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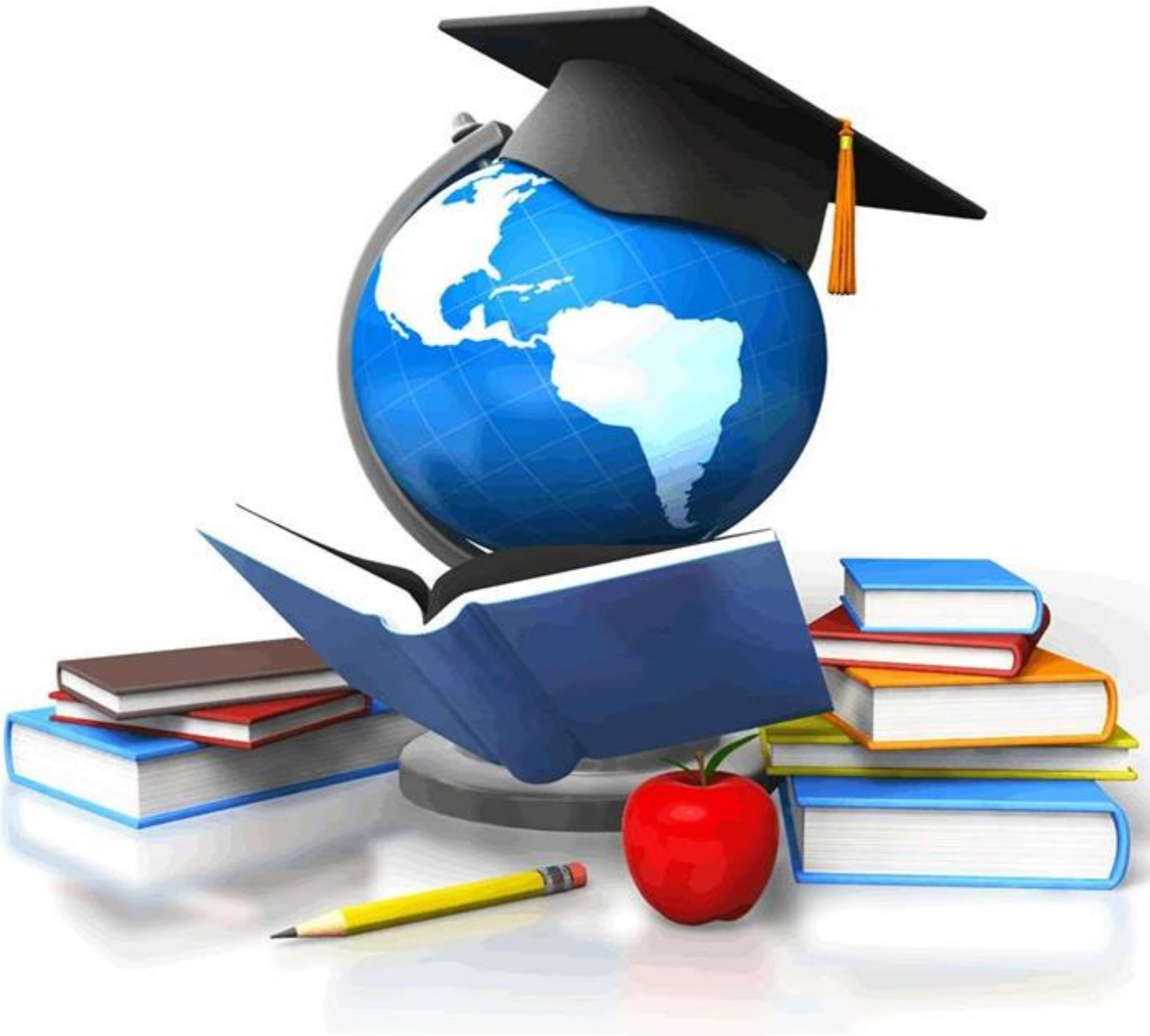

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Enhancing Physics Education in Ugandan Teacher Training Institutions: Technology Integration and Gender-Inclusive Teaching Strategies

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Abstract

Purpose: This article investigates strategies to enhance physics education in Ugandan Teacher Training Institutes (TTIs) by utilizing the TPACK framework. It focuses on technology integration, professional development for educators, and innovative teaching approaches to improve the quality of physics education.

Methodology: Employing a mixed-method design, this study examined ICT and gender integration in physics teaching across three Teacher Training Institutions in Eastern Uganda. The research utilized case study and survey designs, gathering data from 14 Physics Lecturers and 14 TTI administrators through surveys, interviews, observations, and document analysis. Purposive sampling was used to select participants with relevant expertise. Data were analyzed using content analysis and quantitative methods in Excel, adhering to ethical protocols that included obtaining permissions and ensuring confidentiality.

Findings: The study highlights that while physics lecturers possess strong subject matter and pedagogical knowledge, there is a notable deficiency in updated ICT skills and gender-inclusive practices. Key strategies for enhancing ICT competencies include implementing professional development programs, adopting blended learning models, and conducting ICT integration workshops. The research identifies that demographic factors and digital literacy significantly influence ICT integration, emphasizing the need for targeted training and resource allocation to create inclusive, technology-enhanced educational environments aligned with TPACK, DOI, and sociocultural theories.

Unique Contribution to Theory, Practice, and Policy: This study underscores the critical need for comprehensive training in ICT and gender inclusivity within TTIs. It emphasizes the importance of institutional support and policy development to modernize physics education, enhance pedagogical practices, and promote gender equity.

Keywords: *Technology Integration, Physics Education, Innovative Pedagogical Practices*

Introduction

The significance of Science, Technology, Engineering, and Mathematics (STEM) fields is widely acknowledged for future work and economic growth, with physics being a key gateway to STEM careers (Costa et al., 2020; Kiconco & Karyarugokwo, 2022). Governments and industry leaders emphasize the importance of quality education, which is linked to effective teaching and student learning outcomes (Bogere et al., 2013). In Uganda, quality education is prioritized through policies requiring compulsory science subjects at the Ordinary level since 2005.

Despite these efforts, student performance and engagement in physics remain challenging. Global recommendations urge Uganda to invest in science education to achieve sustainable development (Uganda-UNESCO, 2010; Wedgwood, 2005). The "Skilling Uganda" strategy and SESEMAT project aim to improve science education standards and reduce failure rates (Kiconco, 2022; Markon, 2013).

Teaching is a dynamic process involving systematic knowledge transfer, and effective instruction is crucial for meaningful learning (Bakimedeedeniya, 2024; Oxford, 2021). ICT's role in transforming teaching and learning is significant, simplifying abstract concepts and improving outcomes (Heng & Jing, 2012; Ellermeijer & Tran, 2019). ICT integration can also address gender disparities in physics by fostering positive attitudes towards technology use.

Teacher Training Institutions (TTIs) play a crucial role in preparing educators to integrate science and technology into teaching. Technological competence is essential for modern educators, impacting the success of science education reforms (Yucel & Kocak, 2010; Kubrickya & Castkova, 2015). However, gender disparities in physics and STEM fields remain, affecting progress towards gender equality (Guterres, 2019; Plan International, 2022). In Uganda, the Ministry of Education and Sports (MOES) has introduced policies to integrate ICT and gender-responsive pedagogy in teacher education, including the National Teacher Policy (NTP) of 2019 and the establishment of UNITE (MOES, 2018; TISSA, 2013).

This study investigates the ICT competences of physics lecturers and their application in Teacher Training Institutions (TTIs) in Eastern Uganda, focusing on improving student achievement and enrollment in physics while addressing gender disparities.

Literature Review

2.1 Concept of Information and Communication Technology

Information Communication Technologies (ICTs) are defined as a diverse set of technological tools and resources used in communicating, creating, disseminating, storing, and managing information (Heng & Jing, 2012). Tools relevant to educational technology include computers, cameras, tablets, interactive whiteboards, WIFI, internet, e-books, television, radios, emails, blogs, multimedia, CDs, DVDs, and projectors (Narrinderjit, 2020). Mutika et al. (2008) define ICT as a

collection of tools and resources for relations, distribution, reservations, and information management. This investigation focused on the lecturers' ICT competences and use ICT applications relevant to Physics teaching and learning. In the 21st century, a computer refers to modern automated technology needed for gathering, storing, and processing information. Teachers are encouraged to use ICT tools that students already have (Mitchel, 2012).

