

Impact of ICT Enriched Modular Approach on Academic Achievement of Biology Students

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An experimental study was carried out in Pakistan to measure the impact of Information and Communication Technology Enriched Modular Approach on academic achievement of biology students at secondary level. All 9th graders science students studying biology at Islamabad Model Colleges were the population of the study and a sample of 172 biology students was randomly drawn from two schools. Pretest-posttest control group design was employed. Based on prior results of students in the subject of biology, three sub groups were constituted and randomly assigned to experimental and control groups. Based on Gagne's (1974) nine events of instruction, ICT enriched modules of biology were constructed and teachers were trained for a period of one week to use the ICT enriched modular strategy. Teachers were randomly assigned to groups. Modules along with test instrument were piloted and validated. Pre-tests and post tests were carried out to gather data. Analyses of data were done using independent sample t-test and univariate analyses of variance. Findings were highly significant in favor of ICT enriched modular teaching approach.

Key words: *Biology, achievement, secondary level, modular approach, information and communication technology (ICT)*

Introduction

Modules are self-contained, self-instructional materials in which learners participate actively. Content of modules is broken down into small stages and each stage has clear learning objectives, inbuilt assessment and feedback. Students can use modules at their own pace, Variety of methods and media increase the interests of students and meet their needs. Therefore, modules have concern for individual differences. Modular approach is an interactive approach where students actively engage themselves to participate in the learning process. Hence this approach is learner centered.

Heinich (1990, p.187) establishes that the module and modular approach is a new method of viewing the fundamental building units of instruction. Munn report (1977) is considered as first one that brought this concept of module into secondary school curriculum. According to

Entwistle and *et al.* (1990) it is Scotland Action Plan report (1983) that certified the modular approach comprehensively and impacted on secondary school curriculum' philosophy in England and Wales.

Postlethwait, S. N. (1991) found modular approach as an effective and efficient tool that facilitates students' learning. This approach is helpful for teaching most of the subjects. Although development of instructional and teaching material is somehow time consuming job, yet modular effectiveness can be evaluated so that revisions and amendments can be made easily in a positive manner.

The current experimental study is conducted to find the modular effectiveness for secondary school curriculum.

Rationale of the study

National Education Policy 1998-2010 accentuates the use of Information and

Communication Technologies (ICTs) in education. According to NEP 1998-2010 ICTs can be employed creatively to help instructors and learners with a broad array of skills and from diverse social and economic backgrounds. The quality of instruction and managing of educational activities can be enhanced by ICTs use (NEP 2009, Government of Pakistan).

New advancements which are taking place all over the world have changed this world into a well-connected global village. Learners of this 21st century are more creative and interested in technology driven tasks. To teach science to such learners is a bit more challenging these days. Their instructional needs cannot be satisfied by giving long theoretical descriptions of lectures. To make the instruction more interesting and learner centered and relating science content with real life situations, we need to modify or change our teaching methodology for teaching science subjects. For better comprehension of science concepts and themes, we need to teach the science content electronically.

Researcher's experience in this area and earlier researches conducted in the area provided temptations and sound grounds to conduct this quantitative research study. According to Zahorian *et. al.* (2000) modules are smaller than usual courses and are designed skillfully by keeping in view the reusable element and easy configuration. Modules permit creation of a number of educational options to fulfill the diverse needs of learners. Manlove and David (1985) mention that modular approach considers each student as an individual with special particular skills, unique abilities, interests and aptitudes. This approach facilitates in learners' thinking skills. Collis (1996, p.26) defines Information and Communication Technology ICT as New technologies emerged from the union of personal computer technology and telecommunication networks. ICT can reach all over the world through global networks such as the Internet and World Wide Web (www). Achievement refers to, "The knowledge attained or skills developed in the school subjects usually reported in the form of test scores assigned by teachers" (Good, 1973, P.7).

Statement of the Problem

Present article focuses on measuring the effectiveness of ICT enriched modular approach on

academic achievement of secondary school students of biology.

