International Journal of Applied Social Science
(An International Double Blind Peer Reviewed / Refereed Research Journal of Social Science)
Volume 11 (7&8), July & August (2024): 281-290
Received: 01.06.2024; Revised: 15.06.2024; Accepted: 01.07.2024

RESEARCH PAPER
ISSN: 2394-1405 (Print)
DOI: 10.36537/IJASS/11.7&8/281-290

Role of ICT in Quality Science Teaching-Learning: A Study of University Science Teachers' Perception

SYED KHURRAM SHAHABUDDIN*[1] AND HARJEET KAUR BHATIA[2]
[1]Research Scholar and [2]Professor
Department of Educational Studies, Jamia Millia Islamia, Delhi (India)

ABSTRACT

This study explores the perception of university science teachers regarding the role of Information and Communication Technology (ICT) on the quality of science teaching-learning. It highlights the role of ICT in curriculum planning and development, teaching-learning and evaluation processes, research innovation and extension activities. A self-structured questionnaire was administered to collect data from 12 university science teachers were selected on convenience basis from the Department of Biosciences, Biotechnology and Centre for Interdisciplinary Research in Basic Science teaching UG courses. The findings reveal significant positive perception of ICT's role in curriculum planning and development, teaching-learning and evaluation processes, research innovation, and extension activities. The study points out the perception of teachers regarding the significance of integrating ICT into science education to facilitate continuous improvement and adaptation in teaching-learning, ultimately enhancing the quality of science education.The study also highlights the perception of teachers regarding challenges faced by teachers such as data analysis, simulations, and modeling, which can limit the potential of students' projects. Additionally, the lack of training for teachers, resistance to changing traditional methods and may not leverage ICT to create innovative courses. The study suggests that there is need for sensitization of, capacity building programs for, peer collaboration amongst teachers enabling them utilize the potential of ICT in improving science teaching-learning and benefiting the society as a whole.

Keywords: ICT, Science UG Education, Teacher Perception, Educational Technology, Gender Equity, Curriculum Development, Innovation Diffusion, Educational Quality

INTRODUCTION

The integration of Information and Communication Technology (ICT) in face-to-face teaching of science has revolutionized the educational landscape, enhancing both teaching-learning experiences. ICT tools such as interactive simulations, virtual labs, multimedia presentations, and educational apps provide dynamic ways to illustrate complex scientific concepts, making learning more engaging and comprehensible for students. This approach not only caters to different learning styles but also fosters critical thinking and problem-solving skills crucial for scientific inquiry. With the recent UGC directive emphasizing a 40 per cent online mode of educational delivery, incorporating ICT ensures flexibility and accessibility, enabling educators to reach a wider audience while maintaining the integrity and effectiveness of face-to-face interactions in science education.

The post-COVID-19 pandemic has accelerated the adoption of ICT in education, as institutions worldwide were forced to shift to online and hybrid learning models. The integration of ICT into teaching methodologies has become indispensable, not only for enhancing the learning experience but also for meeting international education standards. ICT has revolutionized education by providing innovative tools and resources that facilitate interactive and student-centered learning. According to UNESCO (2015), ICT in education enhances the teaching process

How to cite this Article: Shahabuddin, Syed Khurram and Bhatia, Harjeet Kaur (2024). Role of ICT in Quality Science Teaching-Learning: A Study of University Science Teachers' Perception. *Internat. J. Appl. Soc. Sci.,* **11** (7&8): 281-290.

by providing access to a wealth of digital resources, fostering collaborative learning environments, and enabling personalized learning experiences. The effective use of ICT can improve student engagement and motivation, thus enhancing overall educational outcomes (UNESCO, 2015).

Furthermore, the OECD report suggests that integrating ICT into education systems can bridge educational gaps and promote equitable learning opportunities, especially in under-resourced regions (OECD, 2015). India has recognized the potential of ICT in transforming education and has implemented various policies to promote its integration in classrooms. The National Policy on Education (NPE) 2020 emphasized the establishment of a National Educational Technology Forum (NETF) within the Ministry of Education to oversee the development of digital infrastructure, content, and capacity building for e-education at all levels. NETF is crucial for coordinating the adoption and development of educational technologies, ensuring they meet evolving educational needs and technological changes (Ministry of Education, 2020).

In the realm of science education, the Digital India campaign, initiated by the Government of India, holds significant promise. This campaign endeavours to enhance digital access and literacy nationwide, ensuring that teachers and students alike can leverage ICT tools effectively. The National Mission on Education through ICT (NMEICT) plays a crucial role by providing digital resources and tools specifically tailored for science education. These resources foster an environment conducive to innovative teaching methodologies and enriched learning experiences in science. Consequently, educators are empowered to employ advanced digital technologies to illustrate complex scientific concepts effectively, thereby enhancing student engagement and comprehension. This holistic approach not only enriches the quality of science education but also aligns with the broader goals of digital empowerment and educational enhancement envisioned by the Digital India campaign (NMEICT, 2019; Ministry of Electronics and Information Technology, 2015).

