

**Effects of Information and Communication Technology
(ICT) on Students' Academic Achievement and
Retention in Chemistry at Secondary Level**

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Abstract

The current paper investigated the effects of information and communication technology on the students' academic achievement and retention in chemistry. Fifty students of 9th grade were selected randomly from Kohsar Public School and College Latamber Karak. The students were grouped into equivalent groups based on pretest score. In order to collect data, pretest posttest equivalent groups design was used. Mean, standard deviation and independent

samples t-test were applied through SPSS for data analysis. Based on statistical analysis, it came to light that information and communication technology positively affects students' academic achievement and retention and ICT was found more compelling, effective and valuable in teaching of chemistry when contrasted with conventional techniques of teaching. It is recommended that information and communication technology should be used in teaching chemistry for enhancing students' academic achievement at secondary level.

Keywords: academic achievement, chemistry, Information and Communication Technology (ICT), retention, secondary level

Introduction

Information and technology has a major role to play in forming the new worldwide economy to deliver fast changes in the society. Within the previous decade, ICT has advanced and changed at such a speed, that developing countries have not been able to catch up with the revolution and have been left behind and thus lag in their communication with the developed countries. ICT acts as the foundation stone of the contemporary world; thus, understanding this technology and its fundamental concepts is considered as part of the core of education (UNESCO, 2002). Technology has the potential to renovate the ways of instruction, where and how learning occurs and the roles of students and educators in the instructional process (UNESCO, 2002a). ICT is transforming procedures of instructional process by contributing components of strength to learning situations involving virtual environment. It is an effective

and influential instrument for providing educational opportunities; thus, it is difficult to envision future learning situations that are not bolstered by information and communication technology.

Educational institutions may utilize ICT to enrich the students with skills and knowledge for the 21st century (Andoh, 2012), such that it can add to worldwide accessibility to education, educational equality, broadcasting of quality teaching learning programs, educators' professional growth and to help in obtaining a more effective educational management. Hence, accessibility, inclusion and standard being the key issues of education, can be comfortably addressed through ICT. ICT improves the standard of education by encouraging learning through ongoing discussion, delayed time discussion, directed instruction, self-learning, critical thinking, data seeking and analysis (Yuen, Law & Wong, 2003). Utilization of ICT can enhance outcomes, instruction, administration and create important abilities in the underprivileged groups (Sharma, 2003), and at the same time influence educational instruction and research process (Yusuf, 2005).

In classroom teaching and learning process, the use of ICT is imperative as it gives chance to the instructors and learners to operate, store, control and retrieve data other than to promote self-regulated and active learning (Ali, Haolader & Muhammad, 2013). ICT-based learning includes an expanded propensity towards collaborative learning among learners and instructors, not just in a specific classroom. This kind of collaboration is in contrast to the conventional learning environment, for example, distance learning inspires educators and learners to engage in learning even after school time (Ali, Haolader & Muhammad, 2013). The system helps

instructors to plan and prepare lessons and design materials such as course content (Ali, Haolader & Muhammad, 2013). The rapid development of this system has prompted a revolution in learning as new technological advancement in education has involved the re-examination of new techniques and instruments in instructional process.

Computers and the Internet have been touted as potentially capable means to empower the users for educational changes and improvement, by utilizing various information and resources and reviewing information from different points of view; hence, cultivating the authenticity and actuality of learning situations (Tinio, 2003). ICT helps to make complicated things simple to comprehend by simulations that once more add to real learning situations. Hence, ICT may act as a facilitator of dynamic learning and higher order thinking (Alexander, 1999).

To enhance the academic performance of students, there is a need to turn from conventional teaching methods to modern teaching methods. Computer Assisted Instruction (CAI) is space and time independent making it convenient for students to go through the program either at home or on a school computer. This encourages interactivity, which individualizes content for each learner based on their needs and it provides formative feedback to multiple choice questions. CAI enhances learning rate where the learners are able to learn more materials given the same amount of time as compared to conventionally taught learners. Moreover, students receiving instructions through ICT retain learning better (Cotton, 2001). The issue of low achievement among the learners has been tormenting the instructive framework right from the elementary classes to

university level. This issue wastes human potential and facilities for education. The findings of the study will confirm the effectiveness of ICTs in teaching of chemistry and also predict that ICT based instruction is better than conventional teaching approach. In addition to enhanced achievement scores, the findings of the study will boost the interest and retention of the students in chemistry.