Objectives of the Present Study

Present study was designed to obtain following objectives:

1. To explore the effect of ICT enriched Modular Approach on the academic achievement of biology students
2. To explore if the variation in pre-test, post-test treatments has any effect on gender when analysed in terms of academic achievement of secondary school biology students.
3. To examine the significant differences among the sub groups on the academic achievement of secondary school biology students.
4. To observe variation in pre-test, post-test treatment effects on age groups on the academic achievement of secondary school biology students.
5. To explore if the sub groups and groups interact and how does it affect the academic achievement of the groups.
6. To identify if the sub groups and age groups interact and whether this interaction affects the academic achievement of the groups.

Research Questions

1. Are there any significant differences between the academic achievements of the secondary school biology students taught through ICT enriched modular approach and traditional approach?
2. Are there any significant differences between treatment effects on gender in the academic achievement of biology students?
3. Are there any significant treatment effects on the performance of subgroups of experimental and control groups?
4. Do the age groups have any effects on the performance of experimental and control groups at secondary level?
5. Is there any interaction of sub groups and groups on academic achievement of secondary level biology students?
6. Is there any significant interaction of sub groups and age groups on students post test scores at secondary level?

Delimitations of Research Study

Due to limitations of resources and time constraints, current research study was delimited to the following factors: As it was not possible to conduct this experimental study simultaneously to all model schools of Islamabad, it was delimited to two schools: one for boys and one for girls. Only three sub groups were identified regarding their abilities in biology relying on previous term results in the subject of biology. Ten modules were constructed from the textbook of biology grade IX, from the content areas of *Cell Cycle*, *Enzymes* and *Bioenergetics*. Four modules were constructed from *Cell Cycle*, three modules from *Enzymes* and three modules from *Bioenergetics*. Test instrument that was used to measure academic achievement of class 9th biology students consisted multiple choice test items. Only cognitive domain and lower order thinking skills like knowledge and comprehension were assessed.

Conceptual Framework

In the present study, researcher developed modules integrating them with ICT for the teaching

Methodology

Design for Experimental Research

Following pretest-posttest control group, research design as described by Gay (1990) was used:

Exp. Group	R	O ₁	X	O ₂
Control Group	R	O ₃	-	O ₄

Population and Sample

As Islamabad Model Colleges IMCs were selected for the present study, so the science students of biology grade-IX studying biology as elective subject formed the population. According to Hill, R. (1998), 30 subjects per group is often cited as the minimum for experimental research (p.6). So, two schools were selected from 20 IMCs and a sample of 172 biology students (100 boys & 72 girls) was drawn from the selected two schools. Based on last term examination scores students were divided into three groups: high achievers, average and low achievers. Twenty four above average (6 males & 18 females) students, 76 average (42 males & 34 females) students and 72 below average (52 males & 20 females) students were randomly assigned to experimental and control groups (86 experimental & 86 control group) through basket method. In this

of biology to find out the impact on the achievement of biology students at secondary level. Content of Biology was selected from the National Curriculum 2006, to develop modules. Steps for designing the modules were based on Gagne's (1974) nine events of instructions with some modifications. Content for the modules was taken from the text book of Biology-IX (Pakistan Law decisions [PLD] publishers). To integrate ICT in each module, web sources like movies, simulations, pictures, animations, some websites and important links were added. Portion of cell biology was selected for the preparation. Ten modules were formulated based on the three chapters of cell biology from the textbook of grade-IX. Content of all these ten modules was provided as power point presentations with added pictures, animations and movies clips etc. and all the material (modules [word document], power point presentations, movies, pictures, animations) was stored in storage devices such as Compact Disks (CDs) and Digital Video Disks (DVDs) by researcher.

way, half of the boys (50) were randomly assigned to experimental group and half boys (50) were assigned to control group. To avoid the chance of inclusion of all above average students in one group, and all below average students in other group, technique of stratified random sampling was applied. Ratio of above average, average and below average male students in each experimental and control group was (6: 42: 52) respectively. Ratio of above average, average and below average female students in each experimental and control group was (18: 34: 20) respectively (see figure 1.1). Draw method was adopted to randomly select and assign the students of each category to either experimental or control groups. In this way, it was assumed that all students were similar ability wise, before the start of the experiment.

Overall there were 172 students, 100 boys and 72 girls. Ultimately 86 students (50 boys, 36 girls) formed the experimental group and 86 students (50 boys and 36 girls) formed control group.