2.2 Physics Lecturers' ICT Competence Levels

Computer competence refers to the ability of a person to handle a wide range of computer applications for various purposes (Vannata, 2004). Teachers' computer self-efficacy is a judgment of their ability to use a computer (Compeau & Higgins, 1995). Studies show a correlation between teachers' competences with computers and ICT use in teaching (Knezek & Christensen, 2006). Rogers (2003) defines adoption as the decision to use an innovation as the best course of action. ICT adoption improves teaching and learning outcomes. Williams (2003) describes ICT integration as using any ICT tool to assist teaching and learning.

Teachers' reluctance to use ICT often stems from a lack of confidence and skills (Jones, 2004; Blanskat et al., 2007). Teachers need ICT skills and knowledge to implement ICT initiatives effectively. Medichie et al. (2019) confirm that new technologies can revolutionize teaching and learning quality, especially with the use of ICT simulations (Habbler et al., 2016). Teachers need adequate ICT competences and a positive attitude towards ICT use (Sumak et al., 2011; Hennessy et al., 2022). Teacher competences relevant to ICT integration include knowing the type of pedagogy to incorporate, linking technology with content, and relating it to real-life situations (Langer et al., 2016; Dzikite et al., 2017).

The UNESCO framework for teachers' ICT use includes pedagogy, collaboration, networking, social issues, and technical issues (UNESCO, 2008). Pedagogy focuses on instructional practices and curriculum. Collaboration and networking extend learning beyond the classroom. Social issues address equitable access to technology. Technical issues involve lifelong learning and updating skills on new hardware and software. Rabach (2015) stresses that institutions must ensure teaching staff acquire appropriate ICT skills before integrating ICT in teaching. Blundell et al. (2020) emphasize empowering staff with ICT knowledge and skills.

2.3 ICT Applications Used by Physics Lecturers

Physics lecturers' proficiency in using ICT applications in teaching is crucial for students' success (Amora et al., 2024). Incorporating new technologies can transform physics teaching and learning (Madiche et al., 2019). Wilbrath & Kinzie (2000) stress that teaching staff must have positive computer attitudes and feel self-efficacious. Fulantelli & Allegra (2013) highlight the need for computerized education institutions to enhance working methods through innovative processes.

Physics is often perceived as complex and boring, resulting in a disconnect between teachers and students (Mulhall & Daniel, 2019; Carter, 2018). The incorporation of ICT offers exceptional

opportunities for flexible learning strategies, including synchronous and asynchronous communication (Ramukadev et al., 2018). Effective ICT use involves content websites, online education, and various digital tools. Physics lecturers should design programs exposing students to search engines, simulation tools, synthesizers, emails, eBooks, and social learning platforms like WhatsApp, Facebook, Twitter, and Telegram (Bogusevschi et al., 2020).

ICT tools help in accessing, processing, and sharing information in multimedia forms. Teachers need to structure content, pace lessons, and select instructional activities with a focus on gender (Rizal et al., 2007). The integration of ICT can simplify abstract content and create positive interest in learners (Alma et al., 2016). For effective implementation, there should be a dynamic relationship among content, pedagogy, and technology (Kurt, 2019).

2.4 Incorporating the TPACK Framework in Physics Teaching

The TPACK framework integrates three primary forms of knowledge: Content (CK), Pedagogy (PK), and Technology (TK). For physics lecturers, this means understanding the specific content of physics, knowing how to teach this content effectively, and using technology to enhance learning.

1. **Content Knowledge (CK)**: Physics lecturers need a deep understanding of physics concepts and principles.
2. **Pedagogical Knowledge (PK)**: Lecturers should be proficient in instructional strategies that engage students, such as Problem-Based Learning (PBL), cooperative learning, and Inquiry-Based Learning (IBL) (Zafar & Khan, 2017).
3. **Technological Knowledge (TK)**: Lecturers must be adept at using various ICT tools and applications, from basic computer literacy to advanced digital tools for simulations and interactive learning.
4. **Technological Pedagogical Content Knowledge (TPACK)**: This involves integrating technology into teaching in a way that enhances learning outcomes (Mishra & Koehra,2008). Physics lecturers should use simulations to make abstract concepts more understandable and employ student-centered approaches to promote active learning.

By aligning the lecturers' ICT competences with the TPACK framework, this investigation aims to explore how physics lecturers in TTIs in Eastern Uganda are incorporating ICT to improve the teaching and learning of physics, addressing both content delivery and gender inclusivity.

This structured approach ensures that the integration of ICT in physics education is comprehensive, addressing content knowledge, pedagogical strategies, and technological tools in a cohesive manner.

Methodology

This study used a mixed-method approach to explore ICT and gender integration in physics teaching by Physics Lecturers in Teacher Training Institutions (TTIs) in Eastern Uganda. A concurrent triangulation strategy was employed to collect and analyze both qualitative and quantitative data, providing a comprehensive understanding of the research problem (Dawadi, Shrestha & Giri, 2021).

Grounded in the pragmatism paradigm, the research combined case study and survey designs. The case study design offered in-depth insights into how Physics Lecturers integrate ICT and gender into teaching practices, while the survey design collected quantitative data on lecturers' attitudes and behaviors (Creswell, 2007; Shona, 2021).

Conducted in three TTIs, purposive sampling selected 14 Physics Lecturers and 14 TTI administrators, ensuring relevant expertise (Patton, 2002; Creswell & Plano, 2011). Data collection involved surveys for quantitative insights on ICT skills and integration challenges, interviews for qualitative perspectives, observations of ICT use and materials, and document analysis of lesson plans and assessment records (Biswajit et al., 2017; Creswell, 2014; Jemielniak & Ciesieslska, 2018).

Data analysis used content analysis for qualitative data and frequencies and percentages for quantitative data, facilitated by Excel and Microsoft Word (Creswell, 2014). Ethical considerations included obtaining permissions from Uganda National Council of Science for Technology (UNCST) and securing ethical clearance from Busitema University Faculty of Health Science Ethical Research Committee (BUFHSERC). Confidentiality, anonymity, and consent were maintained, and findings were shared with participating institutions to support teaching improvements (Resnik, 2011). This methodology ensured valid and reliable data collection through a systematic and ethical research process.

Presentation and Discussion of Results

4.1 Presentation of Findings on Physics Lecturers' ICT Competences

4.1.1 Existence of Programs for Enhancing Physics Lecturers' ICT Competences

Enhancement of ICT competences to Physics Education lecturers can be promoted through implementation of several programs with focus to integrating technology into teaching and learning. Examples of such programs included ICT integration workshops ,online learning platform and courses ,professional development programs, subject specific ICT training, collaborative learning communities ,ICT assessment workshops ,blended learning models and institutional support for ICT integration. The implementation of the above mentioned programs was achieved at different degrees as seen in the table below.

Table 1

Table Showing Responses from Physics Lecturers on Availability of Programs that Enhance Their ICT Competences

Program	Frequency	Percentage (%)
ICT integration workshops	06	50
Online learning platforms and courses	04	33.3
Professional development programs	08	66.7
Empowerment on blended learning models	06	50
Institutional support for ICT integration	04	33.3

Source: Primary Data

Professional development programs are the most commonly reported strategy for ICT integration among educators, cited by 66.7% of respondents (Blundeel et al., 2020). These programs align with the TPACK framework by equipping educators with the necessary technological, pedagogical, and content knowledge to effectively integrate technology into their teaching practices. Empowerment on blended learning models, reported by 50% of respondents, reflects the DOI theory, showcasing how educators gradually adopt innovative teaching methods that blend traditional and online learning. ICT integration workshops and institutional support, also reported by 50% and 33.3% of respondents respectively, underscore the importance of continuous support and collaboration, essential from a sociocultural perspective for fostering a culture of innovation and continuous improvement in educational practices (Sumak et al., 2011). Online learning platforms and courses, noted by 33.3% of respondents, indicate areas needing further development and support. These platforms provide opportunities for educators to explore new technologies and collaborate with peers, promoting effective technology integration in line with TPACK, DOI, and sociocultural theories.

