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Impact of Information and Communication Technology (ICT) on Achievement of Students in Chemistry at Secondary Level of CBSE and AP Board in India

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Abstract
To adapt to the modern scientific world and comprehend an environment where science and industrial technology play increasingly vital roles, individuals require a strong foundation in science. The basic scientific knowledge acquired during formal schooling is no longer sufficient. Education, both in terms of knowledge and methodology, must therefore extend throughout one's professional life, making learning a lifelong process. The rising demand for scientific knowledge and training, driven by the advancement of modern society and the rapid expansion of education, has been well recognized. Addressing this need logically calls for the adoption of advanced educational technologies, particularly the widespread use of tools such as television, the internet, and multimedia. In this context, the present study explored the influence of Information and Communication Technology (ICT) on students achievement in Chemistry at the secondary level. For this purpose, a list of CBSE and A.P Board secondary schools was prepared, from which four institutions were selected using the lottery method. The selected schools were then divided into two groups experimental and control groups. Data were collected in two phases, through pre-test and post-test scores obtained from an achievement test in Chemistry. The data were subsequently analyzed quantitatively using statistical methods such as mean, standard deviation, and t-test.

Keywords: Information and communication technology, student's achievement, country specific development. chemistry at secondary level.

1. Introduction

Since ancient times, humans have developed various methods to express their thoughts, needs, and desires to others. In early civilizations, people lived in small, localized communities where communication was easily managed through speech and written messages. As societies expanded across wider geographical regions, long-distance communication methods such as smoke signals and carrier pigeons were adopted. One of the earliest examples of optical communication was the use of fire signals by the Greeks in the eighth century B.C. to send alarms, request assistance, or announce important events. However, due to environmental and technological limitations, it was often more practical and efficient to send written letters through couriers traveling along established road.

The invention of the telegraph by Samuel F.B. Morse in 1838 marked a revolutionary step in communication, ushering in the era of electrical telegraphy. In this system, messages were encoded into sequences of binary symbols that were manually transmitted and received. Over time, the development and application of communication systems using electrical signals became increasingly advanced, eventually leading to the invention of the telephone, radar, and microwave links. Today, such systems form an essential part of modern life, with global circuits transmitting voice, text, images, and countless other forms of information. With recent advancements in integrated circuit technology, computers have become more affordable, widely accessible, and highly efficient, sparking greater interest in connecting them to the internet. The internet, a vast network of interconnected computers, enables millions of users worldwide to exchange information quickly and easily. This revolution in communication has also given rise to supporting fields and services, including Management Information Systems (MIS), Information Technology (IT), and several others.

Information Technology (IT) focuses on the application of technology within large organizations. Specifically, it involves the use of electronic computers and software to convert, store, protect, process, transmit, and retrieve information. Consequently, professionals working in this field are often referred to as IT specialists or business process consultants, while the organizational unit responsible for managing software and technology is commonly known as the IT department. In the United Kingdom, IT was formally introduced into the school curriculum with the development of the national curriculum. It soon became evident that IT skills were valuable across all subjects. With the advent of the internet and broadband connections in schools, the integration of IT knowledge, skills, and applications into various disciplines became a reality[1] . This broader role led to a shift in terminology, with IT increasingly being referred to as Information and Communication Technology (ICT).

Information and Communication Technology (ICT) in education refers to the use of digital tools and resources across all aspects of teaching and learning. It is now widely integrated into schools in developed countries and continues to grow in influence. For instance, the UK government's National Grid for Learning initiative emphasized that teachers should increasingly adopt internet and web-based approaches in classrooms. As Benton (1983) observed, the entire world is undergoing rapid scientific and technological advancement, with nations positioned either as major producers of technology or as consumers of technological innovations from others.

Technology has effectively transformed the world into a global village, and the breakthroughs in ICT have created new milestones in the globalization of education. Its growing adoption has made ICT a critical factor in shaping the fundamental competencies of students, preparing them for participation in a knowledge-driven society.

According to the World Bank, Information and Communication Technology (ICT) encompasses the hardware, software, networks, and media used for collecting, storing, processing, transmitting, and presenting information[2] . The application of ICT in education generally falls into four major categories: constructing knowledge and problem-solving (through tools such as email, databases, CD-ROMs, and videoconferencing), developing process skills, supporting the explanation of concepts, and enhancing communication of ideas through platforms like PowerPoint and desktop publishing (WCEA, 2002).

Integrating ICT into teaching provides a relevant and practical approach to education, equipping learners with the essential skills needed for the modern workforce. It significantly transforms the way we live, learn, and work. In fact, technology has now become an integral part of the classroom, reshaping both teaching and learning processes.

