to resistance to its adoption. When we specifically examine the status of technology integration extent in undergraduate curriculum and instruction contents, learning objectives, learning strategies/experiences, and assessment methods in Ethiopian public universities, are still at an early stage'(APD8, 02 April 2024)

In addition, one of the students' councils' presidents selected from a sample public university shared his experiences about the potential effects of several factors influencing TIUCIS in public universities as,

'During my participation as students' council president and attending my university lessons, I learned that there is a good start of technology utilization in the teaching-learning process. Nevertheless, sometimes, instructors and students use technology in the teaching-learning process, in research activities, and for reading via computers, and mobile phones although there are many challenges associated with factors such as barriers linked to internet access and connection as well as shortage of learning facilities like functional computers with good capacity. However, when we can say technology integration into lessons and the teaching-learning process is given less attention in incorporating into teaching and learning'(SCP22, 15 March 2024).

Another students' council president from another sample public university stated the usual experiences of his university in line with TIUCIS:

'I believe that the integration of digital elements into course materials and the improvement of teaching and learning are essential for creating an engaging and effective educational experience. At my university, access to technology is relatively good, and both teachers and students are utilizing it inside and outside the classroom, as well as for administrative purposes. However, I am uncertain whether technology is closely aligned with the curriculum contents, learning objectives, teaching strategies, assessments, and exam schedules, apart from the use of PowerPoint slides, electronic books, and other reading materials accessed

> via mobile devices during the teaching and learning process. I think that the incorporation of technology into teaching and learning by instructors is not being adequately recognized as a significant component. Additionally, I am not sure that instructors possess proficient technology skills to effectively use the advantages of technology' (SCP21, 20 March 2024).

Concerning policy, administrative, and technical supports regarding the practical implementation of TIUCIS in Universities, one of the program directorates reflected his views and experiences as,

> 'Although there are some limitations to technology use, we are working to capacitate instructors through blended instruction, online learning, flipped instruction, and other learning management systems…. I have full information that some instructors including me learned why, how, and where to incorporate technology in such activities, contents, methods, and assessments. For instance, students are encouraged to create some audio-visual media and present it in their classroom. However, our instructors are not attempting to implement this learning approach to some extent in their classroom settings' (APD10, 21 February 2024).

Regarding resistance/inertia to technology integration in curricular materials and teaching-learning process, one of the quality assurance directorates reflected her experiences and perspectives as,

> 'I think technology is intermingled with our daily life activities including delivery of instruction everywhere and every time without limitation. Nonetheless, our society has technophobia by thinking as if technology affects their Indigenous culture/knowledge by associating everything with technology with social media such as Facebook, TikTak, and YouTube, as the young generation is sensitive to hate speech. These scenarios negatively affected the practices of technology integration into the instructional process at our University. I think the reverse will be fine if we can integrate technology into learning materials and teaching processes. Similarly, the use and incorporation of technology into curriculum and teaching could be negatively affected by the shortage of budget, full infrastructure, and technology facilities' (QA7, 23 February 2024).

One of the quality assurance directorates narrated about his university's practical implementation of TIUCIS as:

> 'Frankly, the idea of technology integration into curricula and instructional settings is fine. Because I think it advances our curriculum and fosters' higher education students' higher order thinking and deep learning that leads to creating graduates with creativity and innovative ideas…. I am sure that the existing

> learning practices are a surface-covering approach because of factors such as lack of human and material resources, internet connectivity, training, and experiential learning among instructors. … I doubt that if the curriculum/course materials are not well organized and integrated with ICT starting from the selection of contents, learning outcomes, teaching methods, and assessment strategies, it might be teaching the large number of students with overcrowded PPT slides to cover the course contents within an hour…. As my university is too young relative to others, we face challenges related to the lack of smart ICT infrastructures and the lack of curriculum designer professionals' (QA6, 22 February 2024).

…. The document review of undergraduate curriculum frameworks shows the ambition as to why the technology-supported teaching-learning process is important. However, it does not show any direction on how to integrate technology into learning objectives/outcomes, contents, learning experiences (interaction between teachers and students), method of teaching, and assessment strategies on top of the low attitudes and professional competencies of instructors concerning implementing TIUCIS. These factors make the practices of technology integration at each level of curriculum and its instruction somewhat cumbersome in public universities in Ethiopia (Document review, November 15-19, 2023).

…The researcher witnessed in consecutive classroom observations that instructors were mainly focusing on PPT slide preparation and sharing with students. However, they were not frequently using technology as a tool to support students in the classroom. Few of the students in the classroom read from their smart mobile telephones and their laptops during teachers' presentations in classrooms (Ob1-Ob7, February 2024).

4.1.7. Mean Differences of Instructors among Public Universities TIUCIS

4.1.7.1. Mean Differences of TIUCIS in Public Universities

Table 4.17: Mean Differences among Instructors' Awareness on the Rationale of TIUCIS

University	N	Items	Item Mean	Scale Mean	SD	Variance	Rank order
ASTU	59	19	3.584	68.096	1.352	25.690	1
ASU	39	19	2.771	52.649	.969	18.409	6
DDU	59	19	3.181	60.439	1.472	27.959	3
JU	61	19	3.387	64.531	1.324	25.156	2
MWU	46	19	2.796	53.124	1.007	19.127	5
OBU	20	19	2.679	50.901	.946	17.968	7
WCU	47	19	2.884	54.796	1.188	22.568	4
Total	-	-	3.042	57.765	1.324	75.474	-

Source: Survey (2024)

Min. and max. Mean of items and along scales= (M=1.00<3.00<5.00; 19.00<47.500 < 95.00), respectively.

Table 4.17 shows the mean differences among instructors' recognition of rationales of TIUCIS in their respective universities. Although the overall recognition of rationales of instructors regarding TIUCIS among the seven sample public universities was rated (M=3.042 or 57.765) above the expected ideal mean (3.00 or 47.500), their awareness and commitments varied among instructors among the sample universities. For instance, the responses of respondents rating show that ASTU, JU, and DDU have a better cognizance of preparative, pedagogical, motivational, and administrative dimensions of rationales of TIUCIS [(ASTU, JU, and DDU [(M=3.584/68.096; 3.387/64.531 and 3.181/60.439)], respectively. However, the average means of ASU, MWU, OBU, and WCU were less than the ideal expected mean (M=3.00/47.500) showing that instructors have less understanding of preparative, pedagogical, motivational, and administrative dimensions of rationales of TIUCIS.

Table 4.18: A summary of One-way-ANOVA on Instructors' Awareness on Rationales of TIUCIS

Sources of variations	Sum of Squares	DF	Mean Square	F	Sig	GM	ES
Between Groups	2187.2301	7	312.429	17.112	.000	.3.042	.301
Within Groups	5879.123	322	18.258				
Total	8066.3531	329					

Source: Survey (2024)

Table 4.18 showed that the one-way-ANOVA performed to test whether/not the difference among the awareness of instructors on rationales of TICUIS [(F(17.112), p < 0.05)] depicted that there were statistically significant differences among the sample public universities although the grand mean (GM = 3.042) was greater than the ideal mean (M=3.00). Therefore, the overall mean scores (GM=3.042 > 3.00) and the effect size (0.301= moderate effect size). The results indicate that there was positive awareness of instructors on the rationales and targets of TIUCIS.

The effect size or correlations among the seven sample universities were calculated by using the formula; Eta = Sum of the square between groups/total sum squares within groups. Where in interpreting the effect size, the following guidance was essential to translate the effect size (Cohen *et al.*, 2018; Cohen, 1988); [(r >.10 - small effect size; r >.30 - moderate effect size; r >.50 - large effect size, and * = p > 0.05)].

Table 4.19: Mean Differences Among Instructors' Practices of TIUCIS

Universities	N	Items	Item Mean	Scale Mean	SD	Variance	Rank
ASTU	59	26	2.965	77.090	.952	24.755	2
ASU	39	26	2.672	69.472	1.101	28.623	7
DDU	59	26	2.893	75.218	.912	23.709	3
JU	61	26	2.995	77.870	.790	20.527	1
MWU	46	26	2.717	73.008	.859	22.326	5
OBU	20	26	2.691	69.966	1.067	27.745	6
WCU	47	26	2.808	70.642	.783	20.353	4
Total	-	-	2.820	73.324	.900	66.014	-

Source: Survey (2024)

Min. and max. Mean of items and along scales= (M=1.00<3.00<5.00; 26.00<65.00 <130.00), respectively

Table 4.19 shows the mean differences among instructors' technology integration practice in course materials, application of technology in instructional delivery, and accessibility and inclusivity in their respective universities. Although the overall practices of instructors regarding TIUCIS among the seven sample public universities were rated (M =2.820 or 73.324) below the expected ideal mean (M=3.00, and above 65.00). The extent of TIUCIS by the instructors in the sample universities varies. For instance, the responses of respondents' ratings show that JU, ASTU, DDU, WCU, and MWU have relatively better practices of TIUCIS compared to ASU and OBU. The grand mean (M= 2.820) shows low practices of TIUCIS in all sample universities.

Table 4.20: A summary of One-way-ANOVA on Instructors' Practices of TIUCIS

Sources of variations	Sum of Squares	DF	Mean Square	F	Sig	M	ES
Between Groups	887.142	7	126.735	4.095	.000	2.820	.147
Within Groups	9965.210	322	30.948				
Total	10852.352	329					

Source: Survey (2024)

*p is significant at 0.05

Table 4.20 shows the one-way-ANOVA performed to test whether/not the difference among instructors' technology integration into course materials, application of technology in instructional delivery and accessibility, and inclusivity TIUCIS [(F (4.095), p < 0.05)]. This depicted that there were statistically significant differences among the sample public universities so that the grand mean (GM=2.820) was less than the ideal mean value (M=3.00). Therefore, the overall mean scores (GM=2.820 < 3.00) and the effect size (0.147= small effect size). The result indicates that there was a poor extent or level of technology integration into undergraduate curricula and instructional settings in Ethiopian public universities.

