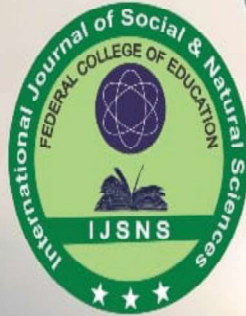


ISSN: 3079-286X

IJSNS
ISSN: 3079-286X

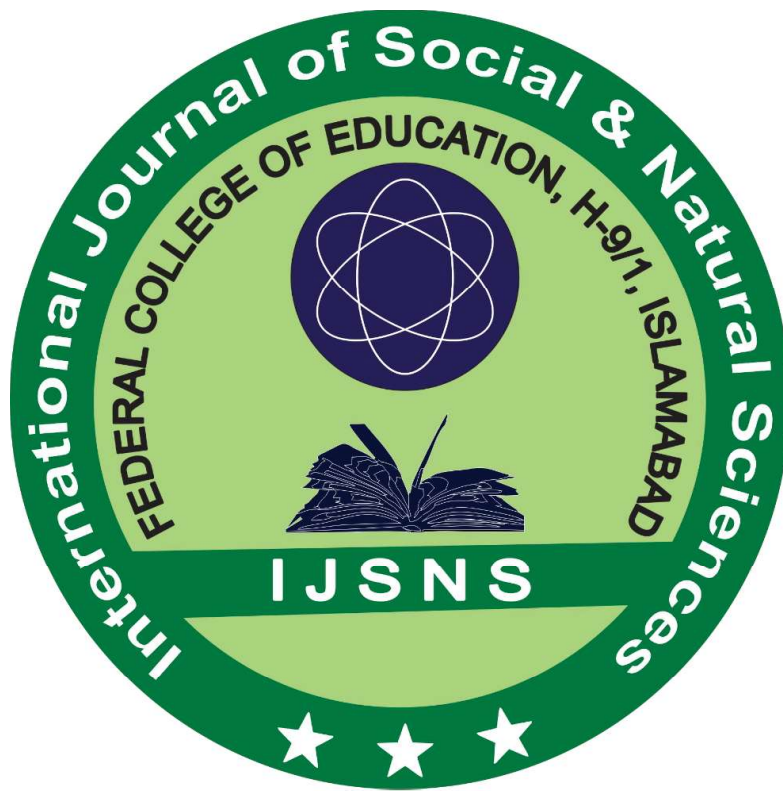


**International
Journal of
Social and Natural
Sciences**

**International Journal of Social
and Natural Sciences**

ISSN: (Print)
ISSN:(Online)

International Journal of Social and Natural Sciences



Vol.1 (01) January 2025

**Federal College of Education H-9/1 Islamabad
Pakistan**

International Journal of Social and Natural Sciences

International Journal of Social and Natural Sciences is a biannual publication of the Faculty of Social Sciences, Federal College of Education H-9, Islamabad, Pakistan. Articles published in the journal are selected based on quality. Views expressed in the journal are those of the authors and do not necessarily reflect the views of the International Journal of Social and Natural Sciences (IJSNS).

SUBSCRIPTION

	Pakistan	Foreign
Single copy:	Rs. 1000	Individual: US \$ 50.00
Libraries & Institutions:	Rs. 2000	US \$ 100.00

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ACKNOWLEDGMENT

I am deeply grateful to Almighty Allah, the Creator of the Universe, and those who contributed to the completion of this research journal. First and foremost, I extend my heartfelt gratitude to Dr. Mukhtar Ahmed , Chairman of the Higher Education Commission, Prof. Dr. Muhammad Akram Shaikh, Director General of PASTIC and Pakistan Science Foundation, and Dr. Maryam Ibrar Additional Director STI, PASTIC National Centre their guidance, constructive feedback, and encouragement have been invaluable throughout this journey. Their expertise and dedication were crucial to shaping this work.

I also wish to thank my peers and colleagues for their insightful discussions and support, which provided me with different perspectives and helped refine my ideas.

