

THE USE OF INSTRUCTIONAL TECHNOLOGY IN EFFECTIVE TEACHING OF BIOLOGY AT SECONDARY LEVEL

By

Dr. Syeda Nosheen Gillani*

Aijaz Ahmed Gujjar**

Bushra Naoreen***

Abstract

Educationists are of the opinion that the educational problems relating to quantity and quality could be tackled by the proper utilization of instructional technology. Instructional technology is a systematic way of designing, carrying out and evaluating the teaching learning process. Instructional technology makes instruction more effective, understandable and meaningful. All types of resources are used to make the learning much easy. Traditional teacher-centred approach in the classroom has been shifted from teaching to learning process. It is called student-centred or resource-based approach, the student being the resource. Learning through hearing alone proves to be the least effective means of learning. One learns eleven percent by hearing as against eighty-three percent by seeing. As far as retention of hearing is concerned, learning through hearing again stands at the lowest ebb because after three days, we recall only ten percent of what we learn through hearing as against fifty percent of what we learn through both hearing and seeing, and ninety percent of what we acquire by applying three of our senses, i.e., seeing, hearing and doing. The major objectives of this study were: (i) To find the relative effectiveness of instructional technology in teaching biology at secondary level to students of experimental group and control group. (ii) To see the difference of treatment effects between the students of low achievers and high achievers. (iii) To see the difference of treatment effects between the students of the control and experimental groups on the variable of retention. This study is significant because the findings have identified the effectiveness of instructional technology and weakness of traditional approach at secondary

* Deputy Head Mistress, F. G. Girls Model School, I-10/4. Islamabad

** PhD Scholar at the Department of Education, Islamia University, Bahawalpur and working as Lecturer, Federal College of Education, H-9, Islamabad.

*** PhD Scholar, at the Department of Education, Islamia University, Bahawalpur and working as Lecturer, G. C. University, Faisalabad.

level in teaching biology. The researchers selected the students of 10th class of the Federal Government Girls Secondary School No.6 and two groups (experimental and control) were randomly secured from total available group. The equivalence of the groups was determined by equating the students of both groups on the pre-test scores. Four chapters of biology were taught during the experiment of both experimental and control groups by two different teachers almost of the same qualification and experience and were intended to measure the outcomes of learning. The post-test was administered to both groups after twelve weeks. The retention test was administered after twelve weeks of the post-test. In order to secure data, pre-test and retention test were administered as research instrument. Data were tabulated, analyzed and interpreted in the light of objectives of the study. In order to see the significance of the results, the t-test was applied. The analysis revealed that the application of instructional technology as supplementary strategy in teaching biology was more effective because the use of instructional technology increased interest and enhanced motivation levels. Instructional technology as supplementary strategy was also found to be equally effective for low achievers and high achievers. On the basis of findings, researchers provided workable suggestions/recommendations for enhancing the effective learning of students of biology at secondary level.

Introduction

At the beginning of the last century, children were taught in a rigidly formal and stereotyped way. Education was then conceived as a process of transmission of factual knowledge only. The teacher adopted an authoritarian attitude. The facts learnt by children were tested from time to time, but such tests were neither concerned with conceptual understanding nor effective performance. The main emphasis was on testing the memory. A long time had intervened between the child's response and the teacher's reinforcement. The teacher very often used the lecture method, which was not much effective for meaningful learning. The teacher did not use other visual material to supplement his/her oral teaching.

The teacher of today does not consider the child as a vessel waiting to be filled up with facts nor as a pliable plastic material, which can be transformed into any shape enabling him/her to project his/her ideas on it. He rather acts as a facilitator (Soto, 2007). Moreover, in today's world, the teacher "considers each child as akin to a plant and helps the child to grow according to its abilities and aptitudes. He/She helps the children to learn. He /She realize that "to teach is to nourish or cultivate the growing child or to give him intellectual exercise or to

train him in the horizontal sense of directing or guiding his/her growth” (Chandra, 2008:11). The modern teacher sees education as a process of interaction between the child and his environment. Children learn by doing and learn how to learn in groups and also individually.