Table 4.21: Mean Differences among Instructors' Roles in TIUCIS

University	N	Items	Item Mean	Scale Mean	SD	Variance	Rank
ASTU	59	24	2.962	71.088	.835	24.755	1
ASU	39	24	2.771	66.504	.955	28.623	6
DDU	59	24	2.871	68.904	.889	23.709	3
JU	61	24	2.898	69.552	.882	20.527	2
MWU	46	24	2.779	66.696	.912	22.326	5
OBU	20	24	2.751	66.024	.967	27.745	7
WCU	47	24	2.794	67.056	.849	20.353	4
Total	-	-	2.832	67.975	.898	67.821	-

Source: Survey (2024)

Min. and max. Mean of items and along scales (M=1.00<3.00<5.00; 24.00<60.00 < 120.00), respectively

Table 4.21 shows the mean differences among instructors' roles in the selection and utilization of technological tools, adapting technology integration-based instructional strategies, and support systems in their respective universities were low. The overall instructors' roles regarding TIUCIS among the seven sample public universities were rated (GM=2.832 or 67.975) below the expected ideal mean (M=3.00, and above 60.00). The roles of instructors in the sample universities vary. For instance, the responses of respondents' ratings show that JU, ASTU, DDU, WCU, and MWU have relatively better identified their roles of TIUCIS compared to ASU and OBU. The grand mean (M=2.832) shows a low role identification in TIUCIS in all sample universities.

Table 4.22: A summary of One-way-ANOVA on Instructors' Roles in TIUCIS

Sources of variations	Sum of Squares	DF	Mean Square	F	Sig	M	ES
Between Groups	988.814	7	141.259	9.767	.000	2.832	.189
Within Groups	4657.217	322	14.463				
Total	10852.352	329					

Source: Survey (2024)

NB: p is significant at 0.05

Table 4.22 shows the one-way-ANOVA performed to test whether/not the difference among instructors' roles identification in TICUIS [(F (9.767), $p < 0.05$)] depicted that there were statistically significant differences among the sample public universities. The grand mean (GM=2.832) was less than the ideal mean (M=3.00). Therefore, the overall mean scores (GM=2.832 <3.00) and the effect size (0.189 = small effect size). The results indicate that there were instructors' poor identification and playing roles in the selection and utilization of technological tools, adapting technology, and integration-based instructional strategies and support systems in their respective universities.

It's important to note that from seven consecutive observations (Ob1-Ob7) conducted in seven public universities, the researcher observed that the sample universities are different in their infrastructure and technology-based facilities, internet access and capacity, and experienced professionals or technical staff; research universities, applied universities, comprehensive universities, and special universities. Accordingly, the learning communities of ASTU, JU, DDU, and WCU have a better understanding of why TICUIS is important, and where to integrate it into the contents of the syllabus, learning objectives, methods of teaching, and assessment, and feedback techniques compared to ASU, MWU, and OBU. The differences in infrastructure and technological resources have an impact on the understanding and integration of TICUIS across these universities (October 2023-April 2024).

4.2. DISCUSSION

The section discusses major findings concerning technology integration into the undergraduate curriculum and instructional settings in Ethiopian public universities based on the study's theoretical framework, conceptual framework, research questions, and objectives. Accordingly, the researcher discussed the major findings of the study theme by theme. The themes include analysis framework (research ends, tools, and methods of analysis), demographic characteristics of study participants, rationale, extent, roles of instructors, and prevailing factors affecting TIUCIS in Ethiopian public universities. Additionally, the researcher compared and discussed the mean differences, effect sizes, and relationships among variables considered among the seven sample universities regarding TIUCIS in Ethiopian public research universities.

4.2.1 Data Analysis Framework

The analysis framework includes research ends, research tools, and methods of analysis. In parallel convergent mixed research, both quantitative and qualitative data need to be logically collected and analyzed simultaneously in appropriate ways. Accordingly, the quantitative data were collected from instructors using a self-constructed questionnaire and analyzed using descriptive statistical methods (percentage, frequency, average mean, SD, and rank order), and inferential statistical methods (one sample t-test, Pearson product-moment correlation, one-way-ANOVA, and stepwise multiple regression). In addition, qualitative data were collected from participants such as program directorates, quality assurance directorates, students' council presidents, MoE curriculum experts, using semi-structured interviews, classroom observation, and document reviews, and analyzed them in themes. Finally, both quantitative and qualitative findings were presented by prioritizing quantitative data first followed by qualitative data, and integrated into the interpretation and discussion phases.

4.2.2. Reflection on demographic information of respondents

The finding of the study demonstrated that although the academic rank and work experience of instructors and academic leaders were reasonable, the number of total male respondents who participated in overall technology integration practices in the present study (89.29%) was much greater than that of female participants of the study (10.71%) due to large number of male instructors compared to female instructors working in sample public universities. This implies that there was a significant statistical difference in proportionality between male and female participants engaged in the present study because of the size of source population differences in the colleges and respective departments of sample public universities.

The present study's finding contradicts the assumption of Dye (2017) which stated that identifying, examining, and understanding the existing contexts, causes and consequences of public policies minimized gender inequalities strengthened gender equality, and contributed to SDGs 3 and 4, which focuses on ensuring gender equality in all sectors and socially inclusive quality education, respectively. The present study's finding further contradicts Longwe's analytical lens that constitutes theoretically independent and interrelated dimensions of gender equality and encompasses interrelationships between education and gender policies, programs, and strategies (Tesfaye & Meseret, 2023). Therefore, improving female graduates' participation and empowerment are important to create an inclusive higher education environment friendly to women and ensure equity and quality of TIUCIS in Ethiopian public universities. Therefore, where there is no gender equality or low participation of female instructors in public universities, it will be impossible to guarantee inclusive, equitable, and quality TIUCIS. This requires further employment and retaining female instructors.

4.2.3. Technology integration into undergraduate curricula and instructional settings

The quantitative and qualitative findings of the present study showed that the combined dimensions of rationales of TIUCIS in Ethiopian public universities were promising at the theoretical level with a grand mean (M= 3.124) which is greater than the expected ideal mean indicating that the preparative, pedagogical, accessibility, motivational, catalystic, and administrative aspects of the theoretical rationales were reasonably supportive of TIUCIS.

Therefore, both quantitative and qualitative findings demonstrated that key stakeholders (students, instructors, academic program directors, quality assurance directors, and KII from MoE) of Ethiopian public Universities well understood the rationales behind TIUCIS practices in Ethiopian public universities.

On one hand, the Ethiopian Ministry of Education has been working on the rationales for why technology integration into curricula and instructional settings a policy direction is. This focuses on ensuring virtual/online learning, blended/hybrid learning, and flipped instruction to realize the digitalization of curriculum and pedagogical practices. On the other hand, the findings indicated that there are some specific limitations belonging to separate dimensions. These include failure to strengthen students' problem-solving skills, pedagogical weakness to improve interactions between instructors and students, inability to access education for learners with difficulties, incapacity to monitor students' learning progress, and misalignment of education and students' living environment in Ethiopian public universities.

The present study shares similarities with the findings of Malinar Nasution (2024) that states understanding the rational foundations of technology can inform curriculum development and teaching methods in the context of technology integration. Similarly, it's strengthened by the findings of Lino et al. (2024) that summarize the integration of emerging technologies requires redefining curriculum development and implementation, promoting communicative interactivity, and facilitating meaningful knowledge construction. Technology integration in higher education also offers numerous pedagogical advantages, including enhanced student engagement, improved learning outcomes, and access to real-world content (Torres, 2022). In the same manner, the findings of Panakaje et al., (2024) indicate that technology integration in higher education has the potential to revolutionize pedagogy and enhance learning experiences. The findings of the present study share similarities with the findings of Chandler & Munday (2020) which identified that technology integration equips learners with a sense of power and allows for improved learning in broad topics. Also, the findings of the present study shares similarities with the findings of Burns (2023) which identified that technologies have the potential and roles to bridge the gaps between ability and opportunity, providing adaptive tools and personalized approaches that empower diverse learners to engage with educational material and processes in a meaningful and effective manner to ensure equity and quality of education. In addition to this, Kukulska-Hulme et al.(2022) elaborated that the world of work has changed because of the roles networked technologies are playing, accelerating and making the student's home a 'third place' for learning and working which arguably increased access to learners although teachers/educators have needed support in improving the instructional design of their courses.

On top of motivating learners, technology assists in building a proactive classroom environment through online and face-to-face instructional systems (Jogezai et al., 2021). In addition, the finding of the present study shares congruencies with the finding of Brown (2017) which, stated that the use of technology in teaching could have profound effects on students' learning regarding the development of higher cognitive capabilities. Furthermore, the findings of Equllinet et al (2023) demonstrated that faculty members with favorable attitudes towards educational technology, demonstrating a high level of acceptance and positive belief hold significant implications for enhancing the effectiveness of technology and ensuring its long-term viability.

The Ethiopian public universities' instructors, academic program directors, quality assurance directors, students' council presidents, and the Ministry of Education curriculum experts are aware of the rationales of technology integration into undergraduate curricula and instructional settings. Key stakeholders' comprehensive understandings of rationales of technology integration into curriculum and instructional settings contribute to both the adoption and contextualization of its practices in Ethiopian public universities. Therefore, the strategies for technology integration into curricula and instructional settings can be associated with the saying "do it, or lose it, and swim or sink" which emphasizes the mandatory nature of incorporating technology curriculum and instruction rather than considering it as an optional component of education. The integration of technology into the curriculum and instructional process is essential for making learning easier and more effective.

4.2.4. The extent of technology integration into undergraduate curricula and instructional settings

The quantitative and qualitative findings of the present study regarding the extent of technology integration into curricula and instructional settings identified bottlenecks that negatively influenced the practices of TIUCIS in Ethiopian public universities. The calculated grand mean

(M = 2.820) was found below the expected ideal mean and indicates that the extent of technology integration into undergraduate curricula and instructional processes in Ethiopian public universities was found to be at its infant stage of development. For instance, concerning technological infrastructures and their applications, the practices of instructors require additional effort for improvement. In addition to this, the instructors' technology use and skills in course materials showed poor practices. The finding further showed that the application of technology for instructional delivery was not supported by digital pedagogical practices. Similarly, the extent in which the instructors in making technology accessible and inclusive were not effective. The skills development activities of technology integration, collaborative and blended learning, and utilization of assessment and feedback through technology practices were not encouraging. The dimensions belong to professional competency, and activities related to the extent of technology integration did not effectively encourage TIUCIS in Ethiopian public universities.