Orientation of Teachers and Students:

One-week orientation workshop was organized separately for teachers of experimental groups of the male and female schools. Control group teachers got one-day orientation only in which they were informed about objectives and significance of this experimental study, methodology, and evaluations through pre-test, post-test. Students of experimental groups were also provided with one-week training to use modular approach. These training sessions were held in male and female schools daily for two hours in the computer laboratories (labs) of the respective schools where multimedia facility was available along with woofer device and speakers. Researcher acted as resource person for these workshops. Printed material related to orientation workshop was already disseminated to all teachers and students of experimental groups.

Variables

Treatments methodologies such as ICT enriched modular approach and traditional approach acted as independent variables. Achievement of students in the posttest of biology was dependent variable in this study. Some of the variables were kept controlled for the experiment. These include equivalent teachers' qualification, same number of learners in groups (experimental and control) and sub groups (high achievers, moderates and low achievers), almost similar duration of teaching experience of biology teachers and similar ICT related facilities at selected schools.

Procedure

ICT enriched modules were prepared in such a way that they could have been used either on students' pace or teacher's pace. Modules were made student centered, having a lot of interactive exercises based on multiple intelligences like work in small groups involving interpersonal intelligence, writing of reflective journals of modules involving intra personal intelligence, using computers involving kinesthetic intelligence. Similarly, assessments involving logico-mathematical intelligence, performing practical experiments using

natural and logical intelligence, drawing different diagrams using spatial intelligence and telling the summary or asking questions using linguistic intelligence. One of the modules was piloted at one of Islamabad Model School for Girls, Islamabad. Observations noticed by the teacher during teaching of biology through ICT enriched module were communicated to researcher. Researcher reset the modules and finally submitted all modules for validation to a committee of experts. These modules were authenticated and validated by a committee of three experts for implementation on selected sample. Email addresses of students were also taken to coordinate with students of experimental groups by respective teachers

A test instrument was prepared with the help of two working senior teachers, teaching biology at secondary level for more than ten years in Federal Government secondary school. Comments were taken on teacher made test, by nineteen teachers. Corrections and revisions were made in the test per comments given by nineteen senior teachers of biology. Final draft was submitted to validation committee. Validity of the test was assured by expert opinions and reliability was checked through try out. Try out was conducted at an Islamabad Model College for Girls, Islamabad. One section of biology grade-IX was selected and Teacher Made Test (TMT) was piloted on whole class of 41 students. After checking the test, test scores were analyzed using SPSS. The final test was reviewed based on item statistics. Item analysis was done, frequencies, Pearson's co-relation were found and alpha α -coefficient of reliability was calculated as 0.814. After the experts' validation, the teacher made test was finalized to be administered on the selected sample of the study.

This instrument was used as pretest and posttest. Pretest was administered to all students of experimental and control groups simultaneously to all boys and girls, same day, same time and in the similar environment before the start of experiment. Experiment lasted for consecutive 12- weeks involving teaching of biology via ICT enriched modules to experimental group and through traditional approach to control groups.

Achievement post-test was administered at very next day on the completion of experimental period. Pre-tests and post tests were compared and

analyzed in the light of research questions. Data were analyzed through SPSS and t-test, one-way ANOVA and two-way ANOVA were employed on gathered data.

Results and Findings

Mean scores of experimental and control groups were 29.21 and 29.70, respectively on the pre-test. It was found that both groups were similar