A special thank you to Prof. Dr. Samia Rehman Dogar, Director, Federal College of Education H-9 Islamabad, whose unwavering support and patience have been a source of motivation and strength and providing the resources and environment necessary to complete this work.

This journal is the result of collaborative efforts, and I am truly grateful to everyone who contributed to its creation.

Editor
IJSNS

Effectiveness of ICT integrated Modularized Instruction on Retention Learning of Science Students

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Accepted: 23 December 2024

Published: 30 January, 2025

ABSTRACT:

In this era of globalization, the needs of digital learners demand the use of technology-driven classrooms and learning resources. To assess the effectiveness of ICT integrated Modularized Instruction, an experimental study was designed and implemented in one of the Islamabad Model Colleges for Girls and one for Boys simultaneously. All science students of class 9th, who were studying Biology as one of the elective subjects at these colleges were the target population. A total of 172 students formed the required sample. Technology-enriched modules were prepared to teach the students of the experimental group. A sample of 172 students was divided into groups (treatment, reference) and subgroups (3-categories) using stratified random sampling. Random assignment of two biology teachers was ensured who were equally qualified and trained. One-week training oriented teachers with the objectives and operational procedures of modularized Instruction. A pretest-post-test control group design was employed to assess the retention learning of students. T-test and ANOVA helped to determine the statistically significant differences among the groups. On the whole, ICT-integrated modularized Instruction enhanced the retention learning of students.

KEYWORDS:

Retention learning, Modularized Instruction, Information and Communication Technology, Integration

INTRODUCTION

In the modern era of science and technology, advancements in Information and Communication Technology (ICT) have placed significant responsibility on educators, curriculum designers, and instructional designers to align curricula with the needs of 21st-century digital learners. Research by Kumar and Chubin (2000) and Fisher (2002) has shown that electronic and information technologies can significantly enhance students' learning processes and classroom environments.

Holliman and Scanlon (2004) noted the potential of ICT in science education, and Scott (2015) emphasized the need for new competencies and pedagogical approaches for contemporary learners.

This study examines the impact of integrating ICT tools with modular teaching strategies on the retention learning of 9th-grade biology students. Modular instruction involves self-instructional, self-paced learning modules, each

designed with specific learning objectives, assessments, and feedback (Shaheen & Khatoon, 2017). This strategy caters to individual student needs, promotes learning autonomy, and increases motivation, interest, and engagement.

Research by Thomas (1993) and Carmen et al. (2005) highlights the benefits of modularizing curricula to meet learners' needs and maintain student involvement through short-term assessment goals. Betts and Smith (1998) found that modular teaching requires more student effort than traditional face-to-face teaching, addressing issues of student committed time effectively.

In Pakistan, educational trends are evolving, and limited research is being conducted to explore the effects of ICT in education. This investigation intends to assess the efficacy of ICT-supported teaching through modules on the retention learning of biology students.

Literature Review

The use of ICT-based instructional strategies is a central point of research globally, with studies highlighting its role in teaching and learning processes. This literature review examines the effectiveness of ICT-integrated modularized instruction on retention learning, drawing on various studies to contextualize the current research.

Research by Ghavifekr, S., & Wan Rosdy, W. A. (2015) emphasizes the effectiveness of ICT integration in schools, noting that well-equipped teachers and professional development

programs significantly enhance students' quality of learning. Similarly, Corlet, D. G., & Alimonsurin, A. V. (2023) highlight the positive impact of ICT on student engagement, critical thinking, and creativity.

Studies specific to science education, such as those by Hussain, I., Bhatti, T. M., & Asad, M. A. (2020) demonstrate that ICT enhances students' educational achievement and retention in courses like chemistry. The use of ICT tools in science education has been shown to build more engaging and cooperative learning environments, leading to better retention of content.