According to Chai, Koh, and Tsai (2013), ICT tools facilitate the design of curricula by enabling dynamic, interactive, and updated content delivery that is responsive to contemporary scientific advancements and student needs. The incorporation of digital resources, simulations, and interactive modules helps create a more engaging and comprehensive curriculum. This approach aligns with the needs of 21st-century learners, who require skills in digital literacy and problem-solving. Aside from this, ICT tools such as virtual labs, educational software, and online resources allow for experiential learning, which is critical in science education (Koehler and Mishra, 2009) to enhance the teaching-learning processes by promoting active learning and student engagement. For instance, virtual labs enable students to conduct experiments in a simulated environment, overcoming the limitations of physical labs (de Jong *et al.*, 2013). Additionally, the use of multimedia resources helps cater to different learning styles, making science education more inclusive and effective.

Additionally, formative and summative assessments in science education can be conducted more efficiently using digital tools (Gikandi, Morrow, & Davis, 2011), such as Online quizzes, e-portfolios, and learning management systems (LMS), which provide immediate feedback and analytics, helping educators track student progress and identify areas needing improvement. Furthermore, adaptive assessment technologies can tailor evaluations to individual student levels, offering a personalized learning experience (Shute and Rahimi, 2017). ICT also fosters research innovation in science education by providing tools for data collection, analysis, and dissemination.

ICT provides researchers with instant access to vast amounts of scholarly literature, databases, and research repositories, enabling comprehensive literature reviews and background research (Athanasiadis *et al.*, 2009).Technologies such as sensors, data analytics software, and simulation tools enable efficient data collection and analysis, enhancing the accuracy and depth of research findings (Lee, 2018). ICT also facilitates access to a vast array of online journals, databases, and research networks, which enhances the quality and reach of scientific research. ICT platforms like collaborative tools and virtual environments enable global research collaborations, fostering interdisciplinary approaches and knowledge exchange (Bozeman and Boardman, 2014).

ICT supports extension activities by enabling broader dissemination of scientific knowledge and community engagement. Online platforms and social media can be used to share research findings, provide educational resources, and conduct outreach programs (Anderson and Anderson, 2010). Additionally, webinars, online workshops, and digital newsletters help extend the impact of educational initiatives beyond traditional classroom

settings, reaching a global audience. A study by O'Dwyer, Carey, and Kleiman (2007) highlights the positive impact of ICT on student achievement in science. Furthermore, research by Hwang, Lai, and Wang (2015) suggests that mobile learning technologies enhance student engagement and learning outcomes in science education.

The National Assessment and Accreditation Council (NAAC) of India define the quality of science education through ICT by emphasizing its role in enhancing learning outcomes, accessibility, and pedagogical innovation. NAAC emphasise the integration of ICT tools such as simulations, virtual laboratories, and interactive multimedia resources to facilitate experiential learning and deeper conceptual understanding in science education. Furthermore, ICT enables real-time collaboration among students and researchers, promotes self-paced learning, and supports the development of critical thinking and problem-solving skills essential for contemporary scientific inquiry. NAAC's framework thus highlights ICT as a catalyst for fostering a dynamic and inclusive learning environment that prepares students to engage effectively with scientific challenges and advancements.

Furthermore, UNESCO has been at the forefront of promoting ICT in education, providing guidelines, frameworks, and support to member states to enhance their educational systems. The UNESCO ICT Competency Framework for Teachers (ICT-CFT) outlines the essential skills and knowledge teachers need to effectively integrate ICT into their teaching (UNESCO, 2023). This framework emphasizes the need for continuous professional development and the creation of supportive environments that encourage the use of technology in education. Furthermore, UNESCO also advocates for the use of Open Educational Resources (OER) to democratize access to high-quality educational materials. OER can play a significant role in supporting teachers, especially in resource-constrained settings, by providing freely accessible and adaptable learning resources (UNESCO, 2012).

In addition, the Horizon Report (2020) emphasizes the trends and difficulties in educational technology, forecasting a substantial increase in the implementation of ICT in higher education institutions. According to the report, technology breakthroughs such as artificial intelligence, virtual laboratories, and interactive simulations are identified as important factors that contribute to high-quality education (EDUCAUSE, 2020). These tools not only improve comprehension of intricate scientific subjects but also cultivate critical thinking and problem-solving abilities in students.

