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Perceptions of Undergraduate Science Students: A study on Role of ICT in Quality Science Teaching-Learning

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ABSTRACT

This study examines undergraduate science students perceive the impact of Information and Communication Technology (ICT) on improving science education. It focuses on three key aspects: curriculum design and development, the teaching and learning process, and research innovation and extension activities. The study explores the integration and impact of ICT on these educational aspects. A descriptive survey design was employed, collecting data from 40 B.Sc. students at Jamia Millia Islamia through a structured questionnaire. The findings reveal that while ICT is widely recognized for its potential to enhance content delivery and align with learning objectives, there are areas, such as personalized learning and the use of digital labs, where its integration remains inconsistent. The study also highlights the importance of ICT in fostering transparency, equity, and collaborative learning. However, the varying levels of student engagement indicate a need for improved access, awareness, and training to fully optimize ICT's benefits in science education in connecting theoretical knowledge with real-world applications. The findings have implications for teachers, policymakers, and researchers seeking to use the potential of ICT in science education.

Keywords: *ICT, Science Education, Educational Technology*

Introduction

The quality of education, particularly in science at the undergraduate level, has been a critical area of focus for teachers, policymakers, and researchers alike. In the rapidly evolving global landscape, the demands on higher education institutions to produce graduates who are not only knowledgeable in their fields but also equipped with critical thinking, problem-solving, and research skills have significantly increased (Aithal, 2020). The teaching-learning process is the fundamental element of the various aspect such as curriculum design, teaching methodologies, evaluation processes, and the inclusion of research and innovation in science education.

The curriculum is often viewed as the backbone of the educational process, shaping the direction and depth of learning that students experience (Ramsden, 2003). The curriculum must not only cover the essential knowledge base of the discipline but also foster critical thinking, practical application, and a spirit of inquiry (Biggs & Tang, 2011). The curriculum's capacity to evolve in response to emerging scientific discoveries, technological innovations, and societal demands is essential for equipping students to navigate the complexities of the contemporary world (Knight, 2007). However, despite its importance, the effectiveness of the curriculum is ultimately determined by the perceptions of the students who engage with it (Harden, 2001).

Teaching and learning are interconnected processes that involve much more than simply transferring knowledge from teacher to student. They also encompass the development of abilities required for scientific inquiry and experimentation (Trigwell & Prosser, 1991). Science education should employ pedagogical methods that encourage active learning, thereby engaging students more fully in the learning process instead of merely receiving information passively (Prince, 2004). This can be achieved through various pedagogical approaches, including problem-based learning, collaborative projects, and the use of technology to enhance understanding (Felder & Brent, 2009). Furthermore, assessment techniques are of utmost importance in evaluating students'

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learning achievements in term of critical analysis, synthesis, and application of knowledge and providing guidance for future teaching. (Boud & Falchikov, 2007).

Research and innovation are also essential components of science education that not only advance the frontiers of knowledge but also enhance students' learning experiences. Engaging students in research activities at the UG level helps to develop their analytical skills, creativity, and ability to solve complex problems (Brew, 2006). It also enhances students' grasp of scientific concepts and methodologies, making their learning experience more significant and applicable (Healey & Jenkins, 2009). Additionally, integrating research with teaching can cultivate a culture of innovation, encouraging students to engage in critical thinking and explore novel ideas (Boyer, 1990). Extension activities, which apply scientific knowledge to real-world problems, are crucial for linking classroom education with societal needs (Mulder, 2015). These activities not only benefit the society but also enrich students' educational experiences, making them more well-rounded and socially responsible individuals.