Modularized instruction, characterized by self-paced, self-instructional learning modules, has been found to cater to individual student needs and promote learning autonomy. Research by Shaheen & Khatoon (2017) and Sadiq & Zamir (2014), Ali, R., Ghazi, S.R., Khan, M.S., Hussain, S., & Fatima. Z.T. (2010). Lodhi (2007), Ali, R (2005) support the effectiveness of ICT-enriched modular teaching over traditional methods, showing significant differences in retention learning between treatment and control groups.

Overall, the literature supports the notion that ICT-integrated modularized instruction can significantly enhance retention learning in science education. The current investigation adds to this kind of research by substantiating scientifically and empirically in the Pakistani context, highlighting the prospective for ICT to improve educational practices and student outcomes.

Main Objective

The focus of the current investigation was to observe the efficacy of ICT-supplemented modularized instruction on the retention learning of secondary-level learners of biology.

Research Questions

1. Does the ICT-integrated modularized instruction have any effect on the retention learning of science students in 9th grade studying biology?
2. Are there any gender-based patterns of retention learning when taught through ICT integrated modularized instructional strategy?
3. Do the significant differences lie among the ability groups (average, below average, and above average) when taught through ICT-enriched modularized instructional strategy?

METHODOLOGY

Ten biology modules for grade IX were developed and integrated with ICT tools, grounded in cognitive theories like Robert M. Gagne's (1974) "Nine Events of Instruction" and the principles of constructivism were used for ICT integration. A pre-test, post-test control group design was employed for the current examination. The methodology includes:

Independent Variables

Information and Communication Technology (ICT) enriched the modular teaching strategy for the experimental group and the traditional teaching strategy for the reference group.

Dependent Variable

Students' retention learning, is determined through the results of delayed post-tests.

Control Variables

For this experiment, certain variables were controlled throughout the defined period of the experiment. Selection of instructors having similar qualifications academically and experience of almost 5 years. Both groups (experimental and control) carried an equal number of students likewise subgroups also comprised of equivalent number of pupils. Accessibility to similar ICT facilities was also ensured in both schools

Uncontrolled Variables

Acquaintance with ICT and the environment at home could have intervened. Similarly, factors such as parents' academic and financial backgrounds, students' home tutoring, and pupil friendship circles were not under the control of the researcher. So these variables remained uncontrolled while they could have interfered with the results.

Limitations and Delimitations

Due to constraints of ICT facilities, only the urban sector of Islamabad was selected for this experiment. The urban sector of Islamabad included secondary and higher secondary schools as well as Islamabad Model Colleges. During initial visits to schools' insufficient ICT facilities, poorly managed labs, and a shortage of biology teachers were found in secondary and higher secondary schools while the availability of multimedia was only found in Islamabad Model Colleges. So the study was delimited to Islamabad Model Colleges only and two schools were selected where appropriate ICT facilities, multimedia, and sufficient biology teachers were available. Likewise, modules of biology were prepared from the middle section of the

book only as the management of the schools hesitated to form experimental and control groups for a longer period.

As experiment lasted from September to December for a period of twelve weeks, which was a crucial time period for grade 9 due to centralized board exams. So assessments were limited to MCQs multiple choice questions only so that they could be completed within the specified time of biology class. In these assessments were limited to lower-order thinking skills of the cognitive domain only.

Procedure

An in-depth review of existing literature was done. Need Analysis was done based on the National Curriculum 2006. Assessments were also formulated from the said curriculum. These modules were integrated and blended with ICT tools like video clips, simulations, thematic poems, web links, animations, pictures and multimedia CD-ROM etc. Each module had the specific end time mentioned with the module. Modules were made a self-learning resource for the learners to cater their individual needs. Compact Disks (CDs) of the said modules were provided to the students of experimental group.

To make the modular content reliable, try out of one module was done in a model college other than experimental colleges. Three experts were contacted to validate the content of the modules. Few alterations were done based on expert feedback and trial observations. Contents of the modules were arranged into small-interrelated phases. Every phase had its defined outcomes, learning strategy, evaluative assessment and corrective feedback. Students can had multiple

trials of the same modules until they succeed in progressing to the next stage.