Several national policies and initiatives reflect India's commitment to integrating ICT in education. The NPE 2020, for instance, outlines a comprehensive strategy for digital transformation in education, including the development of virtual labs, online courses, and digital repositories (Ministry of Education, 2020). Additionally, the SWAYAM platform, an initiative under the NMEICT, offers online courses from premier institutions, making quality education accessible to all (SWAYAM, 2019). The government's focus on teacher training through programs like the DIKSHA platform, which provides digital infrastructure for teacher education, is crucial for building the necessary competencies among teachers to effectively use ICT in their teaching (Ministry of Education, 2017).

This study aims to investigate university science teachers' perception regarding the role of ICT in quality science teaching-learning. It seeks to contribute to the ongoing dialogue on enhancing scientific education quality through technological advancements, aligned with the objectives outlined in NEP 2020 and drawing insights from the Horizon Report.

Research Objectives:

1. To study the perception of teachers regarding the role of ICT in the curriculum planning and development of quality teaching-learning in undergraduate science programs
2. To study teachers' perception regarding the role of ICT in teaching-learning, and the evaluation processes of quality teaching-learning in undergraduate science programs
3. To study the teachers' perception of ICT in research, innovation, and extension activities and their role in quality science teaching-learning

METHODOLOGY

The study used a descriptive survey design. A total number of 12 university science teachers were selected on convenience basis from the Department of Biosciences, Biotechnology and Centre for Interdisciplinary Research in Basic Science teaching UG courses. A questionnaire was developed based on the objectives of the study. Each dimension comprised multiple items designed to study specific aspects of that

respective dimension. Likert scale type items were used to study participants' perception in three dimensions such as curriculum planning and development, teaching-learning and evaluation processes, research innovation and extension activities.

Data was collected through a structured questionnaire administered to participants through a Google Form. Following the collection phase, data was subjected to analysis as per objectives of the study. Percentages were utilized to analyse each dimension of the variables under this study.

RESULTS AND DISCUSSION

The findings have been reported as per the objectives of the study.

Objective 1: To study the perception of teachers regarding the role of ICT in the curriculum planning and development of quality teaching-learning in undergraduate science programs

The curricular aspect covers curriculum design and development, planning and implementation, academic flexibility, curriculum enrichment and feedback system. Curriculum design focuses on the creation of overall courses, blueprint of the courses, making content according to the learning objectives, and how to develop the course outline and build the courses (NAAC, 2020).

The aim of this dimension was to see the perceptions of teachers' regarding the role of ICT in curricular aspect in science education.

The Table 1 shows the perception of teachers regarding the role of ICT in the curricular aspect of quality teaching and learning of science at the UG level. It indicates a positive perception of teachers towards the curricular aspect of quality teaching and learning of science. Specifically, 66.7% of teachers reported mostly using ICT, while 33.3% reported always using it, resulting in a total of 100% of teachers using ICT for creating course content and syllabi for science. This finding is consistent with a study by Tondeur *et al.* (2017), which found that teachers' integration of ICT into their curriculum planning processes was significantly associated with improved instructional practices and student engagement. Furthermore, 75% of teachers perceived that they mostly use ICT, while 16.7% reported always using it. This shows that 92% of teachers employ ICT to develop an inclusive curriculum, whereas 83.33% incorporate it at least 50% of the sometime, and 33.3% always use ICT to access resources for science curriculum planning.The positive perception noted in the study aligns with findings by Ghavifekr and Rosdy (2015), who observed that teachers reported enhanced instructional quality and efficiency when incorporating ICT into their teaching strategies.

Additionally, 50% of teachers indicated that they mostly use ICT, whereas 25% reported that they always integrated ICT into teaching to simplify complex science content, which is consistent with the findings of Balanskat, Blamire, and Kefala (2006), who noted that ICT tools significantly aid in clarifying complex subject matter and engaging students more effectively. Two-third teachers use ICT to create blueprints (33.3% each as mostly and always) and reflect, revise, and update science curriculum, while 58.33% (41.7% mostly and 16.7% always) use ICT to create tailor-made science curriculum. Half of the teachers mostly use ICT to design flexible courses, integrate ICT into the curriculum to provide flexibility for students, and get feedback from stakeholders on the syllabus and its transactions. Approximately 50% of teachersuse ICT, with 33.3% mostly and 16.7% always integrating it to facilitate the inclusion of value-added courses. Likewise, 41.6% teachers use digital laboratories for web-based assessments in curriculum design and development. Literature supports these technologies for enhancing the assessment process and delivering prompt feedback, thereby enhancing the overall learning experience (Redecker and Johannessen, 2013).