Students' perception is crucial for teachers and institutions aiming to synchronize educational methods with the needs and expectations of students. According to Marsh and Dunkin (1992), students' feedback is an important tool for evaluating if existing educational techniques are meeting their changing requirements. This study investigated undergraduate science students' perceptions of Information and Communication Technology (ICT) enhances the quality of science education. It investigates three key areas of educational experience: curricular design, teaching and learning processes, and research, innovation, and extension activities. The research aims to assess how effectively ICT is integrated into science curricula, its impact on teaching methods and assessment practices, and its role in fostering research and innovation. The study underscores the significance of incorporating technology into science education to foster a dynamic learning environment that supports inquiry and stays current with field advancements.

Research Methodology

The study used a descriptive survey design. A total number of forty university students who pursuing B.Sc. were selected on convenience basis from the Jamia Millia Islamia. A questionnaire was developed based on the objective of study. Each dimension comprised multiple items designed to study specific aspects of that respective dimension. Likert scale type items were used to study students' 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 subjugated to analysis as per objectives of the study. Percentages were utilized to analyse each dimension of the variables under this study.

Analysis and Interpretations

This section of the study deals with the analysis and interpretations based on the objective of the study.

The majority of students (52.5%) reported that they mostly utilize ICT to cover the course content taught by their teachers, with 20% always using ICT for this purpose (Table 1). This high level of ICT engagement is consistent with other studies that emphasize the importance of ICT in enhancing content delivery and understanding in science education (Adegoke, 2011). ICT tools such as digital textbooks, online resources, and educational platforms allow students to access up-to-date information and supplement their learning, which is increasingly recognized as essential in modern education (Becta, 2004). A significant proportion of students (55%) mostly use ICT to align the content taught with learning objectives, while 22.5% always do so. This suggests that students acknowledge the contribution of ICT in reaching their educational objectives. Research by Voogt et al. (2013) supports this, showing that ICT can effectively connect teaching and learning goals, equipping students with tools that enhance their comprehension of the subject matter.

A notable 40% of students always use ICT to stay updated with evolving concepts in science, and 35% mostly do so. This highlights the dynamic nature of science education, where new discoveries and advancements are continuously integrated into the curriculum. Research by Kozma (2003) supports the idea that ICT plays a crucial role in helping students keep pace with these changes, ensuring that their knowledge remains current and relevant. The use of ICT in digital labs for interactive learning experiences shows a varied response, with only 17.5% of students always engaging in this activity, and a significant 25% doing so sometimes. The lower engagement levels might suggest challenges such as limited access to digital labs or inadequate integration of ICT into practical learning environments. This is in line with findings by Hennessy, Ruthven, and Brindley (2005), who reported that while ICT has the potential to enhance interactive learning, its effectiveness is often hindered by infrastructural and pedagogical limitations.

When it comes to using ICT for personalized learning and accommodating diverse learning styles, the data shows a moderate level of engagement. While 35% mostly use ICT for a personalized curriculum, 40% only do so sometimes. This suggests that while institutions are making strides in integrating ICT for personalized learning, there is still room for improvement. A study by Means et al. (2010) emphasise the importance of personalized learning environments, facilitated by ICT, in improving student outcomes and engagement. The responses indicate that 37.5% of students mostly agree that their institution provides flexibility through ICT integration, while 32.5% sometimes feel this way. The relatively balanced responses suggest that while institutions are working towards offering flexible learning options through ICT, the implementation may not be consistent across all programs or courses. This aligns with research by Garrison and Kanuka (2004), which suggests that while blended learning and ICT integration can offer flexibility, their effectiveness depends on careful planning and execution.

The integration of ICT into supplementary enrichment programs for the Choice-Based Credit System (CBCS) shows moderate engagement, with 32.5% of students mostly agreeing and 27.5% sometimes agreeing. This reflects a growing trend in higher education to use ICT for enhancing students' learning experiences beyond the traditional curriculum. Studies by Mishra and Koehler (2006) highlight the potential of ICT in supporting diverse and enriched learning experiences, particularly in flexible credit systems like CBCS. Interestingly, a significant portion of students (50%) mostly use ICT to sensitize themselves about professional ethics, which is critical in science education. This high level of engagement is supported by research suggesting that ICT can play a vital role in imparting ethical knowledge and fostering professional integrity (Selwyn, 2007). However, the use of ICT for feedback, both from teachers (27.5%) and to address societal needs (22.5%), shows lower engagement levels. This could indicate a gap in the feedback mechanisms or a lack of emphasis on ICT-mediated feedback processes, which other studies have also identified as an area needing improvement (Nicol & Macfarlane-Dick, 2006).