Literature review

ICT is an augmented term for information technology (IT) which accentuates on the role of integrated communications (Murray, 2011) and the integration of telecommunications (telephone lines and wireless signals), computers and other necessary enterprise software (Foldoc, 2008). Singh (2013) defines ICT as a collection of technical devices and resources which are used to transmit, store and manage information; however, the utilization of ICT in the instructive process has been partitioned into two general classifications: ICT for education and ICT in education. ICT for education suggests the development of ICT particularly for teaching and learning purposes and ICT in education includes the adoption of general parts of ICT in the instructional process (Okoro & Ekpo, 2016).

ICT in education

The emergence of ICT has transformed the existence and activities of contemporary man particularly in the setting of globalization (Evey, Emmanuel, Joseph, Denis & Asinde, 2010). In recent times, there has been an extraordinary advocacy both nationally and internationally for the use of ICT in instructional and

learning process (Okoro & Ekpo, 2016). The educational field has been influenced by ICT, which has explicitly influenced instructional process and research. Davis and Tearle, 1999 (as cited in Yusuf, 2005) believe that ICT has the strength to speed up, improve and extend aptitude reforms as it has the capacity to boost teaching by inspiring and engaging learners, and help schools reform by assisting schools in understanding financial and functional practices. Ashley (2016) reiterates that technology helps educators in preparing students for the real world setting and stresses that as our countries turn out to be progressively more technology dependent, it becomes significantly more essential that to be good citizens, students must figure out how to be well informed about ICT. The utilization of ICT in teaching is a pertinent and practical method for providing education to learners that will enrich them with the required abilities with regards to the world of work.

It offers a totally new and advanced learning environment for learners; consequently they acquire various aptitude sets in order to be fruitful and successful. Critical thinking, research and appraisal aptitudes are developing significantly as learners have expanding dimensions of information from a number of sources to deal with. The incorporation of ICT in instructional process is believed as a medium in which a number of methodologies and pedagogical theories might be implemented; however, ICT as a teaching aid is more difficult and multifaceted as it needs positive attitude from the educators (Salehi & Salehi, 2012).

ICT in schools

ICT in schools gives a chance to instructors to change

their practices by furnishing them with enhanced educational content and more powerful educating and learning techniques. ICT enhances the instructional process through the arrangement of interactive instructive materials that increase learner inspiration and encourage easy attainment of fundamental aptitudes. Utilization of different multimedia tools such as TV, recordings, videos and computers applications provides more challenging and attractive learning atmosphere for learners of any age (Haddad & Jurich, n.d). Furthermore, it enlarges the flexibility of communicating education with the aim that learners can get information on every occasion and from anyplace. It may affect the methodologies through which the learners are educated and how they learn, as the instructional processes are learner driven and they will therefore be prepared for effective learning and the quality of learning will be improved (Moore & Kearsley, 1996).

One more advantage of introducing ICT in schools is that the learners who do not have accessibility at homes may have the opportunity to utilize them in schools. It can be utilized as a learning device to give instructions to enhance the students learning and retention (Aslan & Dogdu, 1993). This technology motivates and conveys dynamism to the classroom and reduces time in learning. ICT can upgrade the nature of instruction by intensifying learner inspiration and instructor training, which are the establishments of higher order thinking aptitudes (Aslan & Dogdu, 1993).

Basically, ICT has changed the learning behavior where it has entered the classrooms to be a part of educating and learning process (Agrahari & Singh, 2013). It is considered to be the most effective

medium of mass communication, which has altered the instructional process in many ways. Poulter and Basford (2003) state that ICT is an instructing device and its potential for enhancing the quality and principles of students' education is noteworthy. The ICT program is more viable than the conventional teaching approach in term of students' achievement scores.

Teaching through ICT

For effective integration of ICT in instructional process, it can be inferred that the factors that teachers' attitudes, ICT competence, computer self-efficacy, professional development, teaching experience, education level, technical support, accessibility, leadership support, pressure to use technology, government policy regarding ICT education and technological characteristics positively affect teachers' and administrators' use of ICT in education (Ali, Haolader & Muhammad, 2013). Andoh (2012) conducted a study to review literature regarding factors influencing integration of ICT and found three levels of factors: (a) teacher-level, (b) school-level, and (c) system-level barriers. Teacher level hindrances comprise teachers' incompetency of ICT use, lack of teacher self-confidence, lack of teacher professional and pedagogical training and lack of differentiated training programs. School-level hindrances include lack of specially designed infrastructure for ICT use, old or ineffectively maintenance of equipment, absence of appropriate instructive programming and software; poor accessibility to ICT, poor project related understanding, and lack of ICT mainstreaming into school's policy. System level hindrances embrace unbending structure of conventional education systems, traditional appraisal, obstructive curricula and limited organizational structure. Knowing

the degree to which these hindrances influence people and organizations may help in deciding how to handle them (Andoh, 2012).