One-third of the teachers (16.7%, both mostly and always) perceived integrated ICT into the curriculum to provide flexibility for students to switch to alternative modes of learning (33.33%), while one-fourth (25%) of the teachers of which of 16.7% mostly and 8.3% always integrated ICT into the science curriculum to create innovative courses such as certificate courses, diploma courses, etc. The findings also resonate with research by Domingo and Garganté (2016), who emphasized the role of ICT in curriculum flexibility and personalization. But 25% of teachers still do not incorporate ICT to create such innovative courses. A small portion of the teachers are not using digital labs (8.33%), web-based assessment (8.33%), or integrating ICT into the science curriculum to provide flexibility to complete courses similarly. 8.33% of teachers perceived that ICT did not assist in the inclusion of value-added courses in the science curriculum. This is consistent with findings from Buabeng-

Table 1: Perception of teachers' regarding role of ICT in curricular aspect

Statements	Never	Rarely	Sometimes	Mostly	Always
I utilise ICT to create blueprint for the science course I teach.	0.0%	0.0%	33.3%	33.3%	33.3%
I use ICT to reflect, revise, and update, including emerging issues in the science curriculum.	0.0%	0.0%	33.3%	33.3%	33.3%
I use the digital lab to create interactive and interesting learning experiences.	8.3%	0.0%	50.0%	33.3%	8.3%
I use web-based assessments for curriculum design and development.	8.3%	0.0%	50.0%	25.0%	16.7%
I use ICT to create tailor-made science curriculum that meets local and global needs	8.3%	0.0%	33.3%	41.7%	16.7%
I use ICT to access a variety of resources for the science curriculum planning process, such as online databases, textbook, and other digital resources.	0.0%	0.0%	16.7%	50.0%	33.3%
I use ICT for creating course content and syllabi that adhere to the institution's mission, goals, and objectives.	0.0%	0.0%	0.0%	66.7%	33.3%
I integrate ICT in science course to provide deeper understanding of complex scientific concepts.	0.0%	0.0%	25.0%	50.0%	25.0%
I use ICT to create a more inclusive and equitable science curriculum that empowers all students to reach their full potential.	0.0%	0.0%	8.3%	75.0%	16.7%
I use ICT to design flexible courses including different activities of science to accommodate different learning styles or approaches.	0.0%	0.0%	50.0%	50.0%	0.0%
I integrate ICT into the science curriculum, which provides flexibility for students to complete course at their own pace	0.0%	8.3%	41.7%	33.3%	16.7%
I integrate ICT in science curricula to give students the flexibility to switch to alternative modes of learning (offline, ODL, online learning, and hybrid learning modes).	0.0%	0.0%	66.7%	16.7%	16.7%
I incorporate ICT into science curriculum to create innovative courses (like certificate, diploma courses) that go beyond the prescribed syllabus	8.3%	16.7%	50.0%	16.7%	8.3%
ICT assists in the inclusion of value-added courses that significantly improve students' educational experiences and outcomes.	0.0%	8.3%	41.7%	33.3%	16.7%
I use ICT to get feedback from stakeholders on the syllabus and its transaction that helps meet the needs of society	0.0%	0.0%	50.0%	41.7%	8.3%

Andoh (2012), who identified barriers such as lack of training, resistance to change, and insufficient infrastructure as significant hurdles to the effective integration of ICT in education.

The results are very prominent and show a highly positive perception about the use of ICT in the curricular aspect of science, with using ICT to create course content and syllabi for science (100%), inclusive curriculum (92%.), accessing resources for science curriculum planning (83.33%), integrating ICT into teaching to simplify complex science content (75%), and using ICT to create a blueprint and reflect, revise, and update the science curriculum (66.66%). This indicates widespread adoption of technology that ensures accessibility and inclusivity in the science curriculum, leveraging digital tools and resources to enhance their curriculum planning process and make science more engaging for students.

The results also show that around half of teachers always use ICT to create tailor-made science curriculum, design flexible courses, use digital labs and web-based assessment, and perceive that ICT assists in the inclusion of value-added courses. This demonstrates personalized teaching and learning, flexibility that focuses on meeting the diverse needs of students and providing learning opportunities within the science curriculum. One fourth of the teachers still do not incorporate ICT to create such innovative courses, while a very small percentage of teachers (8.33%) show a negative perception, suggesting potential barriers that need to be addressed.

Overall, the data suggests a high level of adoption and positive perception of ICT among science teachers, with a focus on enhancing curriculum development, flexibility, inclusivity, and innovation. Hence, the teachers who are already using ICT in their capacity building program must undertake to ensure efficiency and effectiveness in the integration of ICT in the curricular aspect.

Objective 2: To study teachers' perception regarding the role of ICT in teaching-learning, and the evaluation processes of quality teaching-learning in undergraduate science programs

Teaching, learning, and evaluation cover student enrolment and profile, catering to student diversity, the teaching-learning process, teacher profile and quality, evaluation processes and reforms, student performance and learning outcomes, and the student satisfaction survey.Student Enrolment and Profile refers to the process of admitting students to the programmes through a transparent, well-administered mechanism complying with all the norms of the concerned regulatory or governing agencies, ensuring equity and wide access, and representing the student community from various geographical locations, socio economic and cultural backgrounds (NAAC, 2020).