Increase in population and explosion of knowledge are affecting the pattern of human life and also inflicting its full impact on education (Kumari, 2004). The explosion of population and knowledge has raised the serious question of both quantity and quality of education. Educationists are of the opinion that the educational problems relating to the quantity and quality could be tackled by applying systematic approach of instructional technology (Abdelraheem, 2005). Therefore, there has been a rapid development of communication technology in education at all levels with the purpose of extending educational facilities and upgrading instructions. Instructional technology is a field made up of elements of other fields. There is very little content, which is unique. It has taken elements of cognitive psychology, perception psychology, measurement, evaluation, communication, management, media and systems engineering (Ely and Plomp, 1996). These elements are arranged synergistically to a point where the whole is greater than sum of its parts. The field has rapidly evolved from audiovisual education through educational communications to instructional technology. There is overlapping of ideas mainly between three terminologies, viz; educational technology, instructional technology and communication technology.

Though the term instructional technology is often used interchangeably with educational technology, it presents certain refinements that are not found in the meanings of educational technology. Venkataiah (1996) describes instructional technology as “The media born of the communications revolution which can be used for instructional purposes along side the teacher, textbook and blackboard”, and “A systematic way of designing, carrying out and evaluating the total process of learning and teaching in terms of specific objectives based on research in human learning and communication, and employing a combination of human and non-human resources to bring out more effective instruction”. Venkataiah (1996) further states that “technology of instruction can make an ordinary person capable of superior performance and a means, either printed or electronic, to distribute that instruction”.

Instructional technology as considered by Leedham (1967) concerns the systematic use of modern methods and technologies in teaching and learning. It involves teachers in a variety of roles, some of which are traditional, some still emerging. In this definition, special consideration is given to the adaptive role of

the teacher. One purpose of studying instructional technology is surely to help us to make the best use of capabilities of individual teachers. Instructional technology is fundamentally aimed at improving the efficiency of the educational system by increasing the rate, depth, precision and value of the learning, which takes place.

As the major field of education, science was taught in an authoritarian manner as a 'dogma' of facts, principles and laws to be memorized and handed back during the examinations. This is what Parkinson (2004:236) calls the transmission mode. Characteristics of science, i.e., excitement of discovery and critical thinking, were missing in science teaching. There was considerable reliance on chalk talk method for teaching science and very little emphasis on laboratory activities and that without the use of low cost inexpensive instructional materials.

Therefore, Bruner (1969) gave a word of caution when he said: "I do not restrict discovery to an act of finding out something that before was unknown to mankind, but rather include all forms of obtaining knowledge for oneself by the use of one's own mind." We cannot, therefore, expect the pupils at secondary level to make original contribution to the accumulated scientific knowledge of the world. What will be found, no doubt, is already known and probably found in some textbook. In short, discovery does not mean to discover something new and completely unknown.

When child is helped or guided to discover a generalization imposed upon him/her, he/she is developing his rationale powers, gaining an understanding of content and the process learning. Authoritarian teaching consists of imposing upon the pupils the generalization which are truly their own. Children who learn science by the discovery approach will discover for themselves the true structure of the discipline in complete harmony with modern philosophy of science education (Abruscato, 2005).

The teaching method, which is traditionally used, for teaching biology in secondary schools of Pakistan, is a combination of lecture method, textbook recitation method and to some extent chalkboard is used. The lecture method is a teaching procedure with one way channel or communication. The instructor makes an oral presentation of information to which student's role is passive. The student is never put into the situation from where he can move to logical reasoning and critical thinking that reduces their learning process.

Instructional technology can enhance learning process. Instructional technology is made up of the things of learning, the devices and the materials, which are used in the process of learning and teaching. Instructional technology emphasizes the interaction between student and his environment, which is the basic requirement of biology syllabus. The teaching of biology is very important because the knowledge of biology helps in improving the quality of life, biology covers all aspects of life, so it goes without saying that biology should be taught in order to succeed in life. Knowledge of biology helps in solving many social problems relating to health, poverty, food shortage and crop production and environmental conservation.