Safdar, Yousuf, Parveen and Behlol (2011) conducted an experimental study to identify the effectiveness of ICT in teaching mathematics at secondary level and they found that information and communication technology is very effective in teaching mathematics as compared to traditional teaching method. Ziden, Ismail, Spian, and Kumutha, (2011) carried out an experimental study and concluded that ICT has a positive affect on the academic accomplishment of students in science subjects. This study additionally endeavored to decide the distinctions of accomplishment between the female and male participants. The study found that male students showed better performance as compared to female students. Carrillo, Onofa and Ponce (2010) carried out an experimental study on information technology and students' achievement and they found that ICT has a positive effect on the achievement scores in mathematics test, but failed to increase achievement scores in language test. Badeleh and Sheela (2011) inferred that generally to study chemistry, component based achievement, retention of learning and comprehension, ICT was more successful than the laboratory training model of teaching. Avinash and Shailja (2013) discovered that the ICT program is more compelling and effective than the conventional teaching approach in terms of students' achievement scores in chemistry.

Problem of the study

Keeping in view the benefits of ICT in education, the objectives of the study are to (a) investigate the effect of ICT on

students' academic achievement at secondary level in chemistry, (b) examine the effect of ICT on secondary school students' retention in chemistry. The following hypotheses were formed:

H₀1: There is no significant variance in academic achievement of control and experimental groups on pretest.

H₀2: There is no significant variance in the academic performance of students who were taught while using ICT and academic performance of students who were taught through conventional teaching method on post-test.

H₀3: There is no significant variance in retention of students who were taught using ICT and the retention of students taught using conventional teaching method.

Methodology

Pretest Posttest Equivalent Group Design was employed because of the experimental nature of the study. According to the research design, respondents were sorted into equivalent experimental and control groups based on the results of the pretest.

Sample

Population for this study comprised all secondary school students studying in Kohsar Public School and College Latamber of Karak District, Khyber Pakhtunkhwa (Pakistan). This study was confined to four units of chemistry that is Fundamentals of

Chemistry, Structure of Atoms; Structure of Molecules and Physical States of Matter. Fifty students of grade 9 were randomly selected as sample from the list on the record. Pretest comprised 50 MCQs to investigate the existing knowledge of the students before treatment. Sample students were grouped into two proportionate and equivalent groups, that is, experimental and control groups having 25 students each.

Instrument

The instrument was constructed to measure the pre-test and post-test student knowledge. Validity of the test was confirmed with the help of five experts in the relevant field (possessing doctorate degree). Reliability of the research tool was calculated by using Spearman-Brown Prophecy which was 0.82, and indicated that the research tool was reliable and within statistical limits.

Procedure

In order to control extraneous variables, two chemistry teachers with same qualifications and experience were selected through formal permission of the principals of the concerned schools. Before conduction of experiment, the researchers arranged three meetings with the teachers to explain the purpose of the study and its procedure. Teachers of the control group were explained to use traditional teaching method only, while the teachers of the experimental group was told to use, computers, internet, skype, chemistry CDs and other software, emails for teaching. Likewise, students of experimental groups were given one-week training in

using computer applications, composing assignments; browsing concerned websites, using internet and skype, using software, composing, sending, receiving and replying to emails. For each student of experimental group, email addresses were created and they were told to share their emails addresses with their teachers and class fellows. A post-test was conducted after seven days to the respondents of both groups.

Results

The main objective of the study was to investigate the effect of information and communication technology on the achievement of secondary school students in chemistry. This experimental study was conducted in Kohsar Public School & Collage, Latamber, Karak. Rawdata were sorted out, arranged and analyzed on the basis of descriptive and inferential statistics.

Ho 1: There is no significant variance in academic achievement of control and experimental groups on pretest.

Table 1

Difference between the achievement scores of experimental and control groups on pretest

Groups	N	Mean	St. Dev.	SE	Mean Diff	t-value	p-value
Control	25	68.24	3.58	0.98	-0.38	-0.389	0.699
Experimental	25	68.62	3.32				

Insignificant df = 48 tabulated value of t at 0.05 = 2.0106

Based on inferential statistics, Table 1 indicates that the

value of $t_{(cal)}$ of independent sample t-test was calculated to be -0.389, which is insignificant ($p>0.05$) in the light of the fact that it is less than tabulated of $t_{(tab)}$ at $\alpha=0.05$. Thus, null hypothesis 1 cannot be rejected. The results of descriptive and inferential statistics evidently reveal that there is no substantial dissimilarity between achievement of control ($mean=68.24$, $SD=3.58$) and experimental ($mean=68.62$, $SD=3.32$) groups on pre-test.