The aim of this dimension was to see the perceptions of teachers' regarding the role of ICT in teaching-learning and evaluation in science education.

The above Table 2 shows the perception of teachers' regarding the role of ICT in teaching-learning, and evaluation in quality science teaching-learning at the undergraduate level. A significant majority of teachers (91.67%), comprising 41.70% who mostly use it and 50.00% who always rely on it, assert that ICT is pivotal in ensuring transparency during examinations and in the publication of results. This finding corresponds with research conducted by Jimoyiannis and Komis (2007).Three quarter (75%) ofteachers acknowledge the importance of ICT in maintaining student data, which is corroborated by research indicating that ICT tools facilitate efficient student record management and data analytics (Mwalongo, 2011). Most of the teachers (91.67%) using ICT to enhance their teaching abilities is consistent with findings by Chai, Koh, and Tsai (2010), who found that teachers perceive ICT as a vital component in improving instructional methods and pedagogical outcomes. The significant 83.40% of which mostly (16.70%) and always (67.70%) for staying updated with science developments, and 83.30% of which of mostly (50.00%) and always (33.30%) for meeting diverse student learning needs. This emphasis ICT's pivotal role in education, reflecting its critical function in continuous learning and knowledge dissemination in science, as well as its effectiveness in addressing varied student requirements, thereby promoting inclusive educational practices. This supports the findings of Bingimlas (2009), who highlighted the role of ICT in providing diverse and accessible educational resources. More than half (66.7%) of the teachers, including mostly 41.70% and always 25.00%, use digital resources to make learning more personalized and dynamic, which parallels the conclusions of Voogt and Knezek (2008), who emphasized the potential of ICT to tailor educational experiences to individual student needs. 58.33% of teachers employ ICT tools for blended and flipped learning approaches, reflecting the adoption of modern teaching methods that combine online and face-to-face instruction to enhance the learning experience, in line with the work

Table 2 : Perception of teachers' regarding role of ICT in Teaching Learning and Evaluation

Statements	Never	Rarely	Sometimes	Mostly	Always
ICT plays a significant role in ensuring transparency in the student admissions process for UG science courses.	0.0%	0.0%	8.3%	41.7%	50.0%
ICT helps to meet the requirements of students from a variety of backgrounds by addressing their learning needs	0.0%	0.0%	16.7%	50.0%	33.3%
ICT helps to maintain the data, which provide information about Diversity (Sex Ratio, Region, Age etc.) of students so as to design teaching – learning process.	0.0%	0.0%	25.0%	33.3%	41.7%
I use ICT in internal assessments to determine the learning levels of students with special needs	0.0%	8.3%	58.3%	25.0%	8.3%
I use ICT for designing learner's centred education using participative, experiential, and collaborative learning appropriate methodologies to facilitate effective learning	0.0%	0.0%	50.0%	41.7%	8.3%
I use digital resources to make learning more individualize, creative and dynamic.	0.0%	0.0%	33.3%	41.7%	25.0%
I use ICT-enabled tools such as Google Classroom and e-content science study material for an effective teaching-learning process	0.0%	0.0%	41.7%	33.3%	25.0%
I use ICT in blended learning and flipped learning for enriching the teaching-learning experience.	0.0%	0.0%	41.7%	58.3%	0.0%
I use ICT to stay updated with the latest developments in the field of science	0.0%	0.0%	16.7%	16.7%	66.7%

of O'Flaherty and Phillips (2015), which illustrated the effectiveness of these modern teaching methodologies in enhancing student engagement and learning outcomes. Half of the teachers (50%), including 41.70% mostly and 8.30% always, use ICT to design learner-centered education. One third (33.33%) of the teachers use ICT exclusively for the internal assessment of students with special needs, but a small percentage (8.33%) of teachers do not use ICT to assess students with special needs. This observation is consistent with the findings of Florian and Hegarty (2004), who pointed out the challenges and barriers in implementing ICT for inclusive education.

The data highlights the widespread adoption and positive perception of ICT by teachers in various aspects of teaching, learning, and evaluation in undergraduate-level science education. Teachers recognize the benefits of ICT in ensuring transparency and efficiency, improving their teaching abilities, meeting student needs, and enhancing individualized and dynamic learning experiences. However, the use of ICT for assessing students with special needs still requires further attention and improvement, as a significant proportion of teachers are not utilizing ICT for the same (8.33%). This suggests the need for targeted interventions, such as training and resource allocation, to support the integration of ICT in inclusive educational practices. Overall, the results demonstrate the significant role of ICT in the quality of teaching, learning, and evaluation in undergraduate science education, as perceived by the teachers. The result is very prominent and shows a highly positive perception of teachers regarding the role of ICT in teaching-learning, and evaluation in quality science education.