A significant proportion of students (47.5%) always believe that ICT plays a crucial role in ensuring transparency in the admissions process for undergraduate science courses, with 32.5% mostly agreeing (Table 2). This suggests that ICT systems such as online application portals, digital documentation, and automated selection processes are perceived as effective in making admissions more transparent and fair. Studies by Gulati (2008) and Karmakar et al. (2014) support this finding, emphasizing that ICT in admissions processes reduces the potential for bias and errors, thereby enhancing trust in institutional processes. Similarly, 42.5% of students always believe that ICT helps in implementing an admission process that promotes equity and wider access, while 37.5% mostly agree. The role of ICT in broadening access to education, particularly through online application systems and virtual counseling, is well-documented in the literature (Siddiqui, 2008). ICT enables a more inclusive admissions process by reaching a diverse range of applicants, including those from remote or underprivileged backgrounds.

The use of ICT for participating in experiential and collaborative learning is reported by 25% of students as an 'always' activity, with 30% mostly engaging in it. However, a significant 35% use ICT for this purpose only sometimes. This variability suggests that while students recognize the value of ICT in facilitating collaborative and experiential learning, its integration may not be consistent across all courses or learning activities. Research by Johnson et al. (2015) highlights the potential of ICT in supporting collaborative learning through tools like online discussion forums, virtual labs, and project management software, but also notes that effective implementation is key to maximizing its benefits. A notable 40% of students always use digital resources to make learning more individualized, creative, and dynamic, with another 35% mostly doing so. This reflects a strong recognition of ICT's ability to tailor learning experiences to individual needs, fostering creativity and engagement. Studies by Ng (2012) and Redecker (2017) have similarly found that ICT enables more personalized learning paths, allowing students to explore content in ways that best suit their learning styles and interests.

When it comes to accessing Learning Management Systems (LMSs) and other e-resources provided by the institution, only 15% of students always do so, while 35% mostly use these resources. Another 35% use them sometimes, and 10% rarely engage with these systems. This suggests that while LMSs and e-resources are available, their utilization might be hindered by factors such as lack of awareness, user-friendliness, or the perceived relevance of the materials provided. Research by Mtebe and Raisamo (2014) indicates that the effectiveness of LMSs depends heavily on their ease of use, the quality of content in course materials. The data shows that 45% of students mostly use ICT in blended learning and flipped learning models employed by their teachers, with only 15% always doing so. However, the moderate level of consistent engagement (32.5% sometimes) suggests that these methods are still emerging in practice and might not yet be fully integrated into all science courses.

Finally, 37.5% of students always use ICT to make notes and organize content taught by their science teachers, with 35% mostly doing so. This indicates a strong reliance on digital tools for managing academic work, which aligns with studies by Kay and Lauricella (2011) that suggest students find digital note-taking and content organization more efficient and flexible compared to traditional methods.

A significant portion of students (37.5%) reported that their teachers mostly use ICT to stay updated with the latest developments in the field of science, while 35% indicated that teachers always use ICT for this purpose (Table 3). This suggests a strong commitment among educators to leveraging ICT for professional development and staying informed about new scientific advancements. Research by Buabeng-Andoh (2012) supports this finding, emphasizing that teachers' use of ICT is crucial for accessing up-to-date scientific information, which can then be integrated into their teaching practices to provide students with current and relevant knowledge.