Therefore, instructors were forced to use traditional curriculum implementation strategies or traditional pedagogies which are no longer sufficient to train young people with sufficient knowledge, skills, and competencies. Instructors in the sample public universities got access to using a few technological tools such as PowerPoint slides rather than creating technological platforms and more tools such as smart whiteboards, smart computers and mobile phones, video cassettes, and smart plasma as strategies for enhancing pedagogical practices in classrooms. Similarly, instructors are familiar with older software like Eagle Point but many of them lack knowledge about how to use the latest software such as Civil 3D. This causes a lack of instructors' proficiency in applying different technological tools, whether in classroom settings or practical fieldwork. Therefore, the majority of instructors are not able to apply technology although the 21st century requires up-to-date competencies and skills to satisfy their students in classrooms.

The findings of the present study share conceptual and practical similarities with the findings of Kukulska-Hulme et al. (2022) which stated that the designed learning activities and technology platforms create opportunities for the best learning moments at the center of the learning process and focus on the learning experience and its possible technological enhancement. In addition, the findings of the present study coincide with the finding of Becirovic (2023) which stated that traditional pedagogies are no longer sufficient to train young people as workers because the global economy and jobs in the digital age require new knowledge, skills, and competencies. For instance, the implementation of advanced technologies like effective use of e-learning platforms, augmented reality, and virtual reality positively impacts young learner's engagement and academic achievement (Zulfikhar et al., 2024). The finding of the present study concerning technology integration practice contradicts the finding of Kopcha (2012) which reflects some practical gaps with an increasing trend for technology integration in the classroom requiring teachers to incorporate technology into their pedagogy. On the contrary, it shares similarities with the findings of Liu et al., (2023) depicted that undergraduate programs face growing pressure to adapt their curricula and instructional practices to leverage the capabilities of emerging technologies.

The findings of the present study also coincide with the study conducted by Solomon and Yilfashewa (2022) which stressed that the high cost of technological devices and internet service and the lack of internet connectivity minimize the integration of information and communication technology into curriculum and instructional settings. In addition, the study's findings share conceptual similarities with the findings of Birhanu (2021) and Moges (2021) which revealed that students at universities have desktop computers in classrooms and libraries but neither have access to nor the skills to use technologies to enhance their learning process. This shed light on higher education students' technology literacy and competency gaps, which diminished technology integration practices in classrooms. Furthermore, the present findings show alignment with the findings of Chala and Yilfashewa (2023) which indicated that the challenges of connectivity such as no access to the internet render online learning platforms and digital resources inaccessibility, and gaps in digital literacy. The present finding also shares similarities with the findings of Dysart & Weckerle, (2015) which found that there was an absence of provision of ongoing support and training for instructors to effectively integrate technology into the instructional process. The findings further share similarities with the study of Panakaje et al., (2024) which identified that there was no institutional support for enhancing teacher performance and student engagement through technology integration.

Moreover, the findings of the present study show that the skills development activities of technology integration dimensions of technology integration practices in undergraduate curricula and teaching-learning processes such as collaborative and blended learning, research and innovation, and skills development were found to be insufficient. The findings of the present study share similarities with the empirical finding of Karkouti (2021) which highlighted that to use technology effectively, teachers should be familiar with how to operate equipment and effectively use them in the subjects teachers teach and how to incorporate resources into classroom activities that accomplish important learning goals. In addition, the present study's finding coincides with the assumption of Iivari et al. (2020) stated that the young generation needs to be empowered and encouraged to be more proactive in creating and modifying digital technologies, and generally shaping their digital futures. Therefore, technology is not well integrated into the undergraduate curricula and instructional areas such as learning outcomes, contents, teaching strategies, and assessment strategies. In addition, instructors lack the professional and technological skills to effectively incorporate technology into the teaching and learning process. This leads to a cycle of reluctance to adopt new methods, perpetuating a traditional approach to education that may no longer serve the needs of students or society. These shortcomings are associated with technology integration practice in undergraduate curricula and instructional settings that negatively influence the 21st-century knowledge, skills, and competencies of graduates required for work life.

4.2.5. Instructors' roles in technology integration in undergraduate curricula and instructional settings

Concerning the roles of instructors in technology integration in undergraduate curricula and instructional settings, the qualitative and quantitative findings of the present study identified bottlenecks aligned with instructors' roles with the grand mean (M = 2.832). This overall mean was found below the expected ideal mean of 3.00. This clarifies that instructors' technology integration into curriculum and instructional settings roles in assisting knowledge generation and skills development were not familiarizing them with technology. In addition, instructors did not recognize their roles in technology integration into course/lesson plans and the selection and utilization of technological tools.

Moreover, the roles instructors play in the adaptation of teaching strategies, student support and guidance, and assessment and feedback by using necessary technological tools were not sufficient. On top of this, they didn't effectively play the roles of professional development practices and experiences, as well as their collaboration and collegiality in technology integration. In addition, professional development practices and experiences, and collaboration and collegiality of instructors in technology integration into curriculum and instructional settings were not effectively exercised. For example, the majority of instructors of sample public universities lack proficiency in identifying and fulfilling appropriate roles in incorporating technology into curricular materials. This shortfall shows the failures of many instructors to utilize technology as a transformative tool in the teaching and learning process, and a means of knowledge transmission.

Although instructors have positive perceptions about identifying their roles in technology integration, they lack the commitment to pursuing online training, occupational motivation, and professional skills required to effectively integrate technology into curriculum and instruction at the appropriate time and place. In their roles, instructors are unable to facilitate and support students and their instructional process in the classrooms with available technological tools. With the expansion of technology, instructors also were not updated on the latest educational technology trends and tools. They lack understanding of how to effectively integrate technology into their teaching methods to enhance the learning experience for their students. Therefore, these limitations negatively affected the capacity of instructors to foster students' higher-order thinking, and deep learning and equipping them with creativity and innovative ideas via technology integration.

The current study's findings are in line with Singh & Engeness (2021) who identified the absence of four key roles as managing, pedagogical, social, and technical roles instructors typically play in online environments in the process of technology integration into instructional settings. More specifically, the present study's finding agrees with the findings of Karimah & Muslim (2019) indicating that instructors lack the roles of skill development practice to effectively incorporate technology into instruction. In addition, the findings of the present study are strengthened by Faig (2023) who stated that technology has become increasingly prevalent although 21st-century classroom instructors were not capable of adapting their teaching methodologies and taking on new responsibilities. This includes facilitating students' acquisition of technology-related knowledge, motivating them to use technology, and creating situations that require technology integration in learning (Najdabbasi & Pedaste, 2014).

In line with this, Karkouti (2021) demonstrated instructors' ongoing professional development to keep up with how professionals are using technology in the subjects they teach and better understand the essential roles that technology plays in supporting the work and generating knowledge in those subjects. Broadly, MoSHE (2020) underlines that instructors can develop an understanding of the role of ICT in education, design and apply ICT in teaching and assessment, use hardware and software relevant to their subject, and use ICT as a tool for professional development purposes.

In addition, the current study's findings share similarities with the findings of Gebrehiwot and colleagues (2020) who identified poor instructors' involvement in designing technology-based educational programs that meet the diverse learning needs of students. Similarly, the study conducted by Alemayehu and colleagues (2021) emphasized that instructors' roles are essential to ensure the successful integration of technology in higher education in Ethiopia. The present study's findings indicated that educators need to have training and professional support in designing technology-integrated course materials and instructional plans because the roles of instructors and networked technologies are putting students at the center of learning and accelerating their learning which are the missing roles from the present study. In line with this MoSHE (2020) highlights that higher education institutions will be staffed by ICT support staff whose role is to support the integration of ICT in the teaching and learning process and the management of the education system

Therefore, the three independent variables such as rationales, practices, and instructors' roles required in technology integration in curricula and instructional settings showed a positive relationship with each other and with the outcome variable (TIUCIS). These variables contribute to the actual practices of TIUCIS in the sample. Concerning this, Cohen et al (2018) stated that the higher the correlation between the independent variables, and the dependent variables, the more the prediction would be.

4.2.6. Factors Affecting technology integration in undergraduate curricula and instructional settings

The finding showed that the internal consistency of items based inter-item correlations of the five factors related to TIUCIS such as infrastructure-smart learning environments, technology integration in curriculum contents and pedagogical practices, the digital divide, connectivity and internet access, digital literacy and instructors and students' digital competences, policy administrative and technical supports range from, r = 0.642 to 0.704. The correlation of each item with the sum of all other relevant items was (r= .672). The analysis revealed that the reliability coefficients of the five factors' average alpha value were (α =.831). This shows the high level of internal consistency among the data. In addition, the overall average mean of items separately, and along the scale mean of factors affecting TIUCIS were 3.686 and 129.809, respectively where, [R_1 =.405, R_2 =.291, R_3=.287, R_4=.326, R_5 =.307; p.05]. These dimensions fulfilled the five assumptions of multi-collinearity with the leading factor (infrastructure-smart learning environments, R_1=.405). Therefore, improving infrastructure-smart learning environments, technology integration into curriculum contents and pedagogical practices, digital divide, connectivity and internet access, digital literacy and instructors' and students' digital competency, policy, administrative and technical supports boost TIUCIS in Ethiopian public universities.

The findings of the present study showed that the prevailing factors have strong influences on TIUCIS in Ethiopian Public Universities. The five variables in combination accounted for about 53.10% of the proportion of the total outcome variance. Improving all variables significantly contributes to the improvement of TIUCIS in Ethiopian public universities. With the specific contribution of each variable,

Firstly, infrastructure-smart learning environments were the leading factors that were explained by/accounted for 16.4% of the total outcome variable when added into the regression analysis model, indicating TIUCIS mainly depends on qualities and quantities of smart technology infrastructures. The findings regarding the influences of infrastructure-smart learning environments on technology integration into curriculum and instructional settings match with the findings of an empirical study conducted by Amanuel (2019) which stated that in the Ethiopian context, schools have a limited number of computers that are unconnected to the internet for teaching and learning purposes. In addition, the findings of present empirical studies share similarities with the findings of Chala & Yilfashewa (2023), and Moges (2021) who identified the primary challenges and roadblocks. This includes that the infrastructure inadequacy required for seamless integration of technology into education such as lack of reliable electricity, suitable spaces for computer labs, and necessary maintenance and support structure inhibit successful integration of information and communication technology into the educational system. Similarly, the findings of Tilahun (2021) showed that Ethiopian higher education instructors faced a terrible lack of technological inputs and skills except for a few instructors in first-generation universities, the majority have no internet access at home. Therefore, improving a smart technological-based learning environment or infrastructure improves the TIUCIS.

