Information and Communication Technology Emerges as a Beacon of Hope in Online Teaching

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Anuradha Sekhri

Assistant Professor, Institute for Development and Communication

Approved Research Centre Panjab University, Chandigarh, Punjab, India

Abstract

ICT based pedagogy plays a vital role in making school science more relevant, exciting and motivating for students, and it offers opportunities to dissolve the boundaries between school and society. ICT has become a powerful tool that has revolutionised the work of scientists. It is now possible to handle more critical data, and more complex models and simulations can be developed and tested. The communication processes within the scientific community are speeded up because of more accessible access to research results in online scientific journals. With access to the Internet, it is easier to collaborate with fellow researchers across geographical boundaries. The application of ICT can support the quality improvement of the teaching and learning process, facilitating curriculum design and the development of educational skills. Digital tools in teaching and learning can increase students' concentration, communication, motivation and creativity. ICT can facilitate and enable teachers to communicate their information and develop understanding in students. ICT has an important aspect of developing competencies needed for teaching in science education. Since it can be used as an enabler in the delivery and delivery of instruction in science teaching and learning. ICT can enhance science's objectives and goals and at the same time encourage the development of some science skills.

Keywords: Education, ICT, Whiteboard, Pedagogy.

Introduction

Education is life long process. ICT has the potential to provide enriched experiences to reconstruct teaching. Dawes (2001) underlined a statement for the realization of the possibility of ICT. In the early 1980s, computers were started to be used in schools. It was suggested that ICT would emerge as an essential part of education for the next generation (Bransford, Brown, & Cocking, 2000).

It is crucial to identify the possible challenges of integrating ICT to improve the quality of teaching. Balanskat, Blamire, and Kefala (2006) argue that although teachers appear to acknowledge the value of ICT in schools, they continue encountering obstacles during the processes of adopting these technologies into their teaching and learning.

ICT has a significant part in enriching science education and developing science skills. Nevertheless, there may be some disadvantages of using ICT to support science teaching and learning. Classroom ICT applications can be time-consuming, especially in the minimal time teachers have science lessons, notably the data recording on-screen sometimes followed by paper and pencil work.

ICT has also become fundamental to the process of teaching-learning. Replacement of blackboards with whiteboards, smartphones for online learning during class time, and flip knowledge where teachers can use full-time for discussion in the classroom. Teachers are needed to acquire digital skills and training to use technology so to develop critical thinking and preparing students for the global world to deal with challenges of the technological challenges of a knowledge-based society.

Professional Development and Digital Skills

Teachers require specific professional development opportunities to improve their abilities to use ICT for formative learning evaluations, tailored instruction, online resource access, and student interaction and collaboration. Teachers' attitudes about ICT in the classroom should improve as a result of such ICT training. Teachers who do not have this support are more likely to employ ICT for skill-based applications, limiting student academic thinking. (32) It is also critical for education managers, supervisors, teacher educators, and decision-makers to be taught in ICT to support teachers as they adapt their teaching methods.

Bransford, Brown & Cocking (2000) mentioned in their book that based on a learning goal, meaningful learning involves students in tackling the topic to be learned to develop expressive and intelligible knowledge structures.

The importance of self-evaluation in science learning is emphasized by Bransford and Donovan (2005). They advise that a teacher assist students in self-evaluation by providing opportunities to test their ideas by building things or conducting investigations and observing the results. Ryan and Deci (2002), student's mindset plays a significant influence in the motivation process. Motivated behaviour can be (i) self-determined or (ii) regulated, and it can be for various reasons. Self-determined or autonomous behaviour is defined as behaviour that originates from within one's self. On the other hand, controlled behaviour is governed by an interpersonal or intrapsychic factor, such as a curriculum or a task.

Intrinsic motivation has a favourable impact on learning, especially learning quality. The need to feel competent and self-determined drives intrinsically motivated behaviour (Deci & Ryan, 2000).

According to Hoffman (2002), An appropriate setting in which certain science information or themes are addressed and teaching and learning activities may impact the quality of emotional experience, which is crucial for developing situational interest. Juuti, Lavonen, Uitto, Byman, and Meisalo (2004) revealed 9th-grade students' interests in physics in certain contexts. The fascinating items (particularly for ladies) were those that had to do with people. As a result, it is critical to view situations through the lens of human activity. Students' experiences outside of school are diverse. Boys' experiences are more directly tied to traditional physics and technical themes, whereas girls' experiences are more closely related to daily life and health (Uitto, Juuti, Lavonen & Meisalo, 2006).

According to the dual-channel premise, Mayer (2014) explained why learning with digital tools might be advantageous using the three assumptions underlying the cognitive theory of multimedia learning: Learners can organise information into two different cognitive structures, the visual and auditory channel.