When it comes to the dissemination of research findings, the responses are more varied. Only 25% of students always use ICT channels such as online conferences, webinars, and open-access repositories for this purpose, with 27.5% mostly doing so. Interestingly, 22.5% of students use ICT for research dissemination sometimes, and another 22.5% do so rarely. This distribution suggests that while some students are actively engaged in sharing their research outputs through digital means, others may face barriers such as lack of access, technical challenges, or limited awareness of these platforms. A study by Subramanian et al. (2013) highlights the potential of ICT in democratizing research dissemination, but also notes that its effectiveness depends on the availability of infrastructure and training.

Regarding the use of ICT for accessing research outputs, such as the number of research publications, 32.5% of students mostly use ICT for this purpose, while 27.5% always do. A significant proportion, 30%, sometimes use ICT to access research outputs, indicating moderate engagement with these tools. This suggests that while ICT is recognized as a valuable resource for accessing scientific literature and tracking research productivity, students' engagement varies. This finding is consistent with research by Tenopir et al. (2003), which found that while digital libraries and online databases have made research outputs more accessible, students' usage patterns are influenced by factors such as ease of access, search skills, and perceived relevance of the materials.

In terms of utilizing ICT-supported sustainable practices in science to improve extension performance and outcomes, benefiting the university, 30% of students mostly engage in such practices, with 25% always doing so. However, 35% of students only sometimes engage in these practices, and smaller percentages engage rarely or never. This suggests a moderate level of awareness and application of ICT in promoting sustainable practices within the context of science education. The variability in responses could reflect differences in the emphasis placed on sustainability within different courses or the availability of ICT tools that support these practices. Studies by Thorne and Ralston (2017) have highlighted the importance of integrating ICT into sustainability education, noting that digital tools can play a significant role in promoting environmental awareness and supporting sustainable practices within academic institutions.

The use of ICT in extension activities to enhance educational experiences by connecting learning with real-world contexts is highly recognized among students. A substantial 47.5% of students mostly use ICT for this purpose, and 20% always do so. This indicates a strong engagement with ICT as a tool for bridging theoretical knowledge and practical application. Extension activities, which often involve applying scientific knowledge to address real-world challenges, benefit significantly from ICT's ability to provide relevant data, simulations, and communication tools that facilitate learning beyond the classroom. This aligns with research by Karamti (2016), which emphasizes that ICT integration in extension activities not only enriches students' educational experiences but also prepares them to apply their knowledge in practical, real-world scenarios.

Conclusions

This study examines undergraduate science students' perceptions regarding the integration of ICT in their educational experience. The findings emphasize the significant contributions of ICT to various aspects of the science teaching-learning process, including curriculum development, pedagogical approaches, assessment methods, and research endeavours. While students acknowledge the benefits of ICT in covering course content and enhancing curriculum aspects, areas for improvement were identified in personalized learning and interactive digital labs. Institutions should focus on refining access to and implementation of digital tools to maximize ICT's potential in science education. The study highlights ICT's role in promoting transparency in equity, and individualized and collaborative learning experiences. Despite variations in use of blended learning models and LMS, the general positive perception highlights the potential of ICT to enrich educational experiences. Improving awareness and providing training on the efficiently use of technology in science education can significantly enhance its impact on teaching-learning. In the realm of research, innovation, and extension, students perceive ICT as a valuable tool for staying updated with scientific developments and supporting sustainable practices. However, there is potential for improvement in expanding access to digital dissemination platforms and promoting sustainable ICT practices.

Declaration of interest statement
Authors have no competing interest to declare.

Ethics statement: N. A.