Secondly, technology integration into curriculum contents & pedagogical practices entered into the regression model accounted for 8.5% of the total outcome variable when added into regression model analysis indicating that TIUCIS depends on curriculum contents and pedagogical practices in classrooms. Thirdly, factors related to the digital divide, connectivity, and internet access were added to the regression model and accounted for 8.2% of the total outcome variable in regression analysis which shows digital divide, connectivity, and internet access improve practical implementation of TIUCIS. Fourthly, factors related to digital literacy & instructors' and students' digital competencies entered to regression model and accounted for 10.6% of the total outcome variable when added into regression analysis showing that improving instructors' and students' professional competencies related to digital literacy and digital competences increase TIUCIS. Fifthly, the policy, administrative & technical supports accounted for 9.4% of the total outcome variable when added into regression analysis show the improvement of TIUCIS depends on various policy dimensions and administrative and technical support systems. Therefore, the combined variables strongly influenced the outcome variable than separately they do. Therefore, the five variables in combination accounted for about 53.10% of the proportion of the total outcome variances (TIUCIS).

Moreover, the qualitative findings depicted that the society has technophobia by thinking that technology negatively affects their indigenous culture/knowledge by associating everything with technology with social media such as Facebook, Tiktok, and YouTube, the young generation is sensitive to hate speech. These scenarios negatively affected the practices of technology integration into the instructional process in universities. In addition, there are limitations such as a shortage of budget, inadequate infrastructure, and insufficient technological facilities, resistance to its adoption, instructors lack necessary skills and knowledge of leveraging technology in their teaching practices. This remarks that the status of technology integration in undergraduate curriculum and instruction contents, learning objectives, learning strategies/experiences, and assessment methods in Ethiopian public universities, are still at an early stage. Therefore, the accessibility of a smart learning environment, higher education institutions' instructors and students lack the digital divide and internet, lack of access to computers and other resources; instructors lack digital literacy and competencies, and lack of experiences in using digital technological tools negatively influenced the executions of technology integration into undergraduate curricula and instructional settings.

The findings of the present study coincide with the findings of empirical studies conducted by Solomon and Yilfashewa (2022) which stressed on lack of training and technical knowledge, high cost of technological devices and internet service, and lack of internet connectivity minimize the integration of information and communication technology in instructional settings. In addition, the findings of Moges (2021) stated that the integration of digital technology in the Ethiopian education system has prime barriers linked to the limited knowledge and capacity of teachers and students in the use of digital technology. For instance, lack of funds and poor program design, lack of teachers' digital technology and pedagogical skills are common challenges. In addition, the present findings show alignment with the findings of Chala and Yilfashewa (2023) indicating that the challenges of connectivity to no access to the internet, rendering online learning platforms and digital resources inaccessible, and gaps in digital literacy. Therefore, improving these challenges results in the successful integration of technology into the educational system. To this end, the current study's findings associated with factors affecting technology integration into curricula and instructional settings share similarities with related studies that revealed barriers such as insufficient infrastructures, lack of budget, limited administrative and ongoing support, insufficient educator training and poor professional development, curriculum incompatibility, poor student readiness, inadequate digital resources, and low internet access (Amaniampong & Hartmann, 2023; Dinç, 2019; Hasanbasri et al., 2023; Harrell & Bynum, 2018; Ince-Muslu & Erduran, 2020; Pelila et al., 2022)

Moreover, the findings of the present study share similarities with the findings of Rampelt et al. (2018) which confirmed that digital transformation includes the development of new infrastructures. This includes increasing the use of digital media and technologies for teaching and learning, research, support services, administration, and communication, and addressing the need for students and staff to develop new (digital) skills for their current and future workplaces. Similarly, the finding of Xiao (2022) emphasized that from a pedagogical standpoint, open, distance, and digital education are more suitable than the traditional face-to-face mode in light of an increasingly technology-enhanced and mediated reality. The mediation of learning by digital technologies makes it difficult to understand learning without an appreciation of its materiality and technological mediation (Psaros, 2023).

Overall, the prevailing factors such as infrastructure-smart learning environments, technology integration into curriculum contents and pedagogical practices, digital divide, connectivity and internet access, digital literacy and instructors' and students' digital competency, policy, administrative and technical supports mediated technology integration into curricula and instructional setting although the lack of those prevailing factors negatively affected the implementation of TIUCIS in Ethiopian public universities. Therefore, the findings of the present study reflected that the five variables in combination moderately accounted for about 53.10% of the proportion of the total outcome variance (TIUCIS) although variation in mean differences occurred among the seven sample universities.

5.2.7. Mean Differences and Relations among Variables of TIUCIS

The major findings of the study showed that when the item means, scale means, and effect size were determined for each sample university, there were some statistically significant mean differences among them. The suggestions of interviewees and results obtained from classroom observation and document reviews show some perceptual differences.

The overall status of the rationales behind TIUCIS was rated by instructors above the expected ideal mean and found to be encouraging because the grand item mean (GM=3.042) and scale mean (M=57.765) were rated above the average mean. However, there were statistically significant differences among seven sample universities because of their establishment, human and material resources, and other opportunities regarding technology integration into curriculum and instructional settings. For instance, the responses of respondents' ratings showed that ASTU, JU, and DDU have a better awareness of preparative, pedagogical, motivational, catalystic, and administrative dimensions of rationales of TIUCIS. Their ideal expected mean was (M=3.00/47.500). However, the average means of WCU, MWU, ASU, and OBU were found to be less than the ideal expected mean (M=3.00/47.500) showing that they have less awareness of preparative, pedagogical, motivational, catalystic, and administrative dimensions of rationales of TIUCIS. In addition, the one-way-ANOVA [(F (17.112), $p < 0.05$)] depicted that there were statistically significant differences among the sample public universities although the grand mean [(GM=3.042 > 3.00) and the effect size (0.301=moderate effect size)]. Therefore, in some universities, instructors have good feelings towards virtual and blended learning although they lack successive follow-up mechanisms to determine whether instructors are creating interactive instructional processes in and outside classrooms.

There were the mean differences concerning the extent of technology integration of into undergraduate curricula, the application of technological tools in instructional delivery, and accessibility and inclusivity. The grand item or scale mean in the seven sample public universities was rated (M=2.820 or 73.324) below the expected ideal mean (M=3.00), and above (65.00). The extent of technology integration in the sample universities vary. For instance, the responses of respondents' ratings show that JU, ASTU, DDU, WCU, and MWU have relatively at better level in practicing of TIUICS compared to ASU and OBU. The grand mean (M=2.820) shows a low extent of implementation of TIUCIS in all sample universities. The one-way-ANOVA performed [(F (4.095), $p < 0.05$)] depicted that there were statistically significant differences among the sample public universities although the grand mean [(GM=2.820 < 3.00) and the effect size (0.147= small effect size)]. Thus, the result indicates that the extent of TIUCIS were poor.

Although there were mean differences among instructors' technology integration roles in the selection and utilization of technological tools, adapting technology integration-based instructional strategies and support systems in their respective universities (GM=2.832 or 67.975) below the expected ideal mean (M=3.000), and above (60.000). Probably, the responses of respondents' ratings show that ASTU, JU, DDU, WCU, and MWU have relatively better identified their roles of TICUIS compared to ASU and OBU.

The grand mean (M=2.832) shows a low role recognition of TICUIS in all sample universities. The one-way-ANOVA [(F (9.767), $p < 0.05$)] depicted that there were statistically significant differences among the sample public universities although the grand mean [(GM=2.832<3.000) and the effect size (0.189 = small effect size)]. The result indicates that there were poor instructors' recognition of roles in the selection and utilization of technological tools, adapting technology, and integration-based instructional strategies and support systems in their respective universities were low.

Overall, the data shows that instructors of the sample universities fell behind in using technological tools for integrating technology into curriculum and instructional settings. Although they are expecting ready-made technology-integrated curriculums/syllabi from MoE, and course/lesson plans, instructors did not face challenges related to technology adaption, adoption, and infusion regardless of the transformation of technologies. Therefore, although there were large mean differences among instructors in the seven sample universities, they were strong enough in perceiving the rationales, but their professional competencies and skills of role identification and practices were at the infant/early stages of the transformative process of TIUCIS in Ethiopian public universities.

The findings of this study share similarities with the finding of Hardman (2019) which demonstrated that using ICT increases students' achievements and supports their learning and attainment whereas the findings showed that students in technology integration classrooms perform 12% higher than they perform students in traditional settings do. Therefore, avoiding the dark side of digital transformation in the teaching and learning processes (Garcia-Penalvo, 2021) is useful in improving students' academic performances. The findings of the present study align with the universal assumption that digitalization is essential for attracting students, improving teaching materials, mentoring, and the entire teaching process that digital technologies need to be integrated into all school operations, and all processes need to be transformed (Abad-Segura et al., 2020).

4.2.8. Proposed Model of Technology Integration into Curriculum and Instructional Settings

Based on the discussion of major findings related to research questions, objectives, theoretical and conceptual frameworks, and effects of dimensions or factors that contributed to outcome variables or TIUCIS, the researcher developed the following model. This model consists of two major dimensions, namely the outer and inner dimensions. The outer dimension firstly includes technology integration into undergraduate curricula and instructional settings that require adequate infrastructures such as fulfillment of a smart learning environment; Secondly, it requires positive education-technology integration policy and administrative and technical supports. Thirdly, it requires an important digital divide, connectivity, and internet access.

Fourthly, it requires digital literacy, instructors' and students' digital and professional competencies.

In addition, technological tools such as mediation of curriculum and instructional settings link with the inner dimension of the model. The inner dimension of this model includes four areas of technology integration into curriculum and instructional settings. Regarding this, integrating digital tools into the teaching process can significantly assist instructors and students in achieving their goals and objectives (Cabero-Almenara et al., 2020). Additionally, digital pedagogy enhances all types of education processes, whether online, hybrid, or face-to-face. An effective methodology requires knowledge of how to use digital tools, whereas successful digital pedagogy necessitates knowledge of the dynamics and mechanisms of digital media, communication platforms, tools, and applications (Szuts, 2019). Therefore, in the first place technology integration begins by incorporating technology into the contents and activities at the planning stage. Secondly, technology integration is important in pedagogical settings at the implementation stage in classrooms. For instance, making the students prepare and use audio-visual instructional media while learning via various methods of teaching such as demonstration, laboratory method, pyramiding, and cooperative learning to inspire students to boost their motivation towards deep learning and higher order thinking at the components of the inner dimension of the model. The outer layers are infrastructure-creating a smart learning environment, policy, administrative and technical supports, digital divide, connectivity, and internet access, and digital literacy and instructors' and students' digital and professional competencies.