4.1.2 Demands for Successful Incorporation of ICT and Gender in Physics Teaching

Table 2

Lecturers' Responses on Demands for Successful Incorporation of ICT and Gender in Physics Teaching

Approach	Frequency	Percentage (%)
ICT Infrastructure and Resources	10	83.3
ICT Training Programs	12	100
Gender Inclusive Curriculum Design	08	66.7
Promotion of Girls' Interest in Physics	05	41.7
Accessible and Inclusive ICT Tools	09	75
Professional Development on Gender Sensitivity	12	100
Encouraging Collaborative Learning	10	83.3
Regular Assessment and Evaluation	08	66.7
Addressing Gender Stereotypes and Biases	04	33.3
Policy Support and Institutional Commitment	04	33.3

Source: Primary Data

Analyzing lecturers' responses on the demands for successful incorporation of ICT and gender in physics teaching reveals key priorities. Professional Development on Gender Sensitivity and ICT Training Programs are the highest priorities, each reported by 100% of respondents, highlighting the need for educators to gain both technological proficiency and gender sensitivity. These align with TPACK principles, integrating technological, pedagogical, and content knowledge to foster inclusive environments. ICT Infrastructure and Resources, Accessible and Inclusive ICT Tools, and Encouraging Collaborative Learning, reported by 83.3%, 75%, and 83.3% of respondents respectively, underscore the importance of equitable access to technology and collaborative learning, viewed through DOI as steps toward innovation. Gender Inclusive Curriculum Design and Regular Assessment and Evaluation, noted by 66.7% of respondents, emphasize addressing gender biases in curriculum and assessment, aligning with sociocultural theories promoting equity. Less emphasized demands include Promotion of Girls' Interest in Physics, Addressing Gender

Stereotypes and Biases, and Policy Support and Institutional Commitment, each noted by fewer respondents but still crucial for comprehensive gender equity. This underscores that digital literacy shapes educators' ability to use technology in education (Rizal, 2021), and promoting gender equality through equal access to technology is essential (Maria et al., 2022; Plan International, 2022). By addressing these priorities through TPACK, DOI, and sociocultural lenses, educators and institutions can foster inclusive learning environments in physics education.

4.1.3 Administrators' Initiatives in Supporting the Incorporation of ICT and Gender in Physics Teaching

Table 3

Administrator's Views on Initiatives for supporting the Incorporation of ICT and Gender in Teaching Physics concepts.

Support form	Frequency	Percentage (%)
Strategic planning	06	50
Resource allocation	12	100
Professional development programs	12	100
Infrastructure development	08	66.7
Partnerships and collaboration	00	00
Policy development and implementation	05	41.6
Creation of support environment	08	66.7
Advocacy and communication	04	33.3
Monitoring and evaluation	06	60
Celebrating success stories	00	00

Source: Primary Data

Analyzing administrators' views on supporting ICT and gender integration in physics teaching reveals key priorities. Resource allocation and Professional Development Programs are the top initiatives, cited by 100% of respondents, highlighting the importance of providing resources and training to address gender disparities and integrate technology effectively. This commitment fosters gender equity by ensuring equal access to resources and professional growth opportunities.

Infrastructure development, reported by 66.7% of respondents, underscores the need for a supportive technological infrastructure to facilitate effective technology integration, representing incremental steps toward innovation as per DOI.

Strategic planning and Creation of a support environment, reported by 50% and 66.7% of respondents respectively, emphasize establishing a conducive environment for ICT integration and gender equity, aligning with sociocultural theories that highlight the role of broader socio-cultural contexts. Policy development and implementation, Advocacy and communication, and Monitoring and evaluation, though reported by fewer respondents, are essential for creating a supportive policy framework, raising awareness, and ensuring progress towards goals.

Celebrating success stories and Partnerships and collaboration were not reported by any respondents, suggesting opportunities to enhance external stakeholder collaboration and celebrate achievements in technology integration and gender equity initiatives. These elements are crucial for fostering a collaborative and supportive ecosystem that promotes continuous improvement in educational practice

One administrator asked on how physics lecturers are being supported to incorporate ICT and gender in teaching noted that,

> "I allow them to go for ICT related trainings and empower them to purchase what they feel can help them in integrating ICT and gender in teaching" (Interview Transcript from AA1).

The administrator's strategy to support physics lecturers in incorporating ICT and gender in teaching emphasizes autonomy and empowerment. By allowing lecturers to attend ICT-related training and make purchasing decisions based on their needs, this approach fosters a sense of ownership and agency. Through the TPACK framework, this strategy integrates technological, pedagogical, and content knowledge, enabling lecturers to enhance their ICT skills and pedagogical practices. Despite claims of support, observations indicate limited administrator action, echoing Hains (2021) that the onus is on lecturers to embrace technology. From a sociocultural perspective, this method acknowledges educators' expertise and promotes continuous learning and collaboration, supporting a culture of empowerment and professional development. This approach aims to improve teaching effectiveness and inclusivity in physics education

4.1.4 Impact of Physics Lecturers Demographic Factors on ICT and Gender Incorporation in Teaching

Information from the revealed that all Twelve (12) lecturers interviewed , acknowledged that their demographic factors have an influence on their status of incorporating ICT and Gender in teaching representing 100% response score . This finding is in line with what Asmiran et al (2012) that teachers' ICT skills are influenced by their demographic factors. This in the long run influences their readiness or resistance to change based on their perspectives, experiences and approaches used in incorporating ICT and gender in teaching. However, different demographic factors

influence the incorporation of ICT and gender in teaching differently. These deviations can vary from lecturer to lecturer. This means that focus institutional leaders should plan to support lecturers in incorporating ICT and gender basing on the history of their demographic factors. Specifically, they should institute support mechanisms needed to address the specific needs of their teaching staff so as to foster a continuous culture of improvement and innovation.

Table 4

Lecturers' Responses on the Demographic Factors Affecting the Incorporation of ICT and Gender in Teaching Physics concepts

Demographic Factors	Frequency	Percentage (%)
Age	08	66.7
Educational Background	09	75
Gender	07	58.3
Teaching Experience	11	91.7
Technological Competence	12	100
Cultural Background	08	66.7
Attitudes and Support	11	91.7
Access to Professional Development	12	100
Institutional Support	10	83.3

Source: Primary Data

According to Table 4, all interviewed lecturers (100%) confirmed that access to professional development and technological competencies greatly influence their incorporation of ICT and gender in teaching. This was followed by teaching experience, attitude, and support for lecturers, rated at 91.7%. Other demographic factors also influenced ICT and gender incorporation, with response scores above 50%. These findings indicate that demographic factors are crucial in influencing lecturers' integration of ICT and gender in physics education (Asmirani, 2012). For example, older lecturers may have less exposure to modern ICT tools compared to younger lecturers. Those with a background in educational technology are more adept at integrating technology, while gender can influence awareness and understanding of gender-inclusive practices.

Institutional support affects lecturers' willingness and ability to incorporate ICT and gender considerations, and cultural perspectives on gender roles and technology use also play a role. Positive attitudes towards ICT and gender inclusiveness foster better teaching practices. Access to professional development promotes best practices in physics education and helps identify strengths and weaknesses for improvement. Observations confirmed that demographic factors impact lecturers' adoption of ICT and gender in teaching, with higher-educated lecturers more likely to use technology effectively, while older lecturers and those lacking ICT competencies faced challenges. Administrators should use these demographic insights to identify and address lecturers' training needs related to ICT and gender incorporation.

4.1.5 Effect of Lecturers' Digital Literacy on ICT and Gender Incorporation

Digital literacy of lecturers is very important as it influences their ability to use ICT tools, adapt technological changes, develop digital content, use learning management systems ,access online resources, promote gender inclusive practices ,participate in professional development ,engage students and collaborate with the wider community. When lectures were asked of the value of their digital competency in ICT and gender incorporation, this is what was put by different respondents. Only salient responses which were appearing most times were shown.