Objectives

The following were the objectives of the study:

1. To find out the relative effectiveness of instructional technology on the students of experimental group and control group.
2. To see the difference of treatment effects between the students of low achievement and high achievement levels.
3. To see the difference of treatment effects between the students of the control and experimental groups on the variable of retention.
4. To make workable suggestions/recommendations to enhance the learning process during teaching of biology.

Research Methodology

The study was experimental in nature and used a pre-test post-test single group experimental design.

Population and sampling

Population of the study included those students studying Biology subject at secondary level. As a sample, eighty students of 10th class of the F. G. Girls Secondary School No.6, I-10/4, Islamabad, were selected as sample of the study. Sample students were divided into two groups, i.e., control group and experimental group. Both the groups were equated on the basis of their pre-test scores in the selected part of biology. Each group comprised of 40 students.

Contents of the study

Pre-test, post-test and retention tests were developed in order to gauge the performance of the students before and after the treatment. The t-test and ANOVA were used to compare the means of the results of pre-test and the post-test in order to find out whether there was a difference in achievement due

to the treatment. The test comprised of 50 items and each item was allocated one mark weight age.

Great care had to be taken in the selection of the course content for the study because it might have had an adverse effect on the end-term performance of the students. This was perhaps the most important ethical issue of this study. Its difficulty level and discrimination index was found. Difficulty level is determined by the calculation of proportion of examinees who answer correctly and discrimination index is the measure of effectiveness of item which discriminates between high and low achievers of the test. On the basis of two calculations those items were excluded which were not meeting the standard of accepted difficulty level and discrimination index that was:

Difficulty level: 0.30 to 0.70 is acceptable
 0 to 0.20 is rejected due to low difficulty level
 0.80 to 1.0 is rejected due to high difficulty level

Discrimination index: 0.40 and above is acceptable
 0.30 to 0.39 needs no revision
 0.20 to 0.29 needs revision
 0.19 or less than 0.19 to be eliminated/ discarded.

Finally there were 50 items including logical part after pilot study. The division has been mentioned above. Item wise results of pilot study of the test have been mentioned in overall reliability of the test was 0.820.

Treatment

Discovery approach combined with discussion was used for teaching both control and experimental groups. In addition, the instructional technology was used as supplementary strategy for experimental group. Lessons of relevant topics were planned according to the type of learning resources. These planned lessons were prepared by the consultation of experts of biology subjects at secondary level. Recorded movies on relevant topics were used to present questions and elicit answers. Students' activities ranged from very passive, as in viewing films to very active as in making field trips to observe and study actual things. Passivity versus activity varied exceedingly according to kind of resource and the purpose in using it as used transparencies during lesson. Duration of films was about 10 minutes and was used in the beginning of lesson, which motivated students to take part in discussion about relevant topic. During this period of forty minutes, teacher engaged the students in the process of problem solving and rational thinking under various degrees of teacher's supervision. The

teacher's role was to guide the classroom discussion. The teacher emphasized the development of self-initiated and self-directed pupil learning which placed the students in the role of the inquirer.

Findings

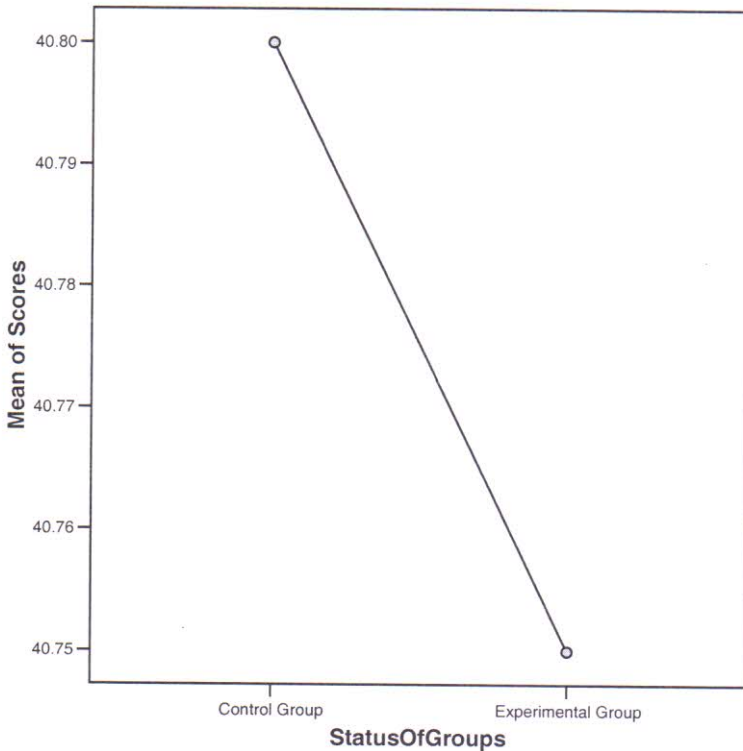
Ho: There is no significant difference between the performance of control and experimental groups on pre test