To maximize the benefits of technology integration into curriculum instructional settings, adequate technological infrastructure, teacher training, relevant curriculum design, and technology accessibility are essential (Zulfikhar et al., 2024). That means the qualities of the aforementioned variables contribute to technology integration into curricula and instructional settings. Similarly, curriculum and instruction are perceived as separate entities, and instructional decisions are made after curricular decisions, (Subandi, 2014). The relationships between curriculum and instruction is viewed as continuous, cyclical, ongoing, and never-ending, and they cannot function in isolation from one another (Lederman, & Niess, 2001; Saban, 2021). This reveals the dynamic nature of the developed and proposed model of technology integration into curriculum and instructional settings.

Therefore, the researcher identified that when the outer dimension of the proposed technology integration into the undergraduate curriculum and instructional settings model is improved, it will improve technology integration into the inner dimensions such as contents and learning experiences, learning objectives/outcomes, teaching and learning strategies, and assessment/evaluation and feedback as pictorially presented in figure 5.1 below:

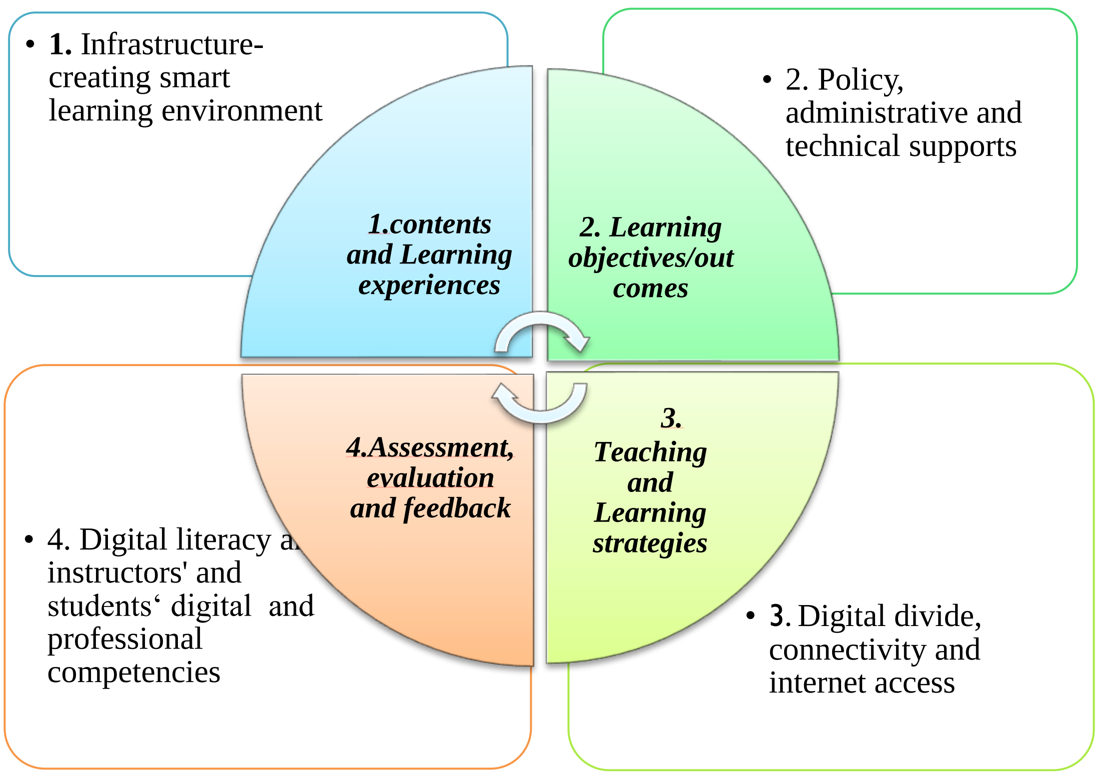


Figure 5.1: Proposed Model of technology integration into curriculum and instructional settings developed by the researcher (2024)

5. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This section presents a summary of the study that covers the problem statement, purpose, research questions, methodology, results, and discussion of the study and major findings. Then, the researcher presented conclusions and recommendations consecutively.

5.1. Summary

With the ultimate assumption of adding a pearl of new wisdom to the existing body of knowledge, the present study examined technology integration into undergraduate curricula and instructional settings in Ethiopian public Universities. There are several important areas where the present study made original contributions regarding TIUCIS in Ethiopian public universities in addition to proposing a new model for future research as far as the Ethiopian context is concerned. The available empirical studies focused merely on the availability of technology infrastructure and technology as teaching-learning assistive tools rather than its integration in curriculum and instructional settings/teaching adaptation strategies as knowledge or information. Evidence showed that no model has been tested and newly developed concerning the TIUCIS in Ethiopian public universities. In other words, there has been conceptual and theoretical ambiguity as well as methodological and practical gaps, which required refinements in a comprehensive and empirical study in the specific context. As such, the researcher formulated five specific research questions that required in-depth inquiry in Ethiopian public universities.

1. What are the reasons behind integrating technology into undergraduate curricula and instructional settings in Ethiopian public universities?

2. To what extent is technology integrated into undergraduate curricula and instructional settings in Ethiopian public universities?

3. What roles do instructors play in integrating technology into undergraduate curricula and instructional settings in Ethiopian public universities?

4. To what extents are the prevailing factors affecting technology integration into curricula and instructional settings in Ethiopian public universities?

5. How do technology integration practices differ among Ethiopian public universities in the contexts of undergraduate curricula and instructional settings?

This study adopted pragmatist philosophical assumptions and employed a mixed approach with a convergent parallel design aligned with the pragmatist paradigm. Then, the researcher selected seven sample public universities from the target population of 35 universities using a simple random sampling technique. The researcher further employed a multi-stage sampling technique to select participants from Universities, Colleges, and Departments consisting target population. The 355 respondents have actively participated in the study. This includes, 331 instructors selected using a stratified sampling technique followed by a simple random sampling technique after allocating proportionality to each department as a stratum in respective colleges. In addition, the researcher selected 24 key informants selected using a purposive sampling technique based on their lived rich experiences as educational leaders and experts. Then, the researcher collected and analyzed quantitative and qualitative data side-by-side and integrated it at the interpretation stage. The quantitative data were collected from instructors using self-constructed structured questionnaires and analyzed using descriptive statistics (frequency, percentage, average means, standard deviation, and rank order), and inferential statistics (one sample t-test, factorial analysis, Person correlation, stepwise multiple regression analysis, and one-Way-ANOVA) using SPSS version-26.00. In addition, the qualitative data were collected through semi-structured interviews, document reviews, and classroom observation, and analyzed through thematic narration.

Based on these justifications, the researcher examined the rationales, practices, roles, and factors affecting TIUCIS to solve paradoxical challenges connected to theoretical, conceptual, methodological, and practical spectacles and find practical solutions in Ethiopian public Universities.

5.1.1. Summary of Major Findings

1. The quantitative results and qualitative findings demonstrated that the Ethiopian Ministry of Education has been working on the rationales why technology integration into undergraduate curricula and instructional settings as policy direction expected to ensure virtual online learning, blended learning, and flipped instruction by thinking curriculum and pedagogical digitization. Thus, instructors' rationale cognizance of preparative, pedagogical, accessible, administrative, and motivational aspects of technology integration with a grand mean (GM=3.124) which was found above the ideal expected mean (3.00). However, the findings indicated that there are some specific limitations belonging to separate dimensions. These include failure to strengthen students' problem-solving skills, pedagogical weakness to improve interactions between instructors and students, inability to access education for learners with difficulties, incapacity to monitor students' learning progress, and misalignment of education and students' living environment in Ethiopian public universities.

2. Although the current MoE policy encourages the application of innovative pedagogies supported by digital technologies, the quantitative and qualitative findings indicate that the extent of technology integration into undergraduate curricula and instructional settings on the ground was at its infant stage of development in Ethiopian public universities with a grand mean (M = 2.820) which lied below the ideal expected mean (3.00). For instance, concerning the technological infrastructures - smart learning environment, the practices of instructors require additional room for improvement. In addition to this, the instructors' technology use and skills in course materials showed poor practices. The finding further showed that the application of technology for instructional delivery was not supported by digital pedagogical practices. Similarly, the practices of instructors in making technology accessible and inclusive were not effective. Besides, the skills development activities of technology integration, collaborative and blended learning, and utilization of assessment and feedback through technology practices were not encouraging. Therefore, the actual practices of TIUCIS were insufficient because the as an instructors curriculum/course syllabus designer and subject matter instructors lacked professional and technical skills in using technological tools.

3. The qualitative and quantitative findings of the present study identified the bottlenecks aligned with instructors' roles in technology integration. The finding of the study showed that instructors

were not professionally competent and familiar with technology integration areas of curriculum and instruction (contents, learning outcomes, methods of teaching, assessment, and feedback techniques). In addition, they were less significantly adapting technology integration-based instructional strategies and collaboration and collegiality of instructors in technology integration practices were not effectively contributing to technology integration into curriculum and instruction with a grand mean (GM=2.832) which lay below the ideal expected mean (3.00).

4. Factors affecting the technology integration into curricula and instructional settings in sample Ethiopian public universities were identified as prevailing factors. Accordingly, the finding showed that the correlation of each item with the sum of all other relevant items was (r =.672) and the reliability coefficients of the five factors' average alpha value were (α =.831). This shows the high level of internal consistency among the data. In addition, the overall means of items separately and along the scale of factors affecting TIUCIS were 3.686 and 129.809, respectively where, [R_1 =.405, R_2 =.291, R_3=.287, R_4=.326, R_5 =.307, p.05]. These dimensions fulfilled the five assumptions of multi-collinearity with the leading factor (infrastructure-smart learning environment factor, R_1=.405). Therefore, improving technological infrastructure, technology integration into curriculum contents and pedagogical practices, digital divide, connectivity and internet access, digital literacy and instructors’ and students’ digital competency, policy administrative and technical supports boost TIUCIS in Ethiopian public universities.