An instrument was developed by a researcher with the help of two biology teachers. This instrument was pilot-tested to ensure its reliability while a group of three experts of biology validated it. Revisions were made accordingly. The reliability coefficient ($\alpha = .80$) was high enough to ensure the reliability of the instrument.

The population of this study included all biology students in 9th grade, studying in Islamabad Model Colleges for Boys and Girls (IMCBs & IMCGs). To conduct this experimental study an application was submitted to the Director Model Colleges to seek permission for the conduction of the investigation at two chosen Islamabad Model Colleges. Management of the mentioned colleges were informed by FDE about this research study and permission was granted. Moreover written consent letters were taken from management of the schools and biology teachers before the start of the experiment and orientation session.

172 learners were purposely selected as the sample of the study from two schools. All 100 boys and 72 girls were initially categorized as above average, average and below average students on the basis of pre-test scores. 24 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. Technique of stratified random sampling was applied. After the categorization of pupils into three subgroups, draw method was used to assign

students randomly to different groups (experimental, control).

Two biology teachers were chosen and assigned to either group at random. It was prior ensured that teachers have the same qualifications and similar experience range. A capacity-building training of one-week duration was organized for the experimental group (teachers and students) to orient and train them regarding the usage of ICT tools, modular content presentation, delivery, assessments, and feedback mechanisms.

Treatment was carried out for a period of consecutive three months in two colleges (male & female) separately. A pretest was conducted in both schools before the start of the experiment on the same day, same time, and in almost similar classroom conditions. Technologically enriched modules using multimedia resources were used to teach the learners of the treatment group while learners of the reference group were taught using conventional ways of instruction.

After twelve weeks, a posttest was conducted to

quantify the attainment of pupils. Two weeks later, following the last day of treatment, the same test was again administered as a retention test or delayed posttest to check the retention learning of students.

Checking and scoring of all tests was done by a subject teacher. Statistical analysis of raw data was done using independent sample t-test, ANOVA, and factorial ANOVA.

RESULTS AND FINDINGS

t-test analysis (table 1.1) for the differences in mean scores of groups (experimental & control) on delayed posttest shows 6.44 mean difference and t-value ‘-6.617’ is very significant ‘0.000’ while ‘ $p \leq 0.05$ ’. This shows retention learning of students of the treatment group was enhanced as compared to the reference group. Treatment of technology-based modularized teaching strategy had positively impacted the retention learning of students

Table 1.1. t-test analysis for means differences in groups (experimental vs control)

Groups	N	Df	Mean	SD	t-value	p-value
Experimental group	86	85	46.87	5.353	- 6.617	.000
Control group	86	85	40.43	7.617		
Difference			6.44			

To find out the gender differences (table 1.2); on retention, a t-test was used. T value ‘-3.110’ was quite significant ‘0.002’ at ‘ $p \leq 0.05$ ’ confidence level, showing that retention learning of girls

(treatment group) was greater than boys students. Moreover, the retention learning of the experimental group (boys & girls) was much better than the learners (boys & girls) of the reference group (Figures 1.1 & 1.2).

Table 1.2. t-test analysis for gender differences regarding retention learning

Group	N	Df	Mean	SD	t-value	p-value
Male	100	99	42.22	7.457	-3.110	.002
Female	72	71	45.67	6.707		
Difference of mean			3.45			