One lecturer from one college AL2 asked on how lecturers' digital competency influences his or her use of ICT in teaching clarified that,

> "If utilized, lecturer's digital literacy eases the lecturer's work as proper illustrations can be provided hence effectively delivering to students. In case it is not utilized, the delivery of the lectures to students will be poor for example when explaining abstract concepts" (Transcript from lecturer AL2 conducted 02/11/2023).

Another lecturer asked on the same noted that,

> "Digital literacy positively influences the lecturer as he uses the ICT in teaching physics since can access the internet for physics content" (Transcript from lecturer BL1).

Lecturer CL2 similarly stressed that "Digital literacy enables the lecturer to search and select relevant content which helps to boost performance" (Transcript of interview from lecturer CL2). One administrator AA2 asked on the way lecturers' digital literacy influences the incorporation of ICT and gender stressed that,

> "The physics lecturers with elementary of ICT don't go further in research work as lack of skill limits them" (Transcript from administrator AA2).

This is supported with another administrator AA1 who also clarified that "Lecturers cannot research much if they cannot understand how to use ICT to get more information **(**Transcript from administrator AA1). Similarly, administrator BA1 clarified that "Lecturer's digital literacy makes them incorporate ICT and gender in teaching physics.

Analyzing the statements through the lenses of TPACK, DOI, sociocultural theories, and gender reveals the significant role of digital literacy in incorporating ICT and gender considerations in teaching physics. From a gender perspective, digital literacy addresses disparities in technology access and use in education. Lecturer statements highlight how digital literacy enhances teaching quality and access to content, benefiting all students (Habbler, 2016). However, disparities in digital literacy among educators, particularly female lecturers, can impact their teaching practices and exacerbate gender inequities. Administrator AA2's statement suggests that limited digital literacy affects educators' research and their ability to incorporate gender considerations. Hennessey et al. (2022) noted the difficulty of integrating ICT in teaching without digital literacy. Plan International (2022) advocated for technology use to promote female participation in physics, emphasizing innovative solutions and gender-inclusive language (Maria et al., 2022). Digital literacy is crucial for transforming STEM education by empowering female educators and addressing gender disparities. Through TPACK, DOI, sociocultural theories, and a gender lens, it is clear that digital literacy affects educators' ability to adopt technology, access relevant content, and navigate socio-cultural factors, ultimately impacting gender equity in education

Another lecturer on the same issue noted that,

> "Lecturers with digital literacy skills are able to cater for individual differences among students by designing appropriate learning activities using ICT" (Transcript from lecturer AL3).

The above is backed with lecturer AL1 who noted that "Digital literacy facilitates the use of ICT in teaching and makes him very confident and effective" (Transcript from lecturer AL1).

Analyzing the statements of lecturers AL3 and AL1 on digital literacy skills through TPACK, DOI, sociocultural theories, and a gender lens reveals the multifaceted impact of digital literacy on education. From a TPACK perspective, digital literacy enhances educators' ability to integrate technology effectively, aligning with content and pedagogical needs. Lecturer AL3 highlights how digital literacy helps design tailored learning activities, while AL1 notes its role in boosting educators' confidence with ICT. DOI principles emphasize that digital literacy improves readiness and effectiveness in adopting technology, benefiting teaching and engagement.

Socioculturally, digital literacy promotes inclusivity and addresses diverse learning needs, as suggested by AL3. However, a gender lens reveals potential disparities, with less digitally literate female educators facing additional challenges, which may worsen gender inequities in education. Rizal (2021) supports this, noting the influence of digital literacy on technology management in physics lessons. Overall, digital literacy is crucial for improving teaching practices, student engagement, and gender equity. Efforts by TTIs administrators to enhance digital skills among physics lecturers through refresher courses and workshops are essential for addressing these challenges.

4.2.6 Nature of Knowledge Possessed by Physics Lecturers

Table 5

Physics Lecturers' Views on the Nature of knowledge they posses

Nature of knowledge	Frequency	Percentage (%)
Subject matter expertise	12	100
Pedagogical knowledge	12	100
Educational technology	06	50
Assessment and evaluation	05	33.3
Research and scholarship	10	83.3
Communication skills	07	58.3
Adaptability and lifelong learning	05	33,3
Inclusivity and diversity	06	50
Collaboration and team work	05	33.3

Source: Primary data

Table 5 indicates that 100% of lecturers have subject and pedagogical knowledge. Additionally, 83.3% (10 out of 12) reported possessing research and scholarship knowledge. However, only 50% (6 out of 12) acknowledged having some knowledge in educational technology and communication skills. Furthermore, 33.3% of lecturers recognized their knowledge in assessment and evaluation, adaptability and lifelong learning, and collaboration and teamwork.

These results suggest a need for lecturers to enhance their knowledge in areas where gaps exist. Improving knowledge in ICT for assessment, promoting inclusion, and fostering teamwork through technology could be beneficial. This can be achieved through targeted training and retraining, with a focus on integrating ICT and gender-friendly strategies in teaching.

Kurt (2019) highlights the importance of dynamic interactions between content, pedagogy, and technology in classrooms, emphasizing the need for lecturers to effectively use their TPACK. Zafar & Khan (2017) advocate for student-centered pedagogies such as problem-based, collaborative, and project-based learning, which integrate ICT and address gender disparities. Training in ICT applications for physics teaching is crucial to achieving these goals.

4.1.7 Gender Knowledge Possessed by Physics Lecturers

Table 6

Showing Responses from Lecturers on Their Gender Knowledge

Gender knowledge	Frequency	Percentage (%)
Gender inclusive teaching strategies	09	75
Awareness of gender stereotypes	08	66.7
Promotion of diversity and inclusion	10	83.3
Equitable assessment practices	08	66.7
Representation in teaching materials	04	33.3
Facilitation of gender inclusive discussions	11	91.7
Addressing implicit bias	07	58.3
Promotion of gender equity in STEM	11	91.7

Source: Primary Data

Table 6 shows that 91.7% of lecturers (11 out of 12) acknowledge their knowledge in facilitating gender-inclusive discussions and promoting equity in STEM. Additionally, 83.3% (10 lecturers) reported knowledge in promoting diversity and inclusion. While other types of knowledge such as awareness of gender stereotypes, equitable assessment practices, and gender-inclusive teaching strategies received over 50% acknowledgment, only 33.3% of lecturers recognized their knowledge of representation in teaching materials.

Mulhall & Daniel (2019) highlight the complexity of teaching physics, necessitating efforts to simplify content and equip lecturers with pedagogical and technological knowledge. Ramakev et al. (2018) advocate for incorporating ICT in teaching through flexible learning strategies, while Bogusevschi et al. (2020) recommend using digital platforms like WhatsApp, Facebook, Twitter, and Telegram to access and share gender-friendly resources. This approach can enhance teaching and learning by providing diverse and accessible educational tools.

4.1.8 ICT Knowledge Possessed by Physics Lecturers

The knowledge based possessed by physics lecturers enables them to create a supporting environment that prepares students for success in Science Education. This section presented

specifically the lecturers' understanding on ICT based on observation of classroom lessons and document analysis. It presents the lecturers' understanding and use of the technological content knowledge which comprises ICT competences and their application in selecting physics content.

Table 7

Acknowledgement on ICT Knowledge Possessed by Physics Lecturers

ICT Knowledge	Frequency	Percentage (%)
Digital literacy	06	50
Educational technology tools	07	58.3
Learning management systems	06	50
Online collaboration tools	07	58.3
Data analysis software	04	33.3
Open educational resources	08	80
Blended learning models	05	41.7
Assistive technologies	05	41.7
Cyber security awareness	04	33.3

Source: Primary Data

Table 7 reveals that 80% of lecturers (8 out of 12) have knowledge of open educational resources, and 58.3% (7 lecturers) are familiar with educational technology tools and online collaboration tools. However, less knowledge is acknowledged in areas like cybersecurity awareness, data analysis software, blended learning models, and assistive technology, with scores below 50%. This suggests a need for physics lecturers to enhance their ICT skills to remain competitive in the workforce. Short ICT courses could help lecturers improve their programming and computer use for teaching physics.