Table – I
Showing the difference between the mean scores on pre test of control and experimental groups

Groups	N	Mean	Std. Deviation	Std. Error Mean	t-value	p-value
Control	40	40.8000	2.86625	.45319	0.077	0.939
Experimental	40	40.7500	2.91548	.46098		

The above-noted table indicates that there is no significant difference between the mean scores of both the groups. Hence, the null hypothesis: "There is no significant difference between the performance of control and experimental group" is accepted. Therefore, both the groups could be treated as equal on the variable of pre test scores in biology.

Figure – 1
Showing the mean plots of control and experimental group on pre test.



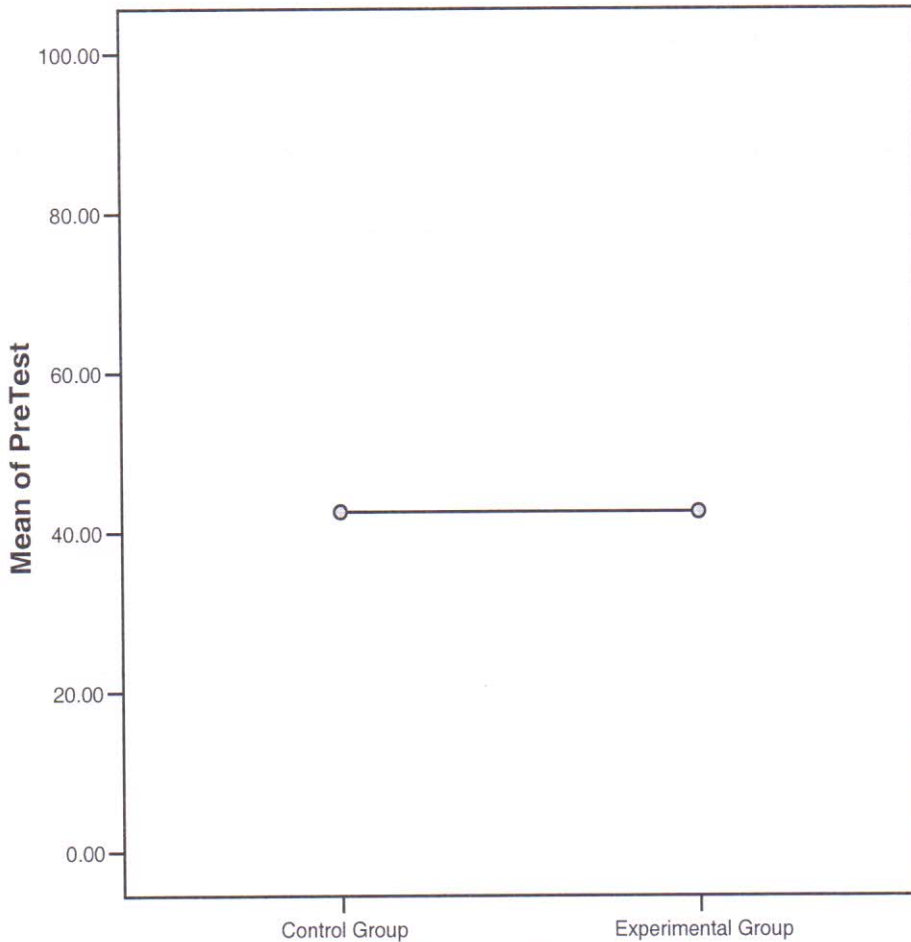
Ho: There is no significant difference between the performance of high achievers of the control and experimental groups on pre test.