Objective 3: To study the teachers' perception of ICT in research, innovation, and extension activities and their role in quality science teaching-learning

Research, Innovations and Extension involves, Promotion of Research and Facilities, Resource Mobilization for Research, Innovation Ecosystem, Research Publications and Awards Consultancy, Extension Activities, Collaboration to promote the culture of research (NAAC, 2020).

The aim of this dimension was to see the perceptions of teachers' regarding the role of ICT in teaching-learning and evaluation in science education.

Table 3 shows the perception of teachers' regarding the role of ICT in research, innovation, and extension in quality teaching-learning of science at the undergraduate (UG) level. 75% of teachers always use ICT to access online research databases, journals, and repositories, while an additional 25% mostly rely on ICT for these purposes. Regarding research outputs, 66.7% of teachers always use ICT, while the remaining 33.3% mostlyuse ICT for this task.According to Dadzie (2005), the accessibility of online databases significantly enhances the research capabilities of educators by providing timely and extensive access to scholarly materials. The majority of teachers use ICT to enhance scientific research and innovation, to disseminate research findings through ICT channels like online conferences, webinars, and open-access

Table 3: Perception of teachers' regarding role of ICT in Research, Innovation and Extension

Statements	Never	Rarely	Sometimes	Mostly	Always
I use ICT to avail funding and resources provided by my university for science research projects	16.7%	0.0%	16.7%	25.0%	41.7%
I use ICT to access a wide range of online research databases, journals, and repositories for science projects	0.0%	0.0%	0.0%	25.0%	75.0%
I use ICT infrastructure provided by my university to aid students in data analysis, simulations, and modelling, enhancing science project outcomes.	0.0%	8.3%	0.0%	25.0%	66.7%
I disseminate of research findings through ICT channels such as online conferences, webinars, and open-access repositories	0.0%	0.0%	8.3%	33.3%	58.3%
I use ICT to enhance scientific research and innovations	0.0%	8.3%	0.0%	33.3%	58.3%
I use ICT to enhance the learning experience and foster innovation among UG level science students.	0.0%	0.0%	25.0%	50.0%	25.0%
I use ICT for getting research outputs such as inventions and discoveries.	0.0%	0.0%	16.7%	41.7%	41.7%
I use ICT for getting research outputs such as number of research publications.	0.0%	0.0%	0.0%	33.3%	66.7%
I use ICT to explore consultancy opportunities from other institutions	8.3%	16.7%	33.3%	8.3%	33.3%
I use ICT in extension activities to enhance students' educational experience by leveraging technology to connect their learning with real-world contexts.	0.0%	0.0%	33.3%	50.0%	16.7%

repositories (91.67%), aligning with the findings of Nicholas and Rowlands (2011). They noted that digital tools and platforms, such as online conferences and webinars, play a crucial role in broadening the reach of scientific communication and fostering collaborative research efforts. Similarly, teachers with 25% mostly and 66.7% always use ICT for data analysis, simulations, and modeling, while 33.3% mostly and 58.3% always disseminate research findings through online channels like conferences and open-access repositories. Moreover, 33.3% mostly and 58.3% always sum up to 91.6% of teachers using ICT to advance scientific research and innovation, underscoring its pivotal role in fostering academic excellence and innovation. This is consistent with the study by Cox and Marshall (2007) which highlighted the importance of ICT tools in enhancing the quality and efficiency of scientific research, particularly in data-intensive disciplines. 83.4% of teachers, of which 41.7% mostly and 41.7% always, use ICT for acquiring research outcomes like inventions and discoveries. Three-quarters (75%) of the teachers, of which 50.00% mostly and 25.00% always, use ICT to enrich the learning experience and promote innovation among undergraduate science students, supported by the study of Mishra and Koehler (2006) who found that ICT integration in education fosters creativity and innovation, enabling students and teachers to explore new ideas and approaches in scientific research. More than half of the teachers utilize ICT to access funding and resources offered by the university for science research projects and in extension activities to enrich students' learning experiences by connecting their education with real-world contexts through technology (66.67%), echoing the findings of Conole and Alevizou (2010) who demonstrated that ICT facilitates access to various funding opportunities and resources, thereby enriching the learning experience and promoting applied research. Teachers with 8.3% mostly and 33.3% always use ICT to explore consultancy opportunities from other institutions, but one-fourth of the teachers still do not use ICT for the same (25%). A small portion of the teachers do not use ICT to avail funding and resources (16.67%), to aid students in data analysis, simulations, and modeling, enhancing science project outcomes (8.33%) provided by the university, and to enhance scientific research and innovation (8.33%). This is consistent with findings by Ertmer (1999), who identified barriers to ICT adoption, such as lack of confidence, insufficient training, and inadequate support.