2. Need and Significance of the Study

The issue of low academic achievement among students has long affected our educational system, spanning from primary school to the university level. This persistent challenge not only leads to a significant loss of human potential and educational opportunities but also results in financial wastage—a burden that developing countries like ours can scarcely afford[3]. The present study seeks to identify effective media for delivering content to large groups of students within the classroom. Specifically, it examines the impact of Information and Communication Technology (ICT) on the teaching and learning of chemistry, aiming to determine whether students taught with ICT tools—such as computers, internet resources, projectors, and video players—achieve better results compared to those taught solely with textbooks[4].

3. Objective of the Study

The present investigation was undertaken with the following objectives:

- To examine the differences in performance between the experimental group taught using ICT and the control group taught through traditional methods.
- To compare the performance of Experimental Group I (A.P. Board) taught using ICT with Control Group I (A.P. Board) taught using traditional methods.
- To compare the performance of Experimental Group II (CBSE) taught using ICT with Control Group II (CBSE) taught using traditional methods.

4. Research Hypothesis

H1: There will be a significant difference in achievement between the experimental group taught through ICT and the control group taught through traditional methods.

H2: There will be a significant difference in achievement between Experimental Group I (A.P. Board) taught through ICT and Control Group I (A.P. Board) taught through traditional methods.

H3: There will be a significant difference in achievement between Experimental Group II (CBSE) taught through ICT and Control Group II (CBSE) taught through traditional methods.

Research Design

The present study adopted a **pretest–post test equivalent group design** as suggested by Best (1983), with some modifications to suit the current research context[5].

Population

The population comprised 9th-grade science students enrolled during the 2011–2012 academic session in various secondary schools affiliated with CSE and A.P. Board in the Common Krishna & Godavari districts region of Andhra Pradesh, all of which had access to ICT facilities[6].

Sampling

A list of CBSE and A.P. Board schools with ICT facilities was prepared, and **four schools were selected using the lottery method**. From these schools, students were randomly assigned to two groups:

1. **Experimental Group** – students taught using ICT-based methods
2. **Control Group** – students taught using traditional teaching methods

A total of **220 students** were selected, with **140 from CBSE schools** and **80 from A.P. Board schools**, ensuring that all participants had comparable **entering behavior, intelligence, and socio-economic status**.

Tools of Research

For the present study, the following research tools were developed[7]:

1. Lesson Plan (Traditional Method): Prepared for the selected topic using conventional teaching methods.
2. Lesson Plan (ICT Method): Developed by the investigator for teaching the selected topic through ICT.
3. Achievement Test in Chemistry: Designed for the selected topic to assess students' learning outcomes.
4. Intelligence Test: Administered to measure students' cognitive abilities.
5. Socio-Economic Status Scale: Used to determine the socio-economic background of the participants.

Data Collection

Data were collected at two stages:

- Pre-test: Conducted before instruction to determine baseline knowledge.
- Post-test: Conducted after instruction to assess learning outcomes.

Analysis and Interpretation of Data

The collected data were analyzed using quantitative techniques. Statistical tools such as mean, standard deviation (S.D.), and t-test were applied to evaluate differences and interpret results according to the study objectives[8].

Section I

H1: There is a significant difference between the experimental group taught through ICT and the controlled group taught using the traditional method.

Table 1

S. No.	Groups	N	Mean	S. D.	't_1' value
1.	Experimental	110	16.32	3.59	3.45
2.	Controlled	110	14.18	5.28	

Table 2

Level of significance	Obtained 't' value	Table value with df=223	Result
0.05	3.45	1.96	Significant
0.01	3.45	2.59	Significant

The calculated **t_1 value** indicates that the null hypothesis is rejected at both levels of significance. Therefore, **Hypothesis 1 is accepted**, confirming that a significant difference exists between the experimental group taught using ICT and the controlled group taught through traditional methods.

Section II

H2: There is a significant difference between Experimental Group I (A.P. Board) taught through ICT and Controlled Group I (A.P. Board) taught using the traditional method[9].

Table 3

S. No.	Groups	N	Mean	S.D	‘t_2’ value
1.	Experimental (A.P Board)	40	14.80	3.46	3.21
2.	Contolled (A.P Board)	40	12.20	3.52	

Table 4

Level of Significance	Obtained ‘t’ value	Table value with df = 73	Result
0.05	3.21	1.99	Significant
0.01	3.21	2.64	Significant

The calculated **t_2 value** indicates that the null hypothesis is rejected at both levels of significance. Therefore, **Hypothesis 2 is accepted**, confirming that a significant difference exists between Experimental Group I (A.P. Board) taught using ICT and Controlled Group I taught through traditional methods.