Table – 2
Showing the difference between the mean scores of high achievers of the control group and experimental groups on pre test

Status of Groups	N	Mean	Std. Deviation	Std. Error Mean	t-value	p-value
Control Group	26	42.5769	1.02657	.20133	0.180	0.840
Experimental Group	26	42.5769	1.02017	.18125		

The above-noted table indicates that there is no significant difference between the mean scores of both the groups. Hence, the null hypothesis: “There is no significant difference between the performance of high achievers of control and experimental group” is accepted. Therefore, both the groups could be treated as equal on the variable of pre test scores in biology.

Figure – 2
Showing the mean plots of on high achievers of control and experimental groups on pre test



Status of Groups

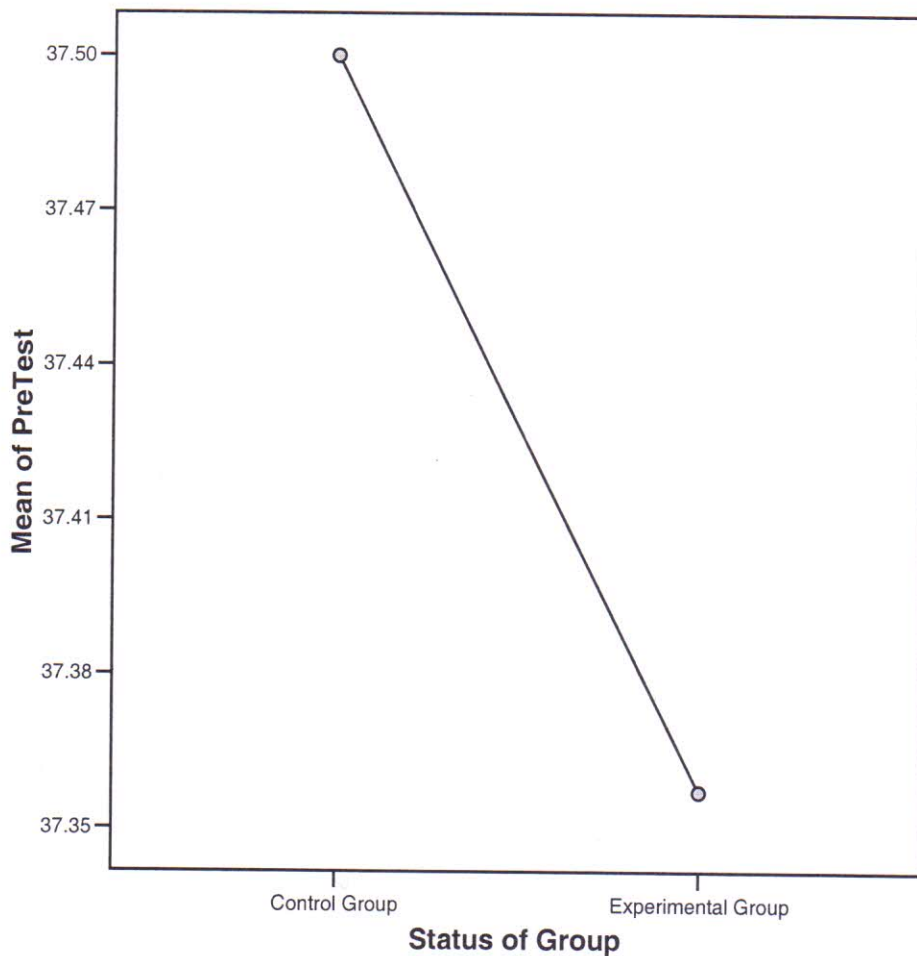
Ho: There is no significant difference between the performance of low achievers of the control and experimental groups on pre test.

Table – 3
Showing the difference between the mean scores of low achievers of the control group and experimental groups on pre test

Status of Group	N	Mean	Std. Deviation	Std. Error Mean	t-value	p-value
Control Group	14	37.5000	2.13937	.57177	0.178	0.860
Experimental Group	14	37.3571	2.09788	.56068		

The above-noted table indicates that there is no significant difference between the mean scores of both the groups. Hence, the null hypothesis: "There is no significant difference between the performance of low achievers of control and experimental group" is accepted. Therefore, both the groups could be treated as equal on the variable of pre test scores in biology.