Figure 1.1 Overall gender differences on the retention test

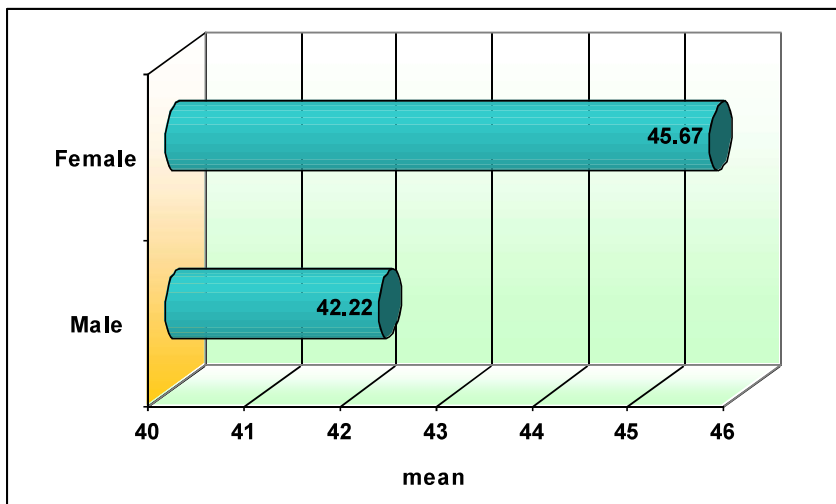


Figure 1.2. Gender differences in treatment and reference group

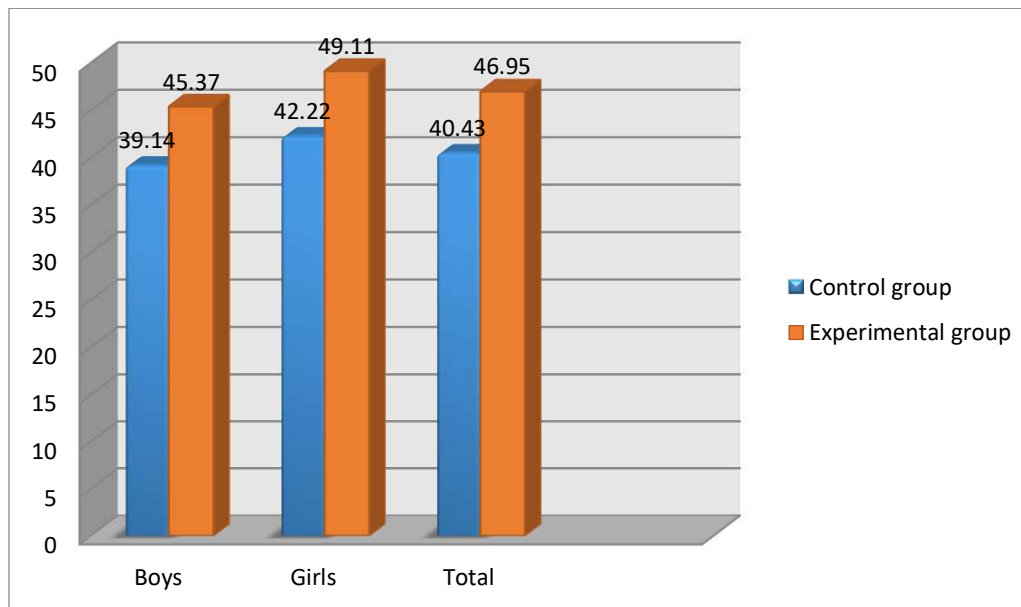
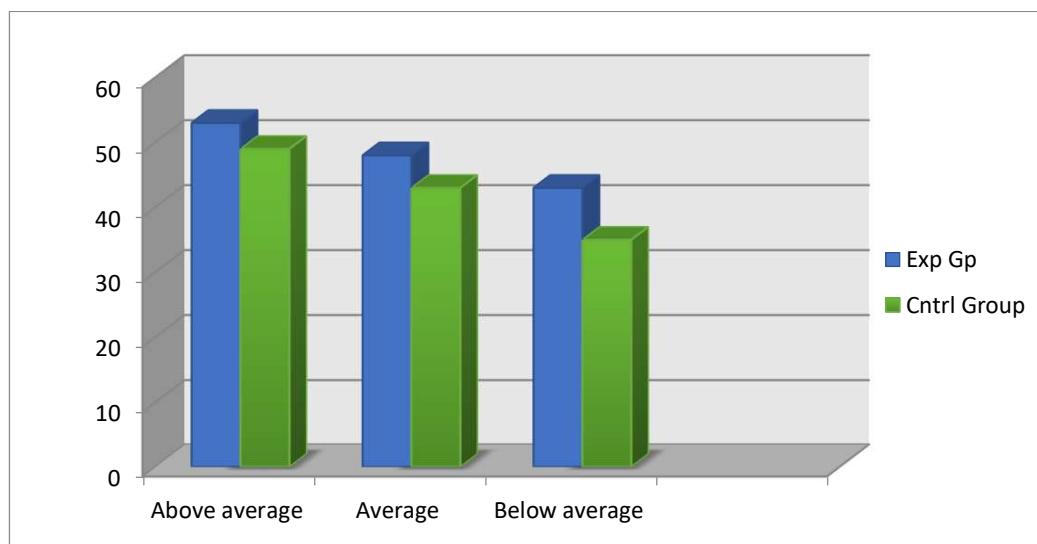