The second assumption is the limited capacity of information processing in one channel. There specific is favourable if learning environments stimulate the activation of both channels, the visual and auditory medium, to prevent a cognitive overload. This is possible, for example, by presenting sound images or spoken texts in combination with written texts or visual images. The third assumption is that learners need to engage actively with learning content to comprehend new information (Mayer, 2014). This is possible by using interactive learning environments, where learners can actively and directly influence their learning processes. In other words, "the defining feature of interactivity is responsiveness to the learner's action during learning" (Moreno & Mayer, 2007, p. 310).

Strmme and Furberg (2015) coined the term "digital resources" to characterise the tools inherent in computer-based inquiry environments to aid student learning. Digital resources include dynamic or static visualisations, computer simulations, interactive activities, collaboration, and argumentation-supporting tools.

The current study aimed to characterise the ICT and trends of theoretical frameworks (theoretical foundation, literature review, or background) of studies investigating science, teacher training, professional development, and the use of ICT due to the importance of integrating ICT in the context of science education.

Tool Applications

Any given technology is frequently viewed as a collection of tools that enable individuals to complete jobs more quickly. The same may be said about ICT, defined as an extensive collection of hardware and software. Word processing (Baker, 1991), graphics packages, scanners, digital cameras, video, presentation programmes, databases, and spreadsheets are some of the most regularly used "ICT tools" (Webb, 1993).

Web/ Internet Virtual Laboratory ICT tools Interactive whiteboard (IWB) Games Animations Wiki Simulation Hypermedia/ Multimedia environment Slowmotion Educational Software Platform Moodle Computers/ Laptops Immersive virtual environment Movies/ video m-phones Videoconference I

Science Education

Science Education is one of the core subjects in any curriculum. Science is part of the curriculum since it helps students acquire knowledge and understanding of scientific phenomena and understand the scientific process or methodologies. Via science Education, students are expected to develop science skills such as questioning, observing and interpreting observations, classifying, designing experiments and investigations, measuring, hypothesising, communicating, identifying and generalising.

The Potential for ICT to Transform Science Teaching and Learning

While opinions on the nature of science and the function of science education are evolving, Information and Communication Technologies poses a challenge to science teaching and learning and the models of scientific activity that instructors and learners may meet.

- Expediting and enhancing work production; offering release from laborious manual processes and more time for thinking, discussion and interpretation
- Increasing currency and scope of relevant phenomena by linking school science to contemporary science and providing access to experiences not otherwise feasible
- Increasing the relevance of underlying abstract concepts by focusing attention on overarching issues
- Providing rapid, visible feedback to encourage exploration and experimentation. Fostering self-regulated and collaborative learning.

ICT use and Pedagogy

Current evidence suggests that it is not reasonable to anticipate that the adoption of such technology will automatically revolutionise science teaching. Instead, we must recognise the teacher's crucial role in establishing the conditions for ICT-assisted learning by selecting and evaluating relevant technology tools.

Data recording systems, databases and spreadsheets, graphing resources, and other ICT tools for data gathering, processing, and interpretation are among the ICT technologies available for classroom science activities.

These types of ICT can benefit science teaching and learn in both practical and theoretical ways.
The following is an example of the potential contribution of technology use:

- Pedagogy for using ICT effectively includes:
- Encourage students to consider underlying concepts and linkages by setting aside time for conversation and assuring that the use is appropriate and adds value to the learning activities.
- Building on teachers' previous experience and students' preconceived notions, there is a need to organise activities while giving students some responsibility, choice, and opportunities to participate actively in reasoning, reflecting, and analysing.
- They are developing skills for obtaining and critically assessing material, as well as focusing on research duties.
- They are making connections between ICT use and continuous teaching and learning activities.
- They are taking advantage of the possibilities of whole-class interactive teaching and encouraging students to contribute their thoughts and results.
- Mishra and Koehler (2006) introduced the Technological Pedagogical Content Knowledge (initially TPCK, now known as TPACK) as an integrated framework to elucidate the essential characteristics of technology integration in classroom settings. It is not appropriate to anticipate that the adoption of such technology

will automatically revolutionise science teaching. Instead, we must recognise the teacher's crucial role in establishing the conditions for ICT-assisted learning by selecting and evaluating relevant technology tools.

Challenges to Integrate ICT in Classroom

The main difficulties of teachers to integrate ICT in the science classroom are discussed in this section. They consider TPACK as an innovative model which effectively combines theoretical and practical aspects of this issue. Moreover, teachers' views and perceptions are strongly influenced by parameters related to the context of the educational system, which is given below:

- To cover content set by the curriculum and the textbooks;
- The restrictions posed into instructional practices by the science textbooks;
- The need to prepare students for the final exams;
- The lack of time to prepare learning activities focused on their students' needs;
- The inherent school resistance to changes forces most teachers to conform to the established school culture and practices.