Figure – 3
Showing the mean plots of low achievers of control and experimental groups on pre test



Ho: There is no significant difference between the performance of the control and experimental groups on post test

Table – 4

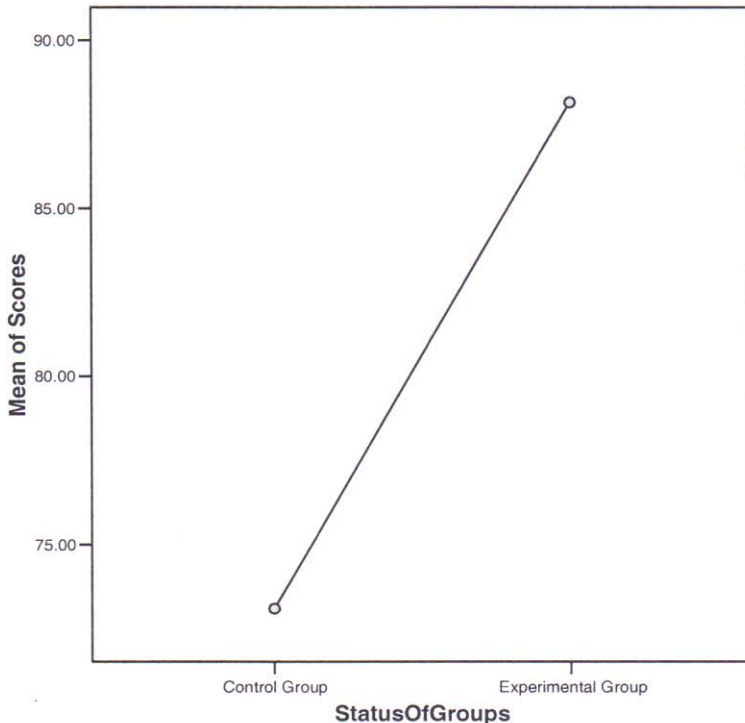
Showing the difference between the mean scores on post test of control and experimental groups

Status of Groups	N	Mean	Std. Deviation	Std. Error Mean	t-value	p-value
Control Group	40	73.1000	3.12804	.49459	14.895	0.000
Experimental Group	40	88.1500	5.57260	.88111		

It is apparent from above table that there is a significant difference between the scores of both the groups. The experimental group is significantly better than control group, so the null hypothesis: “There is no significant difference between the performance of the control and experimental groups on post test” is rejected, and it is concluded that the experimental group is significantly better.

Figure – 4

Showing the mean plots of control and experimental groups on post test



Ho: There is no significant difference between the performance of low achievers of control and experimental groups on post test

Table – 5

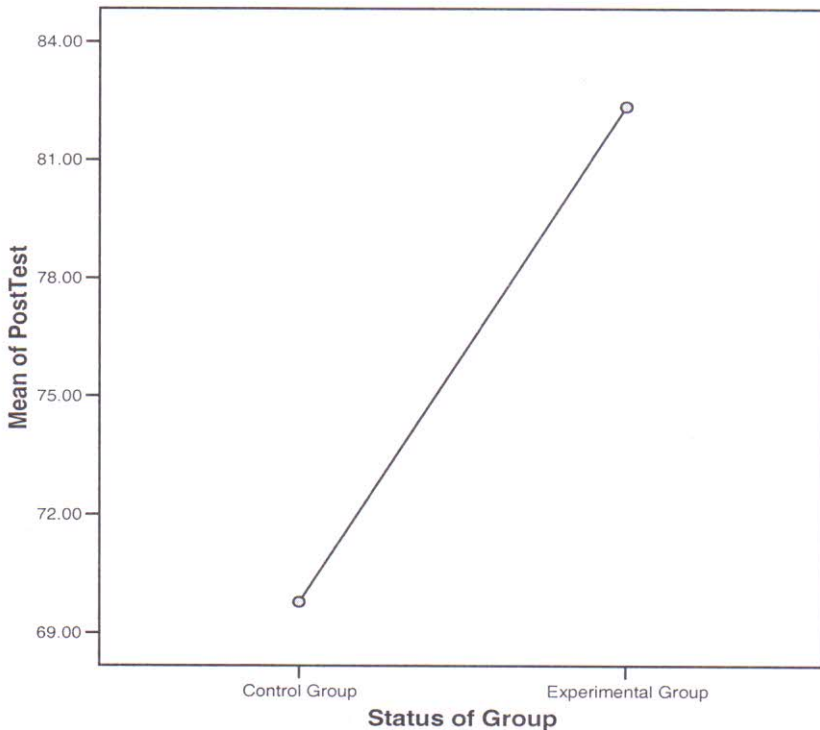
Showing the difference between the mean scores on post test of low achievers of control and experimental groups