The data highlights a positive perception of teachers towards the role of ICT in various facets of teaching, research, and extension activities among undergraduate science teachers. However, a small portion of the teachers still not using ICT in funding, simulation, modeling, etc., which needs to be considered. By suggesting promoting technological awareness among teachers and providing opportunities, we can improve the integration of technology into science education and research, maximizing the benefits for all stakeholders.

Conclusion:

Teachers overwhelmingly perceive ICT as beneficial for enhancing the quality of science teaching-learningat the undergraduate level. This includes using ICT for creating course content, designing inclusive and flexible curricula, and simplifying complex science topics.The majority of teachers integrate ICT into various aspects of teaching-learning, and evaluation, indicating a widespread adoption of digital tools to improve instructional practices and student engagement.

ICT is perceived crucial for transparency in examinations and result publication.It facilitates personalized and dynamic learning experiences, supports blended learning approaches, and helps in meeting diverse student needs effectively.Despite these benefits, there are challenges in using ICT for assessing students with special needs, suggesting areas for improvement and targeted interventions.

Teachers heavily rely on ICT for accessing online research databases, conducting data analysis, simulations, and modeling, and disseminating research findings.ICT plays a pivotal role in advancing scientific research, innovation, and collaboration through digital platforms like online conferences and open-access repositories. Facilitating collaborations between industries and academia to enhance research innovation.There is also significant usage of ICT for acquiring research outcomes, promoting innovation among students, and accessing funding opportunities for science projects.

The study highlights a robust positive perception among teachers regarding the role of ICT in enhancing the quality of science education at the undergraduate level.ICT is widely recognized for its role in improving instructional methods, making curriculum design more inclusive and flexible, and facilitating personalized learning experiences tailored to diverse student needs.ICT tools significantly contribute to advancing scientific research,

fostering innovation, and promoting collaborative efforts both within and beyond educational institutions. Some teachers still do not fully utilize ICT for innovative course creation, accessing consultancy opportunities, and enhancing science project outcomes.Barriers such as lack of training, resistance to change, and inadequate infrastructure continue to hinder the effective integration of ICT in science teaching-learning.Addressing these barriers is crucial for maximizing the potential of ICT in science teaching-learning.The integration of ICT in science teaching-learning is beneficial to society by improving educational quality, fostering transparency in assessments, and accelerating scientific research and innovation. It also enhances learning experiences, prepares students for future careers, and promotes technological advancements that address societal challenges and drive economic growth.

REFERENCES

Anderson, R. E. and Anderson, L. S. (2010). Online professional development for teachers: Emerging models and methods. Harvard Education Press.

Athanasiadis, I. N., Rizzoli, A. E., Mitkas, P. A. and Gómez, J. M. (2009). Information Technologies in environmental engineering. In *Environmental science and engineering*. https://doi.org/10.1007/978-3-540-88351-7

Balanskat, A., Blamire, R. and Kefala, S. (2006). The ICT Role Report: A review of studies of ICT role on schools in Europe. European Schoolnet.

Bingimlas, K. A. (2009). Barriers to the successful integration of ICT in teaching and learning environments: A review of the literature. *Eurasia J. Mathematics, Sci. & Technol. Educ.,* **5**(3) : 235-245.

Bozeman, B. and Boardman, C. (2014). Research collaboration and team science: A state-of-the-art review and agenda. *Research Policy,* **43**(4) : 749-763. doi:10.1016/j.respol.2014.01.014

Buabeng-Andoh, C. (2012). Factors influencing teachers' adoption and integration of information and communication technology into teaching: A review of the literature. *Internat. J. Education & Development using Information & Communication Technol. (IJEDICT)*, **8**(1) : 136-155.

Chai, C.S., Koh, J.H.L. and Tsai, C.C. (2010). Facilitating preservice teachers' development of technological, pedagogical, and content knowledge (TPACK). *Educational Technol. & Society,* **13**(4) : 63-73.

Conole, G. and Alevizou, P. (2010). A literature review of the use of Web 2.0 tools in higher education. *Higher Education Academy*.

Cox, M. and Marshall, G. (2007). Effects of ICT: Do we know what we should know? *Education & Information Technologies,* **12**(2) : 59-70.

Dadzie, P. S. (2005). Electronic resources: access and usage at Ashesi University College. *Campus-Wide Information Systems,* **22**(5) : 290-297.

de Jong, T., Linn, M. C. and Zacharia, Z. C. (2013). Physical and virtual laboratories in science and engineering education. *Science,* **340**(6130) : 305-308.

Domingo, M.G. and Garganté, A. B. (2016). Exploring the use of educational technology in primary education: Teachers' perception of mobile technology learning roles and applications' use in the classroom. *Computers in Human Behavior,* **56** : 21-28.