Section III

H3: There is a significant difference between Experimental Group II (CBSE) taught using ICT and Controlled Group II (CBSE) taught through the traditional method.

Table 5

S. No.	Groups	N	Mean	S.D	‘t_3’ value
1.	Experimental (C.B.S.E Board)	70	17.18	3.42	2.52
2.	Controlled (C.B.S.E Board)	70	15.17	5.72	

Table 6

Level of Significance	Obtained ‘t’ value	Table value with df = 138	Result
0.05	2.52	1.98	Significant
0.01	2.52	2.61	Insignificant

The calculated **t_3 value** indicates that the null hypothesis is rejected at the 0.05 level of significance but accepted at the 0.01 level. Therefore, **Hypothesis 3 is accepted at the 0.05 level**, showing a significant difference between Experimental Group II (CBSE) taught through ICT and Controlled Group II taught via traditional methods.

5. Discussion of the Result

Section-1

A significant difference exists between the experimental groups taught through ICT programs and the controlled groups taught using traditional teaching methods.

Table 1 indicates that the mean achievement score of the experimental groups taught via ICT (M_1 = 16.32) is higher than that of the controlled groups taught traditionally (M_2 = 14.18). The standard deviation for the experimental group was 3.59, while for the controlled group it was 5.28. The calculated

t-value of 3.454 exceeds the table values at df = 223, which are 1.96 at the 0.05 level and 2.59 at the 0.01 level of significance. This demonstrates that the difference is statistically significant at both levels.
The experimental group achieved higher scores on the Chemistry achievement test compared to the controlled group. This can be attributed to their greater exposure to technological programs both inside and outside the school, whereas students in the controlled group had comparatively limited access to such resources.

Section-2

A significant difference exists between Experimental Group I (A.P. Board) taught through ICT programs and Controlled Group I (A.P. Board) taught using traditional methods.
Table 3 shows that the mean achievement score of Experimental Group I taught via ICT (**M_1 = 14.80**) is higher than that of the Controlled Group I (**M_2 = 12.20**) taught traditionally. The standard deviation for the experimental group was 3.46, while for the controlled group it was 3.52. The calculated **t-value** of 3.21 exceeds the table values at df = 73, which are 1.99 at the 0.05 level and 2.64 at the 0.01 level of significance. This indicates that the difference is statistically significant at both levels.

Section-3

A significant difference was observed between Experimental Group II (CBSE Board) taught through ICT programs and Controlled Group II (CBSE Board) taught using traditional methods.
Table 5 indicates that the mean achievement score of Experimental Group II taught via ICT (**M_1 = 17.18**) is higher than that of the Controlled Group II (**M_2 = 15.17**) taught traditionally. The standard deviation for the experimental group was 3.42, while for the controlled group it was 5.72. The calculated **t-value** of 2.52 exceeds the table value at the 0.05 level of significance (1.98) but is lower than the table value at the 0.01 level (2.61), indicating statistical significance at 0.05 level.
This result suggests that the CBSE schools chosen for the study had similar classroom organizational climates and socio-economic structures among students. Even the controlled group had prior exposure to ICT programs, both formally and informally via mass media, which may have reduced the observable impact of ICT in the classroom for this group

6. Major Findings of Study

1. The ICT program proved to be more effective than traditional teaching methods in terms of student achievement scores. Advances in scientific and technological discoveries have highlighted the importance of incorporating technology to enhance the quality, pace, and productivity of the teaching–learning process.
2. ICT is recognized as a powerful medium of mass communication that has transformed the teaching–learning process in multiple ways. In this study, ICT programs specifically designed for classroom instruction were employed to engage students in ways that traditional teaching methods often cannot achieve successfully.
3. As the saying goes, “Seeing is believing,” and “a picture is worth a thousand words.” ICT provides three-dimensional visualizations of content, which help motivate students and address their queries and curiosity regarding various scientific concepts.

7. Implication of the study

In the current educational scenario, educators have recognized the importance of ICT in schools for fostering greater interest and providing up-to-date knowledge of the subject matter. Nevertheless, the role of the teacher remains indispensable. ICT serves as a supportive tool, enabling teachers to deliver more authentic and comprehensive content, particularly in areas that are difficult to explain through words alone. By offering three-dimensional visualizations, ICT motivates students, enhances their engagement, and helps address questions and curiosities about scientific concepts that may be challenging to convey through traditional classroom teaching.

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