The findings of the present study showed that the prevailing factors have strong influences on the TIUCIS in Ethiopian Public Universities on grounds of inadequate infrastructures such as lack of smart learning environments, poor digital connectivity, and poor internet connections. The five variables in combination accounted for about 53.10% of the proportion of the total outcome variance rated showing their inadequacies. The improvements of all variables significantly contributed to the improvement of TIUCIS in Ethiopian public universities. For instance, infrastructure-smart learning environment contributed the most to TIUCIS (R^2 = 16.40%) followed by digital literacy and instructors’ and students’ digital competencies (R^2 = 10.60%) followed by policy, administrative and technical supports (R^2 = 9.40%), technology integration into curriculum contents and pedagogical practices (R^2 = 8.50%), and digital divide, connectivity and internet access (R^2 = 8.20%). However, technology integration practice in undergraduate curriculum contents, activities, and technology-based innovative piratical learning and teaching in Ethiopian public universities is at an early stage because of inadequate infrastructure, inertia to change/low socio-cultural values about the significance of technology in education, and lack instructors' digital literacy and professional competencies, and policy, administrative and technical supports.

5. The overall status of understanding of rationales about the implementation of TIUCIS was rated by instructors above the expected ideal mean was encouraging because the grand item mean (GM=3.042) and scale mean (M=57.765) were above average. However, the separate average mean of each university differs from each other, where ASTU, JU, and DDU ranked 1st, 2nd, and 3rd, and WCU, MWU, ASU, and OBU were ranked 4th to 7th respectively. Therefore, the effect size of the result is [ES = 0.301], which indicates a moderate effect size.

6. Although there are mean differences among instructors' practical implementation (integration of technology in course materials, application of technology in instructional delivery, and accessibility and inclusivity) of TIUCIS, the grand item or scale mean in seven sample public universities were rated (GM=2.820 or M=73.324) the expected ideal mean. The perception of instructors in the sample universities varies. For instance, the responses of respondents' ratings show that JU, ASTU, DDU, WCU, and MWU showed relatively better practices of TICUIS and ranked 1st to 5th compared to ASU and OBU which ranked 6th and 7th. Therefore, the effect size [SE=0.147] - small effect size.

7. Although there are mean differences among instructors' role identification and technology integration roles in the selection and utilization of technological tools, adapting technology integration-based instructional strategies and support systems in their respective universities were below the ideal mean (GM=2.832 or M= 67.975) below the expected ideal mean. Most probably, the responses of respondents' ratings show that JU, ASTU, DDU, WCU, and MWU have relatively better identified their roles of TIUCIS compared to ASU and OBU. Therefore, effect size [ES= 0.189] - small effect size. The result indicates that there were poor perceptions of instructors' roles in the selection and utilization of technological tools, adapting technology, and integration-based instructional strategies and support systems in their respective universities were low.

5.2. Conclusions

From the findings of the study, the following conclusions are drawn:

The study concluded that the researcher used appropriate data collection tools and analysis framework throughout the convergent parallel mixed research design and findings underlined that the sample instructors of seven universities fell behind in using technological tools to integrate into curriculum and instructional settings. Although they are expecting ready-made technology-integrated curriculums/syllabi from MoE, and course/lesson plans, instructors did not face challenges related to technology adaption, adoption, and infusion regardless of the technology transformative process.

On the one hand, the Ethiopian Ministry of Education has been working on the rationales why technology integration in undergraduate curricula and instructional settings as policy direction expected to ensure virtual online and blended learning and flipped instruction thinking that curriculum and pedagogical digitization. The significance of preparative, pedagogical, accessible, catalystic, administrative, and motivational rationale underpinning as an aspect for technology integration into undergraduate curricula and instructional settings were identified. On the other hand, the findings indicated that some specific weaknesses belong to separate dimensions. These include failure to strengthen students' problem-solving skills, pedagogical weakness to improve interactions between instructors and students, inability to access education for learners with difficulties, incapacity to monitor students' learning progress, and misalignment of education and students' living environment in Ethiopian public universities.

Concerning the extent of technology integration, instructors' technology use and skills in course materials, and the application of technology for instructional delivery were not supported by digital pedagogical practices. Similarly, the practices of instructors in making technology accessible and inclusive were not effective. The skills development activities of technology integration, collaborative and blended learning, utilization of assessment and feedback through technology and professional competency, and activities for technology integration practices did not effectively encourage TIUCIS in Ethiopian public universities.

Regarding instructors' recognition of roles in the selection and utilization of technological tools, adapting technology, and integration-based instructional strategies and support systems in their respective universities were low. Overall, instructors of the sample universities fell behind in using technological tools for integrating technology into curriculum and instructional settings. The combined influences of technology infrastructure- smart learning environment, technology integration into curriculum content, digital divide, connectivity & internet access, digital literacy & instructors' and students' digital competencies, and policy, administration, and technical supports accounted for 53.10% of the total variance focusing on TIUICIS. Finally, the study concluded that there were significant mean differences or variations in the implementation of TIUCIS among the sample Ethiopian public universities based on their establishment, material, and human resources, professionally competent professionals, and other opportunities. Therefore, ASTU, JU, and DDU were moderately implementing TIUCIS compared to WCU, MWU, ASU, and OBU.

Despite the current study's promising insights for the implementation of TICUIS, the study has policy, practical, and social significance because when technology integration into curriculum and instruction occurs, the likelihood of improving the quality of education importantly ensures the 21st-century skills and competencies of graduates. Therefore, by implication, tomorrow's workers in their discipline will be occupationally committed and effective at their working institutions or creating their jobs effectively.

5.3. Recommendations

The present study has theoretical and practical implications that promote actual applications of TIUCIS in Ethiopian public universities. Therefore, the researcher forwarded practical suggestions to Ministry of Education curriculum experts and coordination unit, university leaders and academic program directorates, quality assurance directorates, instructors, researchers, and students.

5.3.1. Recommendations for the Ministry of Education

1. The Ministry of Education's higher curriculum experts should work on creating a technologically smart learning environment by enriching smart instructional technological infrastructures by working with governmental and non-governmental organizations.

2. The MoE should create capacity-building strategies on how university instructors will obtain successful training regarding practices on TIUCIS through face-to-face or online and blended learning management systems.

3. The MoE curriculum experts in collaboration with university leaders should develop platforms for monitoring and follow-ups of practices of technology integration into undergraduate curriculum and instructional settings in Ethiopian public universities starting from the time of development to implementation stages in classrooms.

5.3.2. Recommendations for University's Curriculum Coordinator Experts

1. The University's curriculum coordinator unit/expert should be exemplary in bringing good experiences in the academic scenarios of curriculum/course design in their respective universities and execution in classrooms. The university curriculum expert should place himself/herself at the center of technology incubation in line with curriculum design, development, planning, and implementation in the classroom rather than only focusing on static guidelines of curriculum evaluation alone.

2. The university's curriculum coordination unit should update its professional, pedagogical, and technological expertise in curriculum, pedagogy, and technology to assist curriculum developer instructors in producing the university's curriculum/course materials enriched with 21st-century skills and competencies.

6.3.3 Recommendations for University leaders and academic program directorates

1. The university leaders and academic program directors should improve the contributing effects of prevailing factors positively affecting TIUCIS (53.10%) to higher status by improving the quantities and qualities of technological infrastructures, curriculum and pedagogical contents, digital divide, connectivity and internet access, digital literacy and digital competencies of students and instructors, and policy, administrative and technical supports.

2. The university leaders in collaboration with academic directors, college deans, and department heads should encourage female instructors' employment in their respective universities to

contribute to inclusive and equitable quality education or sustainable development goals. This has shown its contribution to the practices of TIUCIS in public universities in Ethiopia.

3. They should also prioritize practices of TIUCIS in their strategic plan because the quality of the curriculum and its executions determine the quality of graduates at the threshold, medium, and top-level graduates' creativity and innovative performances.

4. The curriculum directors or experts in the universities should make critical assessments of whether/not technology integration occurs vertically and horizontally across the programs' curricula (from year 1 to year 4/5) in collaboration with writers of curricula/syllabus by setting appropriate curriculum development and evaluation criteria.

5.3.4. Recommendations for Quality Assurance Directorates

1. The university's quality assurance directors should participate, evaluate, and make decisions on institutional and program quality assessment and audit starting from the time of curriculum design to its execution stages based on the input-process-output system.

2. The quality assurance directors should adjust situations for curriculum developer instructors to get opportunities and access to necessary capacity-building training and access to the internet and other resources.

5.3.5. Recommendations for Instructors

1. On the way to improve the practices of TIUCIS, curriculum/course syllabus designer instructors and subject matter instructors should participate in continuous professional development (CPD) practices to improve their technology integration professional and pedagogical competencies in curriculum and instructional settings. In short, instructors should improve their digital literacy and digital competencies via having appropriate experiential learning, training, and workshops and from the technology itself.

2. Instructors should have occupational commitment, willingness, and responsibilities, and share accountabilities of technology integration into curriculum/course design, development, and planning. In addition, instructors had better use technologies in classrooms as tools that assist instructional processes in classrooms.

3. Instructors as researchers should conduct in-depth experimentally designed research to test the effects of technologically integrated curriculum and instruction through online, blended, and flipped instruction on graduates' performance (deep learning and higher-order thinking) compared to traditionally prevailing approaches in Ethiopian Universities. This will boost the motivation and commitment of curriculum designers and implementers in classrooms.

4. Instructors should be competent enough to use technology as a transformative process rather than implementing traditional adoption, adaption, and infusion processes. In addition, instructors had better identify roles and practices that assist the technology-savvy students to generate knowledge by using technology and boost their understanding using technology as instructional media and tools.

5. Instructors need to improve technophobia related to technology integration into undergraduate curriculum contents, activities, and technology-based innovative practical learning and teaching found at an early stage. Improving the prevailing inertia to change such as low socio-cultural values about the significance of technology in education is very important. Thus, instructors can improve technophobia by developing positive attitudes toward the values of technology in our day-to-day life activities in general and education in particular through experiential learning, reading, training, seminars, and visits.

5.3.6. Recommendations for Students

1. The students should have positive perceptions and commitment to their learning on top of having skills in digital literacy (curriculum contents, methods of teaching, and assessment techniques), and digital competencies or how to use technology in education.