These findings align with Yuccel & Kocak (2010), who assert that technological competence is now essential for teachers. Rizal (2021) highlights the importance of basic computer literacy, data backup, online project work, creativity, and social networking skills. Enhancing lecturers' TPACK and incorporating gender-friendly technology approaches can address these gaps and improve teaching practices

4.1.9 Effect of Lecturers' Attitudes and Efficacy on ICT and Gender Incorporation

The attitude of physics lecturers is crucial as it influences the rate at which they incorporate ICT and gender in teaching. Lecturer AL3 stressed that,

> "Lecturers with positive attitude towards the ICT use with gender friendly strategies are more likely to embrace change and actively seek ways of integrating technology in addressing gender disparities in their instruction."(Transcript for AL3 conducted on 02/11/2023)

Specifically, one administrator AA1 noted that,

> "Attitude is a driving factor to any successful venture. It is therefore hard if the lecturer does not have the interest to the right thing"(Interview Transcript for AA1 conducted on 02/11/2023)

Related to the above, another administrator AA2 clarified that,

> "The mystical attitude of I cannot manage makes them to remain at the ordinary level without attempt to dig into the detailed concepts"(Interview Transcript for AA2 conducted on 02/11/2023).

Findings from another administrator AA3 revealed that,

> "Attitude plays a recommendable role in that the more the attitude is positive, the more the teacher tries to use it in classroom instruction"(Interview Transcript for AA3 conducted on 02/11/2023).

Related to the above, lecturer AL1 clarified that,

> "Negative attitude makes the use of ICT and gender not supported .However, the positive attitude enhances or promotes the incorporation of ICT and gender"(Interview Transcript for AL1 conducted on 03/11/2023).

Another lecturer AL2 stressed that,

> "Fear to use the ICT tools due to failure to manipulate and use them in teaching. The thinking that physics is for boys and not for girls is an attitude among some lecturers" (Interview Transcript for AL2 conducted on 03/11/2023).

AL3 also noted that,

> "Physics lecturers' attitude affects incorporation of ICT and gender in teaching by determining how lecturers effectively and efficiently plan the content to be taught to the students" (Transcript for AL3 conducted on 03/11/2023).

Analyzing the statements of lecturers AL1, AL2, and AL3 regarding attitudes towards ICT and gender incorporation in teaching through the lenses of TPACK, DOI, sociocultural theories, and

the gender lens sheds light on the critical role of attitudes in shaping teaching practices and promoting gender equity in education. From a TPACK perspective, attitudes towards ICT and gender influence educators' readiness to integrate technology into teaching practices while considering content and pedagogical aspects.

The findings align with Valtonnen et al. (2018), who emphasize that teachers' beliefs about technology integration impact their adoption of ICT and gender considerations in physics teaching. Physics lecturers' attitudes towards technology and gender significantly influence their willingness to use technology to address gender disparities in enrollment and performance. To mitigate these issues, TTI administrators should sensitize lecturers on the benefits of ICT and gender inclusivity. Additionally, they should invest in ICT facilities and hire specialist instructors to support lecturers in using ICT tools effectively, thereby reducing gender disparities.

Lecturer AL1 highlights that positive attitudes towards ICT and gender foster their incorporation into teaching, reflecting the integration of technological, pedagogical, and content knowledge. In contrast, AL2 points out that negative attitudes, such as fear of failure or gender stereotypes, can hinder effective use of ICT tools and limit efforts to promote gender equity.

DOI principles underscore that individual attitudes and perceptions are crucial for adopting innovations. Positive attitudes support openness to change and innovation, while negative attitudes create resistance. Sociocultural theories suggest that broader socio-cultural factors shape attitudes and behaviors in education, with gender stereotypes influencing perceptions of ICT and gender roles. Positive attitudes are crucial for promoting inclusivity and addressing gender disparities, especially in traditionally male-dominated fields like physics.

4.2.10 Classroom Lesson Observations on Demonstration of ICT Use

Observations of class lessons revealed that lecturers displayed a lack of positive attitude towards incorporating ICT and gender considerations into physics teaching, progressing slowly in embracing gender inclusivity. There were no clear signs of efforts to use ICT to address gender disparities in physics performance. Lecturers used active learning strategies like group discussions and problem-solving, but these were limited in scope. Setlawan & Rusdiana (2019) emphasize the need for teachers to promote universal access to information by addressing the digital divide, which involves ensuring student access to technology and developing technology-related skills.

Physics lecturers need to be practical in using technology for planning, instruction, and assessment to serve as models for students. Kevinet al. (2008) stress the importance of equipping students with ICT literacy and digital communication skills. Sadaff et al. (2016) recommend that administrators tackle resistance to ICT integration by organizing resources and facilitating integration efforts. The lack of a positive attitude towards ICT and gender-friendly strategies could be attributed to insufficient ICT skills or infrastructure. For instance, among the three colleges studied, only one had internet access, limiting interaction between lecturers and students.

Sociocultural factors also play a role, as students from varied backgrounds face challenges accessing technology. Stakeholders should promote equality by providing equal opportunities for technology use in learning. However, instructional materials, including lesson plans, showed minimal integration of technology to reduce gender disparities, with few lecturers incorporating technology in their teaching methods.

4.2.11 Tutors' knowledge on ICT use

Table 8

Observations on lecturers 'Use of Knowledge on ICT Use

Knowledge	Frequency	Percentage (%)
Use of ICT to understand students and content	02	16.7
Planning ICT informed curriculum	04	33.3
Using ICT in planning	07	58.3
Using ICT integration strategies	03	25
Infusion of ICT in teaching content	08	66.7
Use of ICT in instruction	03	25
Use of ICT in assessing students	02	16.7

Source: Primary Data

Table 8 reveals that 66.7% of lecturers (8 out of 12) effectively used ICT, such as projectors, in teaching content. Additionally, 58.3% (7 lecturers) incorporated ICT in planning content and teaching activities. However, only 33.3% (4 lecturers) planned an ICT-informed curriculum, and just 25% (3 lecturers) used ICT integration strategies for instruction. Furthermore, only 16.7% (2 lecturers) utilized ICT for assessing students and understanding content.

The findings indicate that while many physics lecturers incorporate ICT in teaching and planning, their use of ICT in curriculum planning, student assessment, and instruction is limited. This limitation may be due to a lack of ICT competency and negative attitudes towards ICT use. Hinostroza (2018), Lawrence & Tar (2018), and Kilin et al. (2018) suggest that barriers to ICT integration include insufficient resources, training, technical support, and time.

In Uganda, the absence of ICT instructors and timetabled ICT lessons exacerbates this issue. To address these challenges, refresher courses, workshops, and training sessions should be organized to improve lecturers' and students' TPACK, focusing on practical use of IT equipment, specific software, and making physics more engaging, as emphasized by Aladejana (2007).

4.2.12 Gender Concerns on ICT Use

Table 9

Lecturers' Gender Considerations Exhibited in ICT Use

Gender Concerns in ICT Use	Frequency	Percentages (%)
Promoting accessibility and inclusivity	02	16.7
Using gender representation in leaning materials	05	41.7
Using interactive and collaborative tools	02	16.7
Using flexible learning platforms	02	16.7
Use of Gender inclusive language	07	58.3
Addressing gender stereotypes and biases	04	33.3
Promoting digital literacy to all	03	25
Provision of diverse examples	08	66.7
Encouraging active participation	12	100
Participation in Professional development	07	58.3
Provision of feedback on assessment practices	12	100
Creation of online supportive community	02	16.7

Source: Primary Data

Analyzing Table 9 reveals how lecturers' gender considerations in ICT use align with TPACK, DOI, sociocultural theories, and the gender lens to promote inclusivity, address gender biases, and enhance teaching practices. Observations of physics lessons highlighted efforts to use ICT to reduce gender disparities in performance and enrollment by fostering active interaction between female and male students. Key findings include that all lecturers (100%) actively engaged students and provided feedback on assessments, demonstrating a commitment to using ICT to enhance teaching effectiveness, consistent with TPACK principles, which emphasize the integration of technological, pedagogical, and content knowledge. Additionally, 66.7% of lecturers provided diverse examples, and 58.3% participated in professional development, indicating efforts to address gender biases and promote equitable access to ICT resources. These actions aim to create inclusive learning environments.