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Table 1: ***Perception of Students' regarding curricular aspect in quality teaching-learning of science at UG level***

Statements	Always	Mostly	Sometimes	Rarely	Never
I utilise ICT to cover course content of science taught by our teachers.	20.00%	52.50%	20.00%	5.00%	0.00%
ICT helps me to match content taught by our teacher with learning objectives.	22.50%	55.00%	17.50%	2.50%	0.00%
I utilize ICT to analyze, modify, and stay up-to-date with the ever-evolving concepts in science given in the curriculum.	40.00%	35.00%	22.50%	2.50%	0.00%
I use the digital lab for interactive and interesting learning experiences.	17.50%	17.50%	25.00%	22.50%	10.00%
I use ICT to engage with personalized science curriculum that meets local and global needs.	12.50%	35.00%	40.00%	10.00%	0.00%
My institution provides me flexibility to choose different courses including different activities to accommodate my learning style by integration of ICT in science	20.00%	37.50%	32.50%	10.00%	0.00%
My institution integrated ICT in science curricula to give me the flexibility to switch to alternative modes of learning (offline, ODL, online learning, and hybrid learning modes).	17.50%	32.50%	30.00%	12.50%	2.50%
My institute has incorporated ICT into supplementary enrichment programs for the Choice-Based Credit System.	27.50%	32.50%	27.50%	10.00%	0.00%
I utilise ICT to complete innovative courses (like certificate, diploma courses) that go beyond the prescribed syllabus.	17.50%	25.00%	35.00%	10.00%	10.00%

ICT assists in the inclusion of value-added courses that significantly improve my educational experiences and outcomes.	17.50%	40.00%	35.00%	2.50%	2.50%
I use ICT to sensitize me about professional ethics.	15.00%	50.00%	25.00%	7.50%	0.00%
I use ICT to cover wide range of courses that help me to choose according to my interests and inclination.	27.50%	47.50%	15.00%	7.50%	0.00%
I use ICT that help to foster my excellence in all aspects, contributing to the overall development	25.00%	47.50%	20.00%	5.00%	0.00%
I use ICT to get feedback on my performance from my teacher	7.50%	27.50%	25.00%	17.50%	17.50%
I use ICT to give feedback to address the needs of society and use the input for revision and redesign of curricula.	10.00%	22.50%	37.50%	15.00%	10.00%

Table 2: ***Perception of Students' regarding Teaching Learning & Evaluation in quality teaching-learning of science at UG level***

Statements	Always	Mostly	Sometimes	Rarely	Never
ICT plays a significant role in ensuring transparency in the admissions process for UG science courses	47.50%	32.50%	17.50%	0.00%	0.00%
ICT helps implement the admission process to increase equity and wider access.	42.50%	37.50%	17.50%	0.00%	0.00%
I use ICT to participate in experiential and collaborative learning to facilitate effective learning.	25.00%	30.00%	35.00%	5.00%	0.00%
I use digital resources to make learning more individualized, creative, and dynamic	40.00%	35.00%	15.00%	7.50%	0.00%
I use ICT to access Learning Management Systems (LMSs) and other e-resource in teaching learning process provided by the institution	15.00%	35.00%	35.00%	10.00%	2.50%
I use ICT in blended learning and flipped learning used by our teacher to enrich the teaching-learning experience.	15.00%	45.00%	32.50%	5.00%	0.00%
I use ICT to develop make notes, organises content, taught by our science teacher	37.50%	35.00%	22.50%	2.50%	0.00%

Table 3: ***Perception of students' regarding Research, Innovation and Extension in quality teaching-learning of science at UG level***

Statements	Always	Mostly	Sometimes	Rarely	Never
Our teachers utilise ICT to stay updated with the latest developments in the field of science	35.00%	37.50%	22.50%	5.00%	0.00%
I disseminate of research findings through ICT channels such as online conferences, webinars, and open-access repositories.	25.00%	27.50%	22.50%	22.50%	0.00%
I use ICT for getting research outputs such as number of research publications	27.50%	32.50%	30.00%	2.50%	5.00%
I utilize ICT-supported sustainable practices in science to improve extension performance and outcomes, benefiting the university.	25.00%	30.00%	35.00%	5.00%	2.50%
I use ICT in extension activities to enhance my educational experience by connecting learning with real-world contexts	20.00%	47.50%	25.00%	2.50%	2.50%