Use of ICT in the Schools

The use of ICT in the classrooms is hampered by several factors, including a lack of confidence and experience with technology, limited access to reliable resources, an overburdened science curriculum and a lack of subject-specific guidance for using ICT to support learning. While this technology can theoretically be used in various ways to support various curriculum goals and pedagogical approaches, such limitations have frequently hampered instructors' use of ICT in ways that fully leverage its interactivity. As a result, well-integrated and successful ICT use in the classroom is now uncommon. Even when the technology is available, research demonstrates that it is frequently underutilised and hampered by various practical restrictions and teacher misgivings. Effective integration of ICT in science seems to be confined to a minority of enthusiastic teachers or departments.

Following are given the list of resources for using online laboratories:

- PhET Simulations: The University of Colorado, Boulder, has created simulations in some topics (including Physics, Maths, Chemistry, and Earth Science). PhET is a collection of interactive computer simulations based on research used to teach and learn physics, chemistry, arithmetic, and other sciences. Simulations from the PhET website can be run online or downloaded for free. Students learn by exploration in the simulations, which are animated, interactive, and game-like worlds. Today and always, engage your pupils with scientifically correct virtual labs that are completely free! These open educational resources were designed by curriculum experts and sponsored by the National Science Foundation and other private and federal granting bodies so that you may use them in your classroom with confidence.

1. Free Labs & Simulations

Traditional laboratories, commonly done in campus immersion classes, can be brought to the online learning environment using a digital learning platform, allowing students to fully immerse themselves in the lab experience.

2. Virtual Labs (https://www.scienceinschool.org/content/virtual-labs-real-science)

The Virtual Labs Project began as a Ministry of Human Resource and Development (MHRD) initiative to develop online interactive media that would aid students in learning complex concepts in various domains. A virtual laboratory for Basic Electronics has been created as part of this programme. This lab aims to virtually perform experiments in the Basic Electronics labs close to real-life experience.

Another alternative is several other virtual labs that are available open-source and commercially.

3. Physics

Is a collection of interactive simulations in physics.

4. GeoGebra

Is software designed for Dynamic mathematics for the topics related to geometry, algebra, statistics, calculus and many others also.

5. Colorado School of Mines OERs

The Colorado School of Mines has collated a comprehensive collection of simulations and virtual labs in various areas, including physics and astronomy, chemistry, engineering, mathematics, and earth and environmental sciences.

6. An Astronomy resource using the Sloan Digital Sky Server.

7. Teach Chemistry Simulations

Depending on the level you're teaching, the relevancy of these resources may vary.

8. Chem Collective

Carnegie Mellon created the ChemCollective, which shares virtual labs, simulations, and molecular level visualisations for chemistry.

9. Praxi Labs (https://praxilabs.com/en/ virtual-labs)

Hundreds of 3D simulations for fundamental biological, chemistry, and physics studies are available. Allows your students to use their devices to access a real virtual lab at any time. Additional multimedia files to aid pupils in their scientific experimentation. Biology Physics and Chemistry

10. Lab Xchange

Every field imaginable can be explored and discovered in a library lab. On LabXchange, you may find, engage with, and share what you learn in this spirit. They curate and create world-class digital information via a free online platform that allows you to combine your learning and research activities. Here, you take charge of your education and work together to solve real-world challenges.

11. MERLOT Collection -Virtual Labs

The MERLOT collection includes tens of thousands of discipline-specific learning materials, learning exercises, and Content Builder webpages, as well as associated comments and bookmark collections, all of which are designed to improve the teaching experience of utilising a learning resource. These materials were donated by members of the MERLOT community, who either created the materials themselves or discovered them, found them valuable, and wanted to share their enthusiasm with others in the teaching and learning community. The California State University's Multimedia Educational Resource for Learning and Online Teaching (MERLOT) has compiled descriptions and links to a large variety of chemistry simulations, together with peer review ratings and comments, as well as information on acceptable grade levels.

Conclusion

Curriculum designing is required to achieve new aims and objectives of science education in today's digital education. ICT plays a central and role in the development of skills related to scientific reasoning and critical analysis. Developing new digital tools for teaching and learning science and integrating pedagogy helps facilitate critical aspects of scientific creativity to bridge the gap between theory and practice in 21st-century classrooms.

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Author Details

Dr. Anuradha Sekhri, *Assistant Professor, Institute for Development and Communication, Approved Research Centre Panjab University, Chandigarh,* ***Email. ID:*** *anu.sek2010@gmail.com.*