Efforts to address gender stereotypes and use gender-inclusive materials were evident, with 33.3% of lecturers addressing stereotypes and 41.7% using inclusive materials, reflecting awareness of socio-cultural norms in education. However, promotion of digital literacy (25%), accessibility (16.7%), and interactive tools (16.7%) were less prominent, suggesting gaps in fully integrating these aspects into teaching practices. Recommendations by Cheryl & Laura (2009) suggest that integrating gender and ICT in physics education should include identifying ICT skills of student teachers to plan gender-sensitive classes. Rizal (2021) emphasizes the benefits of digital media in developing skills and career preparation. Overall, lecturers' gender considerations in ICT use reflect a multifaceted approach to fostering inclusivity and addressing gender disparities, highlighting the need for continued investment in these areas to create supportive learning environments for all student

4.2.13 UNESCO ICT Competences Possessed by Physics Lecturers

Table 4. 10

UNESCO Competences Possessed by Physics Lecturers

UNESCO Competences possessed by lecturers	Frequency	Percentage (%)
Teacher's instructional practices and the curriculum.	10	83.3
Communication ability of extending the learning beyond the classroom.	05	41.7
Caring for learners' rights and responsibilities	07	58.3
Updated skills on hardware and software.	04	33.3

Source: Primary Data

Based on Table 4.10, the survey on UNESCO competences among physics lecturers shows that 83.3% (10 out of 12) possess strong skills in instructional practices and curriculum management, indicating a high level of proficiency in these areas. This was the most common competence among the lecturers surveyed. Following this, 41.7% (5 out of 12) demonstrated communication abilities to extend learning beyond the classroom, suggesting that while significant, this skill is less common and could be improved. Additionally, 58.3% (7 out of 12) of lecturers showed competence in caring for learners' rights and responsibilities, though this was less prevalent than instructional practices and curriculum management. Only 33.3% (4 out of 12) reported up-to-date skills in hardware and software, highlighting a need for more training in this area. Table 10 further indicates that, despite strengths in instructional practices and learner care, lecturers lack in communication abilities and updated technological skills. Medichie (2019) notes the

transformative potential of emerging technologies in teaching, emphasizing the need for enhanced TPACK development. Sumak et al. (2011) and Langer et al. (2016) support the need for competencies and positive attitudes towards ICT, suggesting that high-quality, ICT-supported training is essential for addressing these gaps and improving physics teaching and gender equity in performance and enrollment

4.2 Presentation of Findings on ICT Applications Used by Physics Lecturers

4.2.1 Importance of ICT Use in Teaching Physics

Table 11

Lecturers' Views on the Importance of Using ICT in Teaching Physics Education

Importance	Frequency	Percentage (%)
Enhanced Learning Experiences	12	100
Preparation For Real World Applications	10	83.3
Promoting Gender Equity In STEM	12	100
Development of 21st Century Skills	06	50
Personalized Learning	08	66.7
Creation of Global Learning Opportunities	06	50
Data Driven Decision Making	11	91.7
Preparation for Technological Advancements	07	58.3
Adaptation to Technological Changes	09	75
Inclusive and Diverse Learning Environments	10	83.3

Source: Primary Data

Table 11 reveals that lecturers widely recognize the benefits of integrating ICT into physics education. All surveyed lecturers agree on ICT's role in enhancing learning experiences, indicating a consensus on technology's impact on education quality. Additionally, 83.3% of lecturers believe ICT is crucial for preparing students for real-world applications in physics, bridging theoretical knowledge with practical skills.

The unanimous support for ICT's role in promoting gender equity in STEM subjects highlights a shared understanding of technology's potential to foster inclusivity and diversity in education. However, opinions vary on other aspects. For example, 50% of lecturers see ICT as aiding the development of 21st-century skills like critical thinking and collaboration, suggesting moderate agreement on technology's role in cultivating essential student competencies.

While 66.7% of lecturers value ICT for personalized learning and 50% for global learning opportunities, 58.3% acknowledge its importance in preparing students for technological advancements. Notably, 91.7% endorse ICT's contribution to data-driven decision-making in physics education, reflecting broad recognition of technology's role in evidence-based instructional strategies.

These findings align with Hains (2021), who emphasized ICT's transformative impact on teaching and learning. Overall, lecturers demonstrate a strong commitment to leveraging technology to enhance learning, promote inclusivity, develop critical skills, and prepare students for the digital age.

4.2.2 Degree of Integration of ICT and Gender in Teaching

4.2.2 Priority Areas Stressed by Lecturers

Classroom lesson observations of twelve male physics lecturers aimed to assess the integration of ICT and gender in teaching. The focus was on technology usage, accessibility, pedagogy integration, and the quality of teacher training, as well as gender-related patterns such as student participation, inclusive education practices, and the perceptions of lecturers and student teachers.

Findings revealed a significant gender disparity: all twelve lecturers were male, potentially demotivating female student teachers who might perceive physics as a male-dominated field. Of the forty-six science student teachers, only nineteen were female (41.3%), compared to twenty-seven males (58.7%), highlighting gender imbalances in enrollment and performance. This situation calls for increased sensitization and the involvement of female scientists to encourage female students to pursue science.

The integration of ICT and gender was found to be low, with inadequate ICT competencies among both lecturers and students impacting their self-efficacy and ICT use. The shortage of computers, many of which lack internet connectivity, further hampers effective teaching and collaboration. Echoing Kurt (2019), lecturers should leverage their TPACK to incorporate ICT and gender inclusively. Administrators, supported by stakeholders, should address digital divides by providing necessary resources and creating a conducive environment for all learners, as emphasized by Maria et al. (2022).

Table 12

Showing Priority Areas Advocated by Physics Lecturers in Technology Integration

Areas Stressed by lecturers	Frequency	Percentage (%)
Actual use of IT Equipment	05	41.7
Use of specific software	03	25
Use of IT equipment in making physics resources	04	33.3
Total	12	100

Source: Primary Data

Table 12 indicates that most physics lecturers (41.7%) focus on advocating for the use of IT equipment among student teachers, followed by 33.3% who promote using IT to create physics resources, and 25% who advocate for specific software. This suggests that lecturers emphasize areas where they are knowledgeable. To effectively integrate ICT and gender, both lecturers and student teachers need access to necessary resources, including materials, financial support, and ICT experts. Blundell et al. (2020) highlight that technological equipment alone is ineffective without proper competency in ICT integration. Administrators should ensure that teachers receive comprehensive training and resources to support effective ICT implementation, as noted by Ferjsavec (2017).

4.2.3 The Use of ICT and Gender Incorporation in Elimination of Physics Misconceptions

Table 13

Lecturers 'Responses on Ways of Integrating ICT in Eliminating physics Misconceptions Teaching

Way	Frequency	Percentage (%)
Interactive Simulations and Virtual Labs	05	41.7
Multimedia Presentations and Visualizations	05	41.7
Customizable Learning Paths	04	22.2
Online Discussion Forums and Collaborative Platforms	00	00
Gender Inclusive Teaching Strategies	08	66.7
Diverse Representations in Teaching Materials	06	50
Active Learning Strategies	11	91.7
Real Life Application Through Technology	03	25
Feedback and Assessment Strategies	10	83.3
Cultivating a Growth Mindset	07	58.3

Source: Primary Data

Table 13 shows that 91.7% of lecturers use active learning strategies to address physics misconceptions, while 83.3% use feedback and assessment strategies for the same purpose. Other methods, like gender-inclusive technologies and fostering a growth mindset, were used by more than 50% of lecturers, whereas methods like online discussion forums were less utilized. Less than 50% of lecturers employed customizable learning paths (22.2%), real-life applications through technology (25%), and interactive simulations and multimedia presentations (41.7%). Sociocultural theory suggests that learning should occur within specific social and cultural contexts (Rekeda, 2002), emphasizing the need for physics lecturers to incorporate ICT and gender inclusivity. This includes using platforms like WhatsApp and Facebook to enhance student interactions with content.