Table 1.3 indicates the analysis of variances among the three ability groups of average, below average, and above average to assess whether ability groups have any significant or non-significant effect on retention learning. Table 1.3 shows an F-value highly significant ‘0.000’ at the ‘0.05’ level of confidence. This shows a noteworthy impact of ICT enriched modularized teaching strategy was noticed on the sub groups of treatment group. Below-average students were specifically noticed for higher retention learning than average and above-average students (figure 1.3).

Table 1. 3. Retention learning of subgroups: ANOVA

Ability groups	Sum of squares	df	Mean square	F	Sig.
Between Groups	2914.680	2	1457.340	39.492	.000
Within Groups	6236.390	169	36.902		
Total	9151.070	171			

Figure 1.3. Retention learning of sub-groups



Therefore, it is concluded that ICT-integrated modularized instruction is a useful strategy in increasing the retention learning of biology learners.

DISCUSSION

Research on ICT-integrated modular instruction is extensive globally but limited in Pakistan. This study supports findings by Shaheen & Khatoon (2017), who found significant differences between treatment and control groups using ICT-enriched modular teaching for biology students. Sadiq and Zamir (2014) reported similar results.

Tahir (2005) also found significant differences in retention learning with ICT use in mathematics instruction, aligning with the current study's findings. An achievement post-test and a delayed post-test were conducted, revealing that the experimental group retained

more biology content due to ICT-enriched instruction.

Several studies, including those by Pareedy (1989), Barnes et al. (2000), Behlol (2009), and Devi (2006), support the effectiveness of modular instruction and ICT in improving student engagement and retention. Findings from Behlol (2009), Shaheen (2015), Behlol & Khan (2016), and Devi (2006) are consistent with this study.

Gender differences were significant, with female students outperforming males in retention learning, contrasting with Khatoon (2004), who found male students excelled in general comprehension. The current study

shows improved retention for all student subgroups (high achievers, moderate, and low achievers) in the experimental group, echoing results from Sharma (1999), Qadeer (2005), and Ahmed (2007) regarding the effectiveness of ICT-enriched modular instruction for below-average students.

CONCLUSIONS

From the above findings, it can be concluded that ICT-integrated modularized instruction for biology was an effective and efficient way of improving the retention learning of science students in grade 9th. Girls scored well on retention tests as compared to boys, indicating that the retention learning of female students was much enhanced through ICT-integrated modularized instruction. Moreover, this teaching strategy is more effective for less privileged low achievers in increasing their retention of learning.

RECOMMENDATIONS

By looking at the findings of the current study, it is recommended that ICT-integrated modularized instructional strategies may be employed at the secondary level for teaching of science subjects. Curriculum may be made modularized and integrated with ICT tools so that outcomes, content, methodology and assessments for science subjects may be formulated and aligned with modular curriculum.

More detailed and in-depth quantitative as well as qualitative studies are required in this area for science as well as subjects of Humanities, social sciences, and teacher education. This study was conducted in Islamabad city only. Such studies

need to be replicated throughout Pakistan to highlight a broader scenario regarding such impacts.

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