Ho 2: There is no significant variance in the academic performance of students who were taught while using ICT and academic performance of students, who were taught through conventional teaching method on posttest.

Table 2

Difference between the achievement scores of experimental and control groups on posttest

Groups	n	Mean	St. Dev.	SE	Mean Diff	t-value	p-value
Control	25	72.36	3.49	0.97	-15.93	-16.394	0.000
Experimental	25	88.29	3.38				

* Significant df = 48 t'stabulate value at 0.05 = 2.0106

Table 2 indicates that the value $t_{(cal)}$ of independent samples t-test is 16.394, which is significant ($p<0.05$) based on the fact that it is larger than tabulated of $t_{(tab)}$ at $\alpha=0.05$. Thus, null hypothesis 2 can be rejected. Descriptive and inferential statistics explicitly displayed, that there is a substantial dissimilarity between the achievement of control ($mean=72.36$, $SD=3.49$) and experimental ($mean=88.29$, $SD=3.38$) groups on post-test. The students of experimental group performed very well when contrasted with the students of control

group.

Ho 3: There is no significant variance in retention of students who were taught using ICT and the retention of students taught using conventional teaching method.

Table 3

Difference between the achievement scores of experimental and control groups on retention test

Groups	n	Mean	St. Dev.	SE	Mean Diff	t-value	p-value
Control	25	69.32	3.52	0.99	-17.60	-17.829	0.000
Experimental	25	86.92	3.46				

* Significant df = 48

t's table value at 0.05 = 2.0106

Inferential statistics show that the value of $t_{(Cal)}$ is -17.829, which is significant ($p < 0.05$) based on the fact that it is larger than tabulated of $t_{(tab)}$ at $\alpha = 0.05$. Hence, the null hypothesis 3 can be rejected. Descriptive and inferential statistics clearly show, that there is a substantial difference between the performance of control ($mean = 69.32, SD = 3.52$) and experimental ($mean = 86.92, SD = 3.46$) groups on the retention test. Experimental group performed better than control group on retention test.

Discussion

In the past two decades, pedagogical approach to deal with learning has been evolving. This is because of the technological advancements and its integration in educational process, which has produced positive outcomes in some advanced societies. The purpose

of the research paper was to explore the effects of ICT on students' academic attainment and retention in the subject of chemistry at the secondary level.

As far as students' performance on pretest is concerned, it was inferred that the performance of both groups was same before experimental treatment. Regarding effects of ICT on students' academic achievement, ICT was found more effective on students' academic achievement as compared to traditional teaching method on post-test. The results are consistent with Agrahari and Singh (2013) who found that ICT has a positive effect on student achievement scores in chemistry at secondary level. Similarly, Ziden, Ismail, Spian and Kumutha (2011) found that the application of ICT in teaching and learning increased the students' achievement in science subjects. Likewise, Safdar, Yousuf, Parveen and Behlol (2011) concluded that ICT has a positive effect on students' achievement scores. Similarly, Okoro and Ekpo (2016) concluded that students performed well who were taught through ICT as compared to those who were taught via conventional instructional strategy. Utilizing ICT in the study urges the participants to process data better and along these lines upgrade the comprehension and enhance their memory (Hull 1995; Gayeski, 1993). Avinash and Shailja (2013) found that the ICT program is more compelling and effective than the conventional teaching approach in terms of students' achievement scores in chemistry. This contradicts with the findings of Cener, Acun and Demirhan (2015) who concluded that ICT does not have an effect on students' achievement scores. Likewise, Mbaeze, Ukwandu and Anudu (2010) found that there was no significant relationship between ICT and students' academic performance.

Investigating the effects of ICT on students' retention, the findings reveal that ICT was found more effective on students' retention as compared to traditional teaching methods. The results are consistent with the findings of Oginni and Popoola (2013) who found that by using information and communication technology, students' retention scores were better when contrasted with those who were instructed via conventional methods. The students of experimental group retained better than those of control group. Thus, this research affirms the results of the aforementioned researches that claim that students learn and retain better when they are taught through ICT.

Conclusion and recommendations

The rapid development in ICT has brought revolution in the twenty-first century and has influenced the needs of advanced societies. ICT is becoming progressively significant in education as well as in our everyday lives. The findings revealed that ICT positively affects students' academic accomplishment and retention in the subject of chemistry. The media was found more compelling, effective, rewarding and valuable in teaching of chemistry at secondary level; therefore, it is suggested that teachers should employ ICT in teaching of chemistry. ICT and other teachers should be taken on board in all schools on priority basis and should be given special training. It is strongly recommended that the infrastructure of the schools should be designed in such a way that ICT could be used successfully.

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