4.3.2 Categorization of Physics Lecturers

Table 14

Responses from Physics Lecturers Showing Their Categorization

Category	Frequency	Percentage (%)
Innovators	00	00
Early adopters	02	16.7
Early majority	02	16.7
Late majority	04	33.3
Laggards	04	33.3
Total	**12**	**100**

Source: Primary Data

Table 14 shows the adoption of teaching methods by physics lecturers, focusing on technology use to address gender disparities. The majority of lecturers are categorized as the late majority (33.3%) or laggards (33.3%), adopting new methods only after widespread acceptance or under pressure. Early adopters and the early majority each represent 16.7%, indicating limited openness to new practices. No lecturers are classified as innovators, suggesting a lack of pioneering in adopting new methods. To improve ICT integration and address gender disparities, administrators should prioritize procuring ICT equipment, conducting training, and offering access to IT resources. Refresher courses are necessary to enhance ICT competencies and support the integration of ICT and gender in teaching (Salim, 2006).

4.3.3 Methods of Teaching Used by Physics Lecturers

Table 15

' Responses from Lecturers on the Methods Used in Teaching Physics

Method Used by Physics Lecturers	Frequency	Percentage (%)
Project Based Learning	09	75
Blended Learning	02	16.7
Class Experiments	06	50
Flipped Classroom	01	8.3
Inquiry Based Learning	09	75
Collaborative Learning	02	16.7
Interactive Simulations and Virtual laboratory	03	25
Discussion	12	100
Interactive Question and Answer	10	83.3
Lecture	12	100
Online Collaboration and Discussion	04	33.3

Source: Primary Data

Table 15 shows the teaching methods applied by physics lecturers. Traditional methods, such as discussion and lecture-based instruction, are most common, each receiving 100% frequency. This indicates a reliance on direct instruction. Project-based and inquiry-based learning follow, with 75% frequency, showing a commitment to active, hands-on learning. Class experiments, interactive question and answer sessions, and simulations have moderate frequencies (25%-50%), suggesting varied use of practical elements in teaching. However, blended learning, flipped classrooms, collaborative learning, and online methods are less frequently used, indicating potential for more innovative approaches.

The data reflects a mix of traditional and innovative methods, with all lecturers employing discussion and lecture methods, followed by interactive question and answer, inquiry-based learning, project-based learning, and class experiments. The lower usage of methods like blended

learning and online collaboration might stem from lecturers' limited ICT skills. Mishra & Thompson (2009) suggest that improving ICT skills could enhance teaching methods and reduce gender disparities in science education. Jarson (2022) highlights the need for effective communication and support for ICT adoption to innovate teaching practices. Lecturers should focus on participatory methods and ICT integration to improve teaching quality.

4.3.4 ICT Development Stages Reached by Lecturers

Table 16

Responses from Lecturers on Their ICT Development Stages Reached

ICT Development stage	Frequency	Percentage (%)
Recognition	06	50
Persuasion	03	25
Decision adaptation	02	16.7
Implementation	01	8.3
Confirmation	00	00
Total	12	100

Source: Primary Data

Table 16 shows the ICT development stages of lecturers. The majority (50%) are at the recognition stage, acknowledging ICT's potential benefits. Following this, 25% are at the persuasion stage, working to convince themselves or others of ICT's value. About 16.7% are at the decision adaptation stage, adjusting their ICT implementation decisions, while 8.3% are in the implementation stage, actively incorporating ICT into their teaching. None are at the confirmation stage, meaning no lecturers have fully confirmed the success of their ICT efforts. The data indicates varied progress in ICT integration among lecturers, with overall low adoption. This low adoption may stem from a lack of knowledge about specific technological tools for teaching physics (Kurt, 2019). To address this, refresher courses should be organized to help lecturers better understand and integrate ICT and learner-centered teaching methods

Conclusion

The investigation into physics lecturers' ICT competence levels revealed a varied landscape, with some demonstrating high proficiency and others showing inconsistent skills, influenced by factors like training access, attitudes toward technology, and institutional support. The study also

identified a diverse range of ICT applications—such as simulation software, learning management systems, and educational apps—used to enhance teaching effectiveness and student engagement. These findings emphasize the need for targeted professional development, improved access to resources, and institutional support to better integrate ICT into teaching practices and address the diverse competencies among lecturers

Recommendations

Moving forward, it is imperative to prioritize ongoing professional development initiatives tailored to enhancing lecturers' ICT skills and knowledge. Providing access to training workshops, online courses, and peer mentoring programs can empower educators to leverage technology effectively in their teaching practices. Additionally, fostering a supportive institutional culture that values innovation and invests in ICT infrastructure is essential for sustaining long-term improvements in teaching quality.

To guide effective ICT integration, we recommend following practical guidelines and best practices. These include selecting appropriate technology tools that align with learning objectives, designing engaging learning activities that leverage the affordances of ICT, and adopting inclusive pedagogical approaches that cater to diverse student needs. Furthermore, evaluation and assessment strategies should be employed to measure the impact of ICT integration on student engagement, learning outcomes, and overall teaching effectiveness.

As educators embark on this journey of ICT integration, a wealth of resources and tools are available to support their efforts. Curated lists of recommended websites, software applications, instructional videos, and scholarly articles can serve as valuable repositories of knowledge and inspiration. Moreover, sharing exemplary case studies and success stories can provide concrete examples of effective ICT integration in practice, motivating educators to explore new possibilities and innovate in their teaching approaches.

Finally, fostering collaborative opportunities for knowledge sharing and professional networking is crucial for building a community of practice around ICT integration in physics education. By facilitating dialogue, collaboration, and peer support, educators can collectively advance their ICT skills and knowledge, ultimately enhancing teaching effectiveness and improving student learning experiences.

In closing, the integration of ICT holds immense potential to transform physics education, fostering innovation, engagement, and access to diverse learning resources. By embracing this opportunity and committing to ongoing professional development, educators can empower themselves to harness the full benefits of technology in the service of teaching and learning excellence.

References

Aladejana,F(2007).The Implications of ICT and NKS for Science Teaching :Whither Mgera.11e-1fe:complex systems publications.inc

Alma,R,M,z,& Magoma,M(2016).Does the Integration of ICT in Physics Instruction in Secondary Schools play the Magic card? *European Journal of Education Studies.* doi.10.5281/zenodo.61193 available online www.oapub.org/edu Volume 2.(3).2016

Alt, D (2018). Science Teachers' Conception of Teaching and learning. ICT Efficacy, ICT professional Development and ICT practice enacted in the classroom. *Teaching and Teacher Education*, 73, 141-150. https://doi.org/10.1016/j.late.2018.03.020.

Amora,M.V,Batan,A.Q,Caay,M.C.B.,Levardo,K.T,& Palileo.A.G(2024).Integrating Technology in Schools for Teaching and Learning : Basis for Outcomes –Baed Instructions ,*International Journal of Innovative and Science and Research Technology*, Volume 9,Issue 1,pp 800-806.

Balanskat, A., Blamire, R., & Kafal, S. (2007). A Review of Studies of ICT Impact on Schools in Europe. European School net.

Bergonia,C(2017) Teacher competency on the use of ICT in teaching physics in the junior high school KnE social sciences /4th *International Research Conference on Higher Education* pages 177-204

Biswajit,D.,Durgesh,T,Sumitha.C&Huma,P(2017).QualitativeMethods:SurveyCommunicationsResearch,*ResearchandMediaandCommunicationStudies.*RetrievedfromResearchGate.https;//www.researchgate.net/publicat/318959206

Bluridell, C, Lec, K.T. & Nykvist, S.(2020). Movi ng beyond Enhancing Pedagogies with Digital Technologies. Frames of Reference, Habits of Mind and Transformative learning. *Journal of Research on Technology in Education*, 52, 178-196. https://doi.org/10.1080/15391523.2020.1726235.

Bogere,A, Abu,R, & Rahman,M (2013).Improving Performance Of Science Subjects In TVET Institutions By Using Collaborative Learning. Reference To Uganda .International Journal of Engineering Sciences and Research Development, 2(10), October 2013,ISSN:2277-9655.

Bogusevschi, D., Muntean, C. , & Muntean, G.M.(2020). Teaching and learning Physics using 3D virtual Learning Environment. A case Study of Combined Virtual Reality and Virtual Laboratory in Secondary School. *Journal of Computers in Mathematics and Science Teaching*, 39,5-18.

Carter, A.M.(2018). An Eye toward change: Examining Requests in Teacher-student writing conferences. Indiana University of OPennsylvania.