EDUCAUSE. (2020). *2020 EDUCAUSE Horizon Report: Teaching and Learning Edition*. EDUCAUSE. Retrieved from https://library.educause.edu/resources/2020/3/2020-horizon-report-teaching-and-learning-edition

Ertmer, P. A. (1999). Addressing first- and second-order barriers to change: Strategies for technology integration. *Educational Technol. Res. & Development*, **47**(4) : 47-61.

Florian, L. and Hegarty, J. (2004). ICT and Special Educational Needs: A Tool for Inclusion. *McGraw-Hill Education (UK)*.

Ghavifekr, S. and Rosdy, W. A. W. (2015). Teaching and learning with technology: Effectiveness of ICT integration in schools. *Internat. J. Res. Education & Sci.,* **1**(2) : 175-191.

Gikandi, J.W., Morrow, D. and Davis, N.E. (2011). Online formative assessment in higher education: A review of the literature. *Computers & Education*, **57**(4) : 2333-2351.

Hew, K.F. and Brush, T. (2007). Integrating technology into K-12 teaching and learning: Current knowledge gaps and recommendations for future research. *Educational Technology Res. & Development*, **55** : 223-252.

Hwang, G.J., Lai, C.L. and Wang, S.Y. (2015). Seamless flipped learning: A mobile technology-enhanced flipped classroom with effective learning strategies. *J. Computers in Education*, **2** : 449-473.

Jimoyiannis, A. and Komis, V. (2007). Examining teachers' beliefs about ICT in education: Implications of a teacher preparation programme. *Teacher Development,* **11**(2) : 149-173.

Koehler, M. J. and Mishra, P. (2009). What is technological pedagogical content knowledge (TPACK)? *Contemporary Issues in Technology and Teacher Education*, **9**(1) : 60-70.

Lee, I. (2018). Big data and AI strategies: Machine learning and alternative data approach to investing. Palgrave Macmillan.

Ministry of Education. (2017). *DIKSHA*: National Teacher Platform. Retrieved from https://ciet.ncert.gov.in/initiative/diksha

Ministry of Education (2020). *National Policy on Education 2020*. Retrieved from https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf

Ministry of Electronics and Information Technology (2015). *Digital India*. Retrieved from https://www.meity.gov.in/sites/upload_files/dit/files/Digital%20India.pdf

Mishra, P. and Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A framework for teacher knowledge. *Teachers College Record,* **108**(6) : 1017-1054.

Mwalongo, A. (2011). Teachers' perception about ICT for teaching, professional development, administration, and personal use. *Internat. J. Education & Development using ICT,* **7**(3) : 36-49.

National Mission on Education through ICT (NMEICT). (2019). Retrieved from https://www.education.gov.in/technology-enabled-learning-0

Nicholas, D. and Rowlands, I. (2011). Social media use in the research workflow. *Information Services & Use,* **31**(1-2) : 61-83.

O'Dwyer, L.M., Carey, R. and Kleiman, G. (2007). A study of the effectiveness of the Louisiana Algebra I Online Course. *J. Res. Technol. Education*, **39**(3) : 289-306.

OECD (2015). *Students, Computers and Learning: Making the Connection.* PISA, OECD Publishing. https://doi.org/10.1787/9789264239555-en.

O'Flaherty, J. and Phillips, C. (2015). The use of flipped classrooms in higher education: A scoping review. *The Internet. & Higher Education,* **25** : 85-95.

Redecker, C. and Johannessen, O. (2013). Changing assessment—Towards a new assessment paradigm using ICT. *European J. Education,* **48**(1) : 79-96.

Shute, V. J. and Rahimi, S. (2017). Review of computer-based assessment for learning in primary and secondary education. *J. Computer Assisted Learning*, **33**(1) : 1-19.

SWAYAM. (2019). Retrieved from https://swayam.gov.in

Tondeur, J., van Braak, J., Ertmer, P. A. and Ottenbreit-Leftwich, A. (2017). Understanding the relationship between teachers' pedagogical beliefs and technology use in education: a systematic review of qualitative evidence. *Educational Technology Research & Development*, **65**(3) : 555-575. http://dx.doi.org/10.1007/s11423-016-9481-2

UNESCO (2012). *2012 Paris OER Declaration*. Retrieved from https://unesdoc.unesco.org/ark:/48223/pf0000246687

UNESCO (2015). Information and Communication Technology (ICT) in Education in Sub-Saharan Africa: A comparative analysis of basic e-readiness in schools. UNESCO Institute for Statistics.

UNESCO (2023). *UNESCO ICT Competency Framework for Teachers*. Retrieved from https://www.unesco.org/en/digital-competencies-skills/ict-cft

Voogt, J. and Knezek, G. (2008). International handbook of information technology in primary and secondary education. *Springer Science & Business Media*.

****