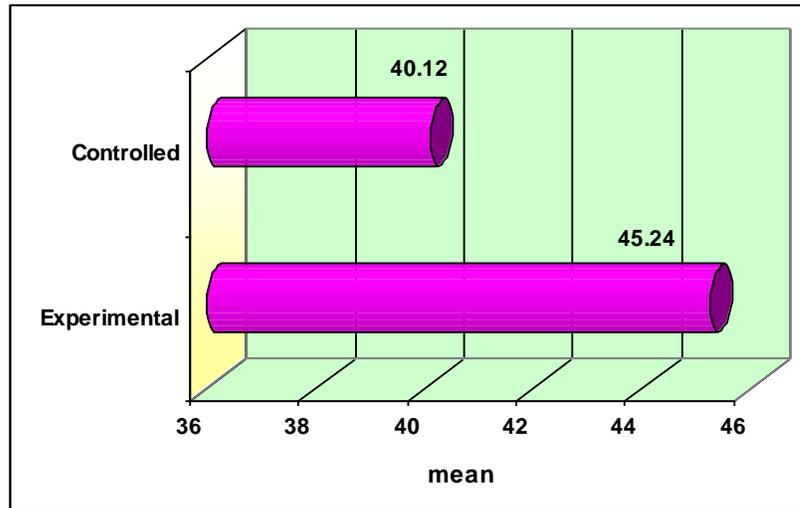
before the start of the experiment as there was no significant difference between the mean scores of groups. When groups' mean scores were compared on the post test, it was found that mean of the experimental groups (45.24) was much greater than control group (40.12) (figure 1.2). The p-value was significant at alpha .05 (table 1.1) showing the preeminence of ICT enriched modular approach over traditional lecture method.

Table 1.1

Mean and t-value on the scores of posttest

Group	N	Df	Mean	SD	t-value	p-value
Expt. Group	86	85	45.24	6.382		
Cont. Group	86	85	40.12	8.097	- 4.613	.000

Figure 1.2: Mean of Experimental and control groups on post test



Significant gender differences were also found on post test scores. Mean score of female students was much greater than that of male students

(table 1.2). ICT enriched modular approach was helpful for both male and female students.

Table 1.2

Mean score and t-value on the scores of posttest for male and female students

Group	N	Df	Mean	SD	t-value	p-value
Male	100	99	40.41	7.882		
Female	72	71	45.83	6.262	- 4.840	.000

Table 1.3

Effect of ability groups on post test

Ability groups	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3543.433	2	1771.716	45.216	.000
Within Groups	6621.980	169	39.183		
Total	10165.413171				

Significant effects of subgroups (high achievers, moderates & low achievers) were found on achievement posttest. ANOVA (table 1.3) indicated that achievement of sub groups was impacted by ICT enriched modular approach. This approach helped all three ability subgroups to achieve better scores in the subject of biology and

assisted especially low achievers to improve significantly because of ICT enriched modular approach. ANOVA (table 1.4) shows no significant effects of age groups on achievement posttest. So, it can be concluded that the performance of male and female students was not dependent on their age groups. Students of experimental group performed better irrespective of their age group level.

Table 1.4

Effect of age groups on post test

Age groups	Sum of squares	df	Mean square	F	Sig.
Between Groups	43.819	2	21.909	.366	.694
Within Groups	10121.594	169	59.891		
Total	10165.413	171			

To find the interaction of ability sub groups and groups, factorial ANOVA was applied. (Table 1.5) shows no mutual interaction of groups with sub

groups. Achievement of students was not affected by their groups (Experimental & control) and subgroups (high achievers, moderates & low achievers) interaction.

Table 1.5

Interaction of ability groups and groups

Sources of variation	Sum of Squares	df	Mean Square	F-Ratio	Sig.
Group (E.G & C.G)	773.149	1	773.149	23.678	.000
Ability group	3543.433	2	1771.716	54.260	.000
Interaction	71.020	2	35.510	1.087	.339
Error	5420.256	166	32.652		
Total	323481	171			

To find any existing interaction between ability sub groups and age groups, univariate analysis of variance i.e factorial ANOVA was applied. Table (1.6) shows insignificant interaction

of subgroups and age groups on achievement posttest. So, it can be concluded that achievement post test scores were not impacted by any interaction of sub groups and age groups.

Table 1.6*Interaction of ability groups and age groups on students post test*

Source of variation	Sum of Squares	df	Mean Square	F-Ratio	Sig.
Age	7.496	2	3.748		0.0960.908
Subgroup	1179.275	2	589.637	15.115	0.000
Interaction	258.075	4	64.518		1.65 0.163
Error	6358.525	163	39.009		
Total	323481	171			

Discussion

ICT enriched modular approach is an effective teaching method and employed to assess its effectiveness on academic achievement of biology students. Some of the researches have been