2. On top of improving their digital literacies in subject matter knowledge, skills, and competencies of using instructional technologies, they should actively meet the assumptions of flipping the flipped to guarantee everywhere, every class and everyday learning synchronously and asynchronously in the presence and absence of instructors.

5.3.7. Recommendations to the Scientific Community

The results of this study have shed light on the value of research and the scientific community regarding technology integration into education, curriculum, and teaching and learning processes. This will effectively provide new insights and advance the understanding of rationales and practices of integration into educational settings. Accordingly, educators, policymakers, curriculum experts, researchers, and students should work toward curriculum and pedagogical digitalization using technology-mediated instructional systems. Concerning this, public universities should boost master card foundation technological practices in the learning management system. For instance, blended learning through flipped instructional methodologies is a welcome approach.

6.3.8. Future Research Outlook

Despite the lack of causal-effect relationships in the present study, future research ought to focus on exploring the mediating effects of technology integration into curriculum and instruction on students' learning engagements and performance through a quasi-experimental research design using structural equation modeling at a specific university. Such research endeavors would contribute to a deeper understanding of the impact of technology integration into curricula and instruction on student learning and pave the way for evidence-based instructional strategies.

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Appendixes

Appendix-I: Questionnaire

HARAMAYA UNIVERSITY

COLLEGE OF EDUCATION AND BEHAVIORAL SCIENCES

A Questionnaire to be filled in by Academic Staff Members

Dear Respondents,

I am reaching out to you to collect data for a research study titled "Technology Integration into Undergraduate Curriculum and Instructional Settings Ethiopian Public Universities" This study is being conducted as part of a PhD dissertation in the field of Curriculum Studies at Haramaya University. The success of this study relies heavily on your honest and genuine responses to each questionnaire item. Thus, I kindly request you to provide your genuine responses, as they are crucial to meeting the research ends. Rest assured that the data you provide will be used solely for this research and will be kept confidential.

Completing the questionnaire may take approximately fifty minutes of your time. Please note that participation in this study is voluntary. I kindly ask that you refrain from including your name on the questionnaire. If you have any questions or require assistance during the process, please contact me at 0911942170/0930291828, and I will promptly address your concerns.

I sincerely appreciate your willingness and kind cooperation in participating in this research. Thank you in advance for your valuable contributions.
Gadissa Bekele, PhD Candidate.

General Directions

Part I: Demographic Data

The first part of the questionnaire contains demographic information (College/Faculty/School, Department, Sex, Service Year, and Academic Rank). Thus, the researcher kindly requests you to give the necessary responses for each item by putting a tick (√) mark or by writing the correct response in the space provided. The responses you provide to these demographic characteristics will be used only to compare and contrast the results of this research.

1. University: ____

2. College/Faculty/School: __________________________________

3. Department: ____

4. Sex: Male ☐ Female ☐

5. Service Year in the University _______________________

6. Academic Rank: 1/ Graduate Assistant ☐ 2/Assistant Lecturer ☐ 3/Lecturer ☐ 4/Assistant Professor ☐ 5/Associate Professor ☐ 6/ Professor ☐

Part II: Rationales Underpinning Technology Integration in the Ethiopian Public Universities Curricula and Instructional Settings

Please rate the level of importance of the following reasons for technology integration into the curriculum and instructional settings in Ethiopian Public Universities by putting a tick (√) mark under the appropriate numbers. Use the following rating scales.

1= completely not important 2= Barely important 3= Undecided 4= Reasonably important 5= Very important

Rationales	To what extent the following reasons are important for technology integration into the curriculum and instructional settings at your university?	1	2	3	4	5
	Technology integration:					
Preparative	1. Prepare students for their future job/occupation					
	2. Teach students the value of technology (appreciation).					
	3. Help students to cooperate with each other in their learning.					
	4. Help students to use technology with their own responsibly.					
	5. Help students to strengthen their problem-solving skills.					
Pedagogical	6. Support students learning progress by engaging them in their learning process.					
	7. Help to adapt the education to fit the students' needs.					
	8. Help to offer authentic learning environments.					
	9. Help to improve the interactions between instructors and students during the learning process.					
Catalytic	10. Help to realize a planned educational reform					
	11. Help to express the educational mission					
Accessibility	12. Make education accessible for students with learning problems					
	13. Help to reduce inequalities of opportunities among					

	different groups of students					
	14. Help to realize distance education.					
	15. Help to realize education to be limitless of the session hours.					
Motivational	16. Help to inspire students to learn					
	17. Help to align education to the living environment of the students.					
Administrative	18. Help to monitor students' learning progress.					
	19. Help to manage educational processes.					

If you have any additional comments, please state them below.

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Part III. The Extent of Technology Integration into the Ethiopian Public Universities Curricula and Instructional Settings

Please rate the extent of technology integration into your university's curricula and instructional settings by putting a tick (√) mark under the appropriate numbers. Use the following rating scales.

1 = Note at all 2 = Little 3 = Somewhat 4 = large extent 5 = Great extent

Dimension of technology integration	Items	1	2	3	4	5

Availability of Technological Infrastructure	1. Computer labs are equipped with up-to-date hardware.					
	2. Computer labs are equipped with up-to-date software.					
	3. There is reliable internet connectivity in college/school.					
	4. There are multimedia facilities (projectors, smart boards, etc.) in classrooms.					
Integration of Technology in Course Materials	5. Digital resources (e-books, online journals, educational websites) are incorporated into the curriculum.					
	6. There are online learning management systems (LMS) or platforms used for course delivery and interaction.					
	7. Instructors provide digital learning materials or resources to students.					
Use of Technology for Instructional Delivery	8. Instructors use multimedia presentations or videos during lectures.					
	9. Online discussions, forums, or virtual classrooms are utilized for student engagement.					
	10. Instructors employ educational apps or software for interactive learning experiences.					
Assessment and Feedback through Technology	11. Online assessments (quizzes, exams) are conducted through digital platforms.					
	12. Instructors use plagiarism detection software for evaluating student work.					
	13. Technology is used to provide timely feedback to students on their assignments or performance.					
Technology Skills	14. There are courses or workshops offered to enhance students' digital literacy skills.					

Development	15. Instructors receive professional development opportunities to improve their technological proficiency.					
	16. Support is available for instructors in using technology effectively.					
	17. Support is available for students in using technology effectively.					
Research and Innovation with Technology	18. Students are encouraged to use technology for research and /or project work.					
	19. Instructors utilize technology for their research activities.					
	20. initiatives are promoting technological innovation and entrepreneurship among students.					
Collaborative and Blended Learning	21. There are online collaboration tools used for group projects or team-based learning.					
	22. There are blended learning approaches where technology is integrated with face-to-face instruction.					
	23. Technology is used to facilitate virtual meetings or webinars for academic purposes.					
Accessibility and Inclusivity	24. Accommodations are provided for students with disabilities using assistive technologies.					
	25. There is consideration given to ensure that technology integration does not create barriers for certain students.					
	26. Resources and materials are available in different formats to accommodate diverse learning needs.					

If you have any additional comments, please state them below.

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Part IV: Roles of Instructors in Integrating Technologies into the Ethiopian Public Universities Curricula and Instructional Settings

Please indicate your level of agreement about instructors' roles in integrating technologies into their curricula and instructional settings by putting tick (√) mark under the appropriate numbers. Use the following rating scales.

1 = Strongly Disagree 2 = Disagree 3 = Undecided 4 = Agree 5 = Strongly Agree

Dimension of Instructors' role	To what extent do you agree with the following roles of instructors in your respective discipline?	1	2	3	4	5
Familiarity with Technology	1. Instructors are familiar with the available technological tools and resources.					
	2. Instructors possess basic computer skills and proficiency in using digital devices.					
	3. Instructors are knowledgeable about educational technologies relevant to their discipline.					
Integration of Technology in Lesson Planning	4. Instructors incorporate technology into their lesson plans and instructional activities.					
	5. Instructors make their learning objectives to be aligned with the integration of appropriate technological tools.					
	6. Instructors consider the pedagogical benefits of technology integration when planning their lessons.					
	7. Instructors choose appropriate technological tools based on the learning goals.					
	8. Instructors are aware of various educational software,					

Selection and Utilization of Technological Tools	apps, or online platforms.					
	9. Instructors use technology to enhance student engagement and learning experiences.					
	10. Instructors modify their teaching strategies to integrate technology effectively.					
Adaptation of Teaching Strategies	11. Instructors combine traditional teaching methods with technology to create a blended learning environment.					
	12. Instructors utilize active learning approaches that leverage technology for student participation.					
	13. Instructors provide guidance and instructions on using technology for learning.					
Student Support and Guidance	14. Instructors are available to assist students in the technical aspects of using educational tools.					
	15. Instructors offer resources or training to help students develop digital literacy skills.					
	16. Instructors use technology for assessing student learning and providing feedback.					
Assessment and Feedback through Technology	17. Instructors make online assessments, quizzes, or assignments to be integrated into the instructional process.					
	18. Instructors utilize digital tools for tracking student progress and performance.					
	19. Instructors are provided with professional development opportunities related to educational technology.					
Continuous Professional Development	20. Instructors are engaged in self-learning and exploration of new technological tools.					
	21. There are support systems or workshops available for instructors to enhance their technology integration skills.					
	22. Instructors collaborate with colleagues to share					

	successful practices of technology integration.					
Collaboration and Sharing Best Practices	23. There are platforms or communities where instructors can exchange ideas and experiences.					
	24. Instructors actively contribute to the improvement of technology integration at the institutional level.					

If you have any additional comments, please state them below.

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Part V: Factors Hindering Technology Integration into Ethiopian Public Universities Curricula and Instructional Settings

Please describe your level of agreement concerning the potential factors hindering technology integration into curricula and instructional settings in your respective discipline by putting a tick (√) mark under the appropriate numbers. Use the following rating scales.