Christense, R. & Knezek, G. (2006). Pathway for Preparing Tomorrow's Teacher to Infuse Technology Computers in the schools. Vol.23.No.3/4,pp.1-21.

Compean, D.R., & Higgins, C.A. (1995). Computer Self-efficacy: Development of ameasure and initial test. MIS Quarterly, Vol.23. No: 2 ; pp.145-158.

Creswell, J. W. (2007). *Educational research: Planning, conducting and evaluating quantitative and qualitative research* (Pearson new international edition, 4th edition) . Pearson.

Dawadi,Saraswati,Shrestha,Sagun & Giri,Ram,A(2021).Mixed Methods Research :A Discussion on Its Types, Challenges and Criticisms. *Journal of Practical Studies in Education*,2(2)pp.25-36

Dzikite, C, Nsubuga, Y, & Nkonki, V.(2017). Lecturers' competences in Information and communication Technology (ICT) for effective implementation of ICT-integrated teaching and learning in Textiles and Clothing degree programmes. *International Journal of Educational sciences*,17,61-68.

Erlmer, P.A., Paul, A., Moll1), L., Eva, R., & Denise, W. (2019). Examining Teachers' Beliefs about the Role Technology in Elementary Classroom *Journal of Research on Computing in Education*, 32(1), 54-72.

Glenn,B. (2009).*Documentary Analysis as Qualitative Research Method*. 27–40.https://doi.org/10.3316/QRJ0902027

Habber, B., Mayor, L. & Hennessy, S.(2016). Tablet Use in Schools. A critical Review of the Evidence for learning outcomes. *Journal of Computer Assisted Learning*, 32,139-156. https://di.org/10.1111/jcal.12123.

Hains, M (2021).Teacher ICT Skills: A practical Reference of Preferred Levels of Technological Abilities for Teachers.

Hennesy, S., D'Angelo, S., Mclntyre, N., Koomar, S., Kreimeia, A., Cao, L., Brugha, M., & Zubairi, A.(2022). Technology Use for Teacher Professional Development in Low and Middle Income Countries. A systematic Review. Computers and Education open, 3, Article ID:100080. https://doi.org/10.1016/jcaco.2022.100080.

Hinostroza, J.E.(2018).New Challenges For ICT in Education Policies in Developing Countries. The Need to Account for the Widespread Use of ICT for Teaching and Learning outside the School. *In ICT- Supported Innovators in Small Cities and Developing Regions* .pp 99-119.Springer.Cham.

International Telecommunication Union (ITU) (2022). Bridging the Gender Gap, Geneva

Irma,H& Geert, I, Monique ,V & Admuraal (2009). Gender Inclusiveness in Education Technology and Learning Experiences of Girls and Boys. *Journal of Research on Technology in Education*, JRIE 41(3).253-276

Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a Definition of Mixed Methods Research. Journal of Mixed Methods Research, 1(2), 112-133

Kiconco, M ,& Karyarugokwo,D (2022) ,A critical Analysis of the Compulsory Science Education Policy at the Secondary Level Education In Uganda, *Advances In Social Sciences Research Journal ,Vol.9.No.8,297-306*

kilinc, E., Tarman, B.,& Aydin,H.(2018).Examining Turkish Social Studies Teachers' Beliefs About Barriers to Technology Integration. *Tech Trends.* 62 (3). 1-3. https://doi.org.10.1007/511528-018-0280-y.

Kurt,S(2019).Mishra & Koehhler,M,J (2006).Technological Pedagogical Content Knowledge: A frame work in teachers' knowledge: *Teachers' College Record,108(6),1017-1054*

Langer,T., Jazmati,D., O., Schulz, C., & Schnell, M.W.(2016). Medical Students' Development of Ethical Judgement. Exploring the Learners' Perspectives using a Mixed Methods Approach. GMS Journal for Medical Education, 33,Doc74.

Lawrence, J,E., & Tar,U.A.(2018).Factors that Influence Teachers 'Adoption and Integration of ICT in Teaching Learning Process. *Educational Media Technology*, 55(1), 79-105.

Madichie,N.O,Taura,N.D.,&Bolat,E.(2019).What next for digital entrepreneurship in sub Saharan Africa? In N.Taura,E. Bolat,& N. Madichie (Eds). Digital Entrepreneurship in Sub Saharan Africa (pp221-240).Palgrave Macmillan

Maera,J(2016).Physics Teaching Methods Module for BED , School of Education, Masai ,Meru University.

Markon,G(2013).Perspectives of ICT Perception in Ugandan schools. Michigan Technological University

Michael,B. (2018).*EducationalResearch.47*(1).

Mishra, P.,& Koehler, M.J.(2008). Introducing Technological Pedagogical Content Knowledge. Annual Meeting of the American Educational Research Association, 1, 16.

MOES (2018).National Teacher Policy .Kampala

Mulhall, P. & Daniel, S.(2019). Changing Attitudes to Learning Physics through Participation in the Victorian Young Physicists' Tournament. In Deakin STEM Education Conference 2016 Proceedings.

Narrinderrit, K(2020).ICT Tools in teaching and learning Chemistry, Kanya Maha Vdyalaya

Patton, M.Q.(2002).Qualitative Research & Evaluation Methods. 3rd Edition. Sage Publications, Inc.

Rabach, J.(2015). Benefits and Challenges of Information and Communication Technologies (ICT) Integration in Quebec English Schools. *Turkish online Journal of Educational Technology-TOJET, 14, 24-31.*

Resnick,D.(2011).NationalInstituteofEnvironmentalHealthSciences.Retrievedfrom:http://www.niehs.nih.gov

Rizal ,R,Seitiawan,W,& Rusdiana,D (2019).Digital Literacy of Pre-service Science Teachers. *Journal of Physics Conference Series* 1157, pp.1-6.

Rizal,R,Rusdiana,D,Setiawan,W,Siahaan,P&Ridwan,IM (2021).Gender Differences in Digital Literacy Among Prospective Physics Teachers ,International Conference on Mathematics and Science Education(ICMSE) 2020, *Journal of Physics : Conference Services* 1806 (2021) 012004.doi.10.1088/1747-6596/180611/012004

Rogers, E.M. (2003). Diffusion of Innovation. New York, Free Press

Roland, C, David, A. Gavin & Ann,S(1991). Education for Judgment: The Artistry of Discussion Leadership

Sadaf, A., Newby, T.J., & Ertmer (2016). An Investigation 0f the Factor that influence Pre-service Teachers' Intentions and integration of Web. 2. 0 Tools. Educational Technology Research and Development, 64 (1), 37-64.

Shona,M(2022).WhatisaResearchMethodology?:StepsandTips,Scribbr.

Siemens, G.(2017).Connectivism. In R.E. West (Ed), Foundations of Learning and Instructional Design. Ed Tech Books.

Sumak, B., Hericko, M., & Pusnik, M.(2011). A meta-analysis of E-learning Technology Acceptance. The Role User Types and E-learning Technology Types. Computers in Human Behaviour, 27, 2067-2077. https://doi.org/10.1016/jchb.2011.08.005.

TISSA (2013). Challenges Affecting the Quality of Education in Uganda

UNESCO (2021). UNESCO Science Report of 2021, Share of Women among Total Researchers by Country.

Uwizeyimana, D., Yadav, L.,Musengimana, T., & Uwamahoro, J.(2018). The Impact of Teaching Approaches on Effective Physics Learning. An Investigation conducted in Five

Secondary schools in Rusizi District Rwanda. *Rwandan Journal of Education, 4, 4-14.*

Vannata), R. & Fordham, N. (2004). Teacher Dispositions as Predictors of classroom Technology use. Journal of Research on Technology in Education, Vol.36.No.3, pp.253-223

Yucel,A.S &Kocak (2010)Evaluation of the Basic Technological Competency of the Teachers' Candidate According to the Various Variables .*Procedia Social and Behavioral Sciences Volume 2 ,Pp 1310-1315.*

Zafar, S., & Khan, Z.A.(2017). An Empirical Study of the Impact of Project-based Learning (PBL) Approach on Technical Writing skills. In Explorations. Teaching and Learning English in India (pp.30-40). British council.