At the completion of the experiment a remarkable difference was noticed in the academic achievement of experimental and control groups. ICT enriched modular approach proved very useful in enhancing achievement scores of experimental groups. Findings of the present study are in accordance with the results of Pareek and Rao (1981). They conducted an experimental study to investigate the effectiveness of modular teaching and inferred that the modular teaching was helpful in creating interest in the studies and ultimately experimental group performed significantly better than control group. Results of current research study verify the findings of prior study carried out by Khatoon, S (2004). She concluded that modular teaching was very effective for the moral sense development of secondary level students as compared to traditional method of teaching. Ali (2005, p.138) found that modular teaching was effective and useful strategy as compared to traditional lecture method for the teaching of biology as this strategy provides better opportunities for learning and they study at their own pace. Moreover, this strategy is designed keeping in mind the needs and abilities of students. So, results of current study corroborate the findings of Ali (2005). Results of present study verify the findings of Lodhi (2007) and Ahmed, S (2007) who conducted experimental studies and concluded the effectiveness of modular teaching strategies. Behlol (2009) found a significant difference between the mean scores of experimental and control groups on posttest, concluding that the achievement of experimental group, was significantly appreciable than control group. Hence results of current study are in complete agreement with Behlol (2009). Findings of present study are

conducted on modular approach while a few were carried out on ICT based learning. None of the researches were conducted to find out the effectiveness of ICT enriched modular approach on academic achievement of biology students.

contradictory to the findings of Gordijin and Nojhof (2002), who investigated the effects of complex feedback on computer assisted modular instruction and deduced that the application of complex feedback is somehow effective but does not increase the post test result notably (p.183). Several studies advocate the importance and impact of Information and Communication Technology on the learning of students. Kulik and Kulik (1980, 1984, 1991) reviewed 284 controlled evaluation studies of technology mediated learning. In 81 % of the studies supported the technology mediated learning. Hence present study is also in the favor of ICT enriched modular teaching approach. Devi, P. (2006), investigated the use of ICT based modes of communication for distance learning at University of the South Pacific and found ICT modes of communication very effective. These findings are in line with the findings of present study. Gender differences were also investigated in the current research study. Female students performed significantly better on posttest than male students. These findings are contradictory to the findings of Khatoon (2004). She found boys better than girls in general comprehension while there was no significant difference between male and female students in textual comprehension. Significant differences were also found among the students of different abilities. High achievers of experimental group attained more than the high achievers of control group. This finding supports the findings of Behlol (2009). However, findings of Woods (1986) and Ali (2005) contradicts the finding of current study. They found that modular approach did not increase the achievement of high achievers. Moderate students of experimental group attained

more than the moderate students of control group. Likewise, low achievers of experimental group attained considerably better than the low achievers of control group. This strategy was more helpful for low achievers and they improved significantly because of ICT enriched learning environment.

Findings of Barnes *et al.* (2000), and Block (1987) and Behlol (2009) support the results of current study. Valletutti and Salpino (1985), as mentioned in Ali (2005) that modular teaching strategy was most helpful for below average students. Shipley *et al.* (1989) reported that modular teaching strategy has equal benefits for all ability groups like above average, average and below average students.

Qadeer, A. (2005) also found that below average students benefited more than average and below average students when taught through ICT based learning. So, findings of Valletutti and Salpino (1985), Ali (2005), Shipley *et al.* (1989) and Qadeer, A. (2005) corroborate the findings of present study. Ahmed, S (2007), and Behlol (2009) also found the similar results. No significant effect of age groups was found and there was no interaction of groups or sub groups with age groups. Qadeer (2007) also found similar results.

Conclusions

From the above-mentioned findings, it is concluded that ICT enriched modular teaching strategy was more effective for secondary level biology students in increasing their academic achievement. Gender differences were also found there. Female students attained more as compared to male counterparts in achievement posttest. Female students were observed to be highly motivated and interested towards ICT enriched modular teaching strategy. This strategy was very effective for high achievers, moderate and low achievers. Low achievers significantly improved because of this strategy. It can be concluded that this self-instructional strategy of ICT enriched modular approach is specifically beneficial for low achievers. Age groups of the students had no significant role in the achievement of biology students. No interaction of age groups was found with groups (experimental & control) or sub groups (high achievers, moderate and low achievers).

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Figure 1.1: Sampling technique: Stratified Random Sampling