1 = Strongly Disagree 2 = Disagree 3 = Undecided 4 = Agree 5 = Strongly Agree

Factors related to:	Potential factors hindering the integration of technology into curriculum and instructional settings.	1	2	3	4	5
Infrastructure	1. Inadequate or outdated technological infrastructure (e.g., computer labs, internet connectivity).					
	2. Insufficient availability of devices or equipment for students and instructors.					
	3. Power supply issues or unreliable access to electricity.					
Technical Support	4. Insufficient technical support staff to address technological challenges or issues.					
	5. Lack of regular maintenance of technological resources.					
	6. Inadequate training or professional development					

	opportunities for technical support staff.					
Digital Divide and Access Disparities	7. Inequitable access to technological resources among students.					
	8. Disparities in digital literacy among instructors.					
	9. Disparities in digital literacy among students.					
Resistance to Change and Technophobia	10. Resistance from instructors towards integrating technology in the instructional process.					
	11. Fear or lack of confidence in using technology among instructors.					
	12. Reluctance to adopt new instructional approaches that integrate technology.					
Policy and Administrative barriers	13. Inadequate institutional policies or guidelines regarding technology integration.					
	14. Lack of support from university administration for implementing technology integration initiatives.					
	15. Inadequate budget allocation for technology infrastructures.					
Pedagogical Challenges	16. Insufficient understanding of how to effectively integrate technology into pedagogical practices.					
	17. Difficulty in aligning technology use with instructional objectives.					
	18. Lack of training or professional development opportunities for instructors on technology integration strategies.					
Curriculum and Content Constraints:	19. Lack of integrating technology-related topics or courses in the curriculum.					
	20. Inflexible curriculum structures that do not allow for technology integration.					
	21. Limited availability of digital learning materials or resources.					
Cultural and Societal issues	22. Limited societal acceptance or recognition of the value of technology integration in education.					

	23. Cultural norms or attitudes that discourage the use of technology in teaching and learning.					
	24. Language barriers or lack of localized educational content in digital formats.					
Resource	25. Insufficient budgeting for obtaining technological resources.					
	26. Limited availability of educational tools or up-to-date software.					
	27. Challenges in obtaining licenses or permissions for using certain technologies.					
Connectivity and Bandwidth Limitations	28. Inconsistent or unreliable internet connectivity in the university.					
	29. Bandwidth limitations that hinder the use of online resources or tools.					
	30. Slow internet speeds that affect the effectiveness of technology integration					

If you have any additional comments, please state them below.

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End.

Appendix-II: Interview guide question

HARAMAYA UNIVERSITY

COLLEGE OF EDUCATION AND BEHAVIORAL SCIENCES

Interview questions for MoE experts

Interview Protocol for the Research Entitled "Technology Integration into Undergraduate Curriculum and Instructional Settings Ethiopian Public Universities"

Consent Form

University: ____

Name of Interviewee: ______________________________ Title: _________ Date: ______

Department: ____________________ Years of Service: _____ Phone: ________________

Interviewed by: _______________________________________

The purpose of this interview is to gather information about the extent to which technology has been integrated into the curriculum and instructional milieu of the Ethiopian public university. In addition to this, how leaders, academic staff, and students at the institution feel and how it has been used to deliver instruction

Your identity will never be in jeopardy due to the confidentiality of the information you provide being breached; it will only be utilized for research mentioned above. My interest is to gain knowledge from your experience. To achieve the goal of enhancing technology integration into Ethiopian public universities' curriculum and instructional milieu, the comments, experiences, and ideas gathered from you and other participants will be compiled, coded, and analyzed.

Thank you in advance for your willingness and cooperation to be interviewed.

Gadissa Bekele (PhD) candidate, 0911942170/0930 291828, mail address: robsgad@gmail.com

Interview Questions for MoE Experts

1. How long have you been working at the Ministry of Education?
2. What is your educational background?
3. What is your current position in the ministry?
4. Is there a policy guideline regarding technology integration in the EPU's curriculum?

5. Is technology integration in EPU's curriculum and instructional milieu a priority area for MoE?
6. What do you think are the theoretical and practical reasons behind technology integration in EPU's curriculum and instructional milieu at the national level?
7. How often do instructors participate in EPU's curriculum development and design?
8. To what extent do you think that technology is integrated into the EPU's curriculum?
9. What do you say about the roles of instructors in integrating technology into EPU's curriculum and instructional process?
10. What factors could hinder the integration of technology into EPU's curriculum and instructional settings?

HARAMAYA UNIVERSITY

COLLEGE OF EDUCATION AND BEHAVIORAL SCIENCES

Interview guides for directors

Interview Protocol for the Research Entitled "Technology Integration into Undergraduate Curriculum and Instructional Settings Ethiopian Public Universities**"**

Consent Form

University: ____

Name of Interviewee: _________________________________ Title: _________ Date: ______

Department: _____________________ Years of Service: _____ Phone: _________________

Interviewed by: ____

The purpose of this interview is to gather information about the extent to which technology has been integrated into the curriculum and instructional milieu of the Ethiopian public university. In addition to this, how leaders, academic staff, and students at the institution feel and how it has been used to deliver instruction

Your identity will never be in jeopardy due to the confidentiality of the information you provide being breached; it will only be utilized for research mentioned above. My interest is to gain knowledge from your experience. To achieve the goal of enhancing technology integration into Ethiopian public universities' curriculum and instructional milieu, the comments, experiences, and ideas gathered from you and other participants will be compiled, coded, and analyzed.

Thank you in advance for your willingness and cooperation to be interviewed.

Gadissa Bekele (PhD) candidate, 0911942170/0930 291828, mail address: robsgad@gmail.com

Interview Questions for Universality's Quality Assurance Directors and Academic Program Directors

1. What is your educational background?
2. What is your university experience in teaching?
3. How long have you been working at this position?
4. What do you think the theoretical and practical reasons behind technology integration in EPU's curriculum and instructional milieu at your university?

5. To what extent the issue of technology integration into curriculum and instructional milieu is considered as a criterion for quality assurance?
6. Is there a policy emphasis on technology integration into the curriculum of EPU?
7. To what extent do you think that technology is integrated into the EPU's curriculum?
8. What do you say about the roles of instructors in integrating technology into EPU's curriculum and instructional process?
9. What factors could affect the integration of technology into EPU's curriculum and instructional settings?

HARAMAYA UNIVERSITY

COLLEGE OF EDUCATION AND BEHAVIORAL SCIENCES

Interview guides for students' council presidents

Interview Protocol for the Research Entitled "Technology Integration into Undergraduate Curriculum and Instructional Settings Ethiopian Public Universities"

Consent Form

University: ____

Name of Interviewee: ______________________________ Title: _________ Date: ______

Department: ____________________ Years of Service: _____ Phone: ________________

Interviewed by: _______________________________________

This interview aims to gather information about the extent to which technology has been integrated into the curriculum and instructional milieu of the Ethiopian public university. In addition to this, how leaders, academic staff, and students at the institution feel and how it has been used to deliver instruction

Your identity will never be in jeopardy due to the confidentiality of the information you provide being breached; it will only be utilized for the research mentioned above. My interest is to gain knowledge from your experience. To achieve the goal of enhancing technology integration into Ethiopian public universities' curriculum and instructional milieu, the comments, experiences, and ideas gathered from you and other participants will be compiled, coded, and analyzed.

Thank you in advance for your willingness and cooperation to be interviewed.

Gadissa Bekele (PhD) candidate, 0911942170/0930 291828, mail address: robsgad@gmail.com

Interview Questions for the Students' Council Representative of the University

1. How do you see the importance of integrating technology in your learning?
2. To what extent do your instructors use technology for teaching purposes during instructional process?
3. Is there any support from your instructors in order to use technology for your learning?
4. What kinds of technological tools do your instructors use during the instructional process?
5. What do you think about factors hindering technology integration during your learning?
6. What technological devices or tools do you use?

Appendix III- Document Review Checklist

HARAMAYA UNIVERSITY

COLLEGE OF EDUCATION AND BEHAVIORAL SCIENCES

Curriculum Review Checklists

Curriculum review guide for the research entitled Technology Integration into

S.N	Curricula of the Programs	Learning outcome			Contents			Teaching Strategies			Assessment Techniques		
		I	LI	NI	I	LI	NI	I	LI	NI	I	LI	NI
1	Nursing												
2	Physics												
3	Economic												
4	English Language and Literature												

Undergraduate Curriculum and Instructional Settings Ethiopian Public Universities.

5	Civil Engineering												
6	Natural Resource Management												

Key: ‘I’ = Integrated, ‘LI’= Less integrated, and ‘NI’ = Not integrated.

Appendix-IV: Classroom Observation Checklists

HARAMAYA UNIVERSITY

COLLEGE OF EDUCATION AND BEHAVIORAL SCIENCES
Classroom Observation Checklists

Classroom Observation checklists for the Research Entitled "**Technology Integration into Undergraduate** ***Curriculum and Instructional Settings Ethiopian Public Universities***"

University: ____

Department: ____ Date: ________

Classroom/Course observed: _____________________________________

Interviewed by: _______________________________________

The purpose of classroom observation is to gather information about the extent to which technology has been integrated into the instructional settings of the Ethiopian public university. To know the methods that instructors are delivering instructional process, and students using technological tools for learning. Hence, this is to enhance the validity and triangulation of the data.

Thank you in advance for your willingness and cooperation for this classroom observation.

Gadissa Bekele (PhD) candidate, 0911942170/0930 291828, mail address: robsgad@gmail.com

Classroom Observation

The following are the indicators used for classroom observation about instructors' and students' practices in their classroom technology integration activities.

S. N	Classroom Observation areas	Indicators			Evidence
		Integrated	Somewhat integrated	Not integrated	
1	The status of the contents of the subject matters.				
2	Status of technological tools into learning objectives.				
3	Teaching strategies used by instructors and students.				
4	Assessment Techniques Used by Instructors				
	Classroom environment setup				

Haramaya University
College of Education and Behavioral Sciences
Department of Adult Education and Community Development

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Date: June 14, 2023.

Ref.no: Hu- AECD-1- 028/23

To

Asossa University
Jimma University
AST University
Wachamo University
Oda Bultum University
Madawalabu University
DireDawa University
Addis Ababa University
MoE.

Subject: Letter of Support for Data Collection for Dissertation

Mr. *Gadissa Bekele Geda* ID.No (PhD/0111/11) is our PhD student in the field of Curriculum Studies at Haramaya University, College of Educational and Behavioral Science, Department of Adult Education and Community Development. He is currently conducting his research on following title "**Integration of Instructional Technology into Ethiopian Public Universities 'Curriculum and Instructional Milieu"** and he needs to collect the necessary data from your Organization/Institute.

Therefore, under your best consideration, we kindly request your genuine cooperation and support to provide him with the necessary information related to the area of study indicated above.

With Best Regards,

Getinet Tesfaye Wadajo
ጌትነት ተስፋዬ ወዳጆ
Head Department of AECD

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