Status of Group	N	Mean	Std. Deviation	Std. Error Mean	t-value	p-value
Control Group	14	69.7857	3.01735	.80642	9.799	0.000
Experimental Group	14	82.3571	3.73357	.99784		

It is apparent from above noted table that there is a significant difference between the scores of both the groups. The experimental group is significantly better than control group, so the null hypothesis: “There is no significant difference between the performance of low achievers of control and experimental groups on post test” is rejected and it is concluded that the experimental group is significantly better.

Figure – 5

Showing the mean plots of low achievers of control and experimental groups on post test



Ho: There is no significant difference between the performance of high achievers of control and experimental groups on post test

Table – 6

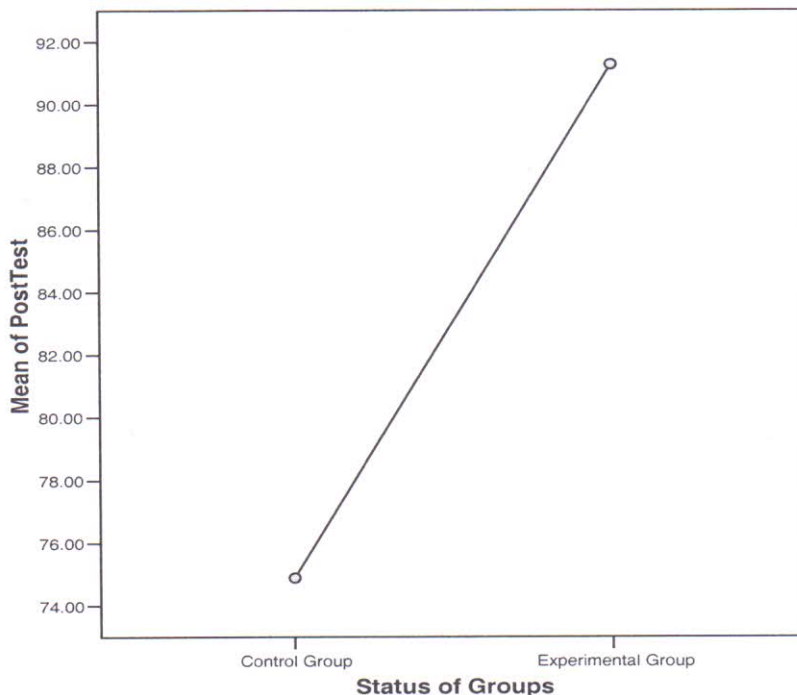
Showing the difference between the mean scores on post test of high achievers of control and experimental groups

Status of Groups	N	Mean	Std. Deviation	Std. Error Mean	t-value	p-value
Control Group	26	74.8846	1.03255	.20250	22.865	0.000
Experimental Group	26	91.2692	3.50494	.68738		

The above-noted table reflects that difference between the mean scores of high achievers of control group and experimental group on posttest was statistically significant at .000 level in favour of experimental group. Hence, null hypothesis: "There is no significant difference between the performance of high achievers of control and experimental groups on post test" is rejected and the performance of high achievers of experimental group was significantly better than those of control group.

Figure – 6

Showing the mean plots of high achievers of control and experimental groups on post test



Ho: There is no significant difference between the performance of the control and experimental groups on retention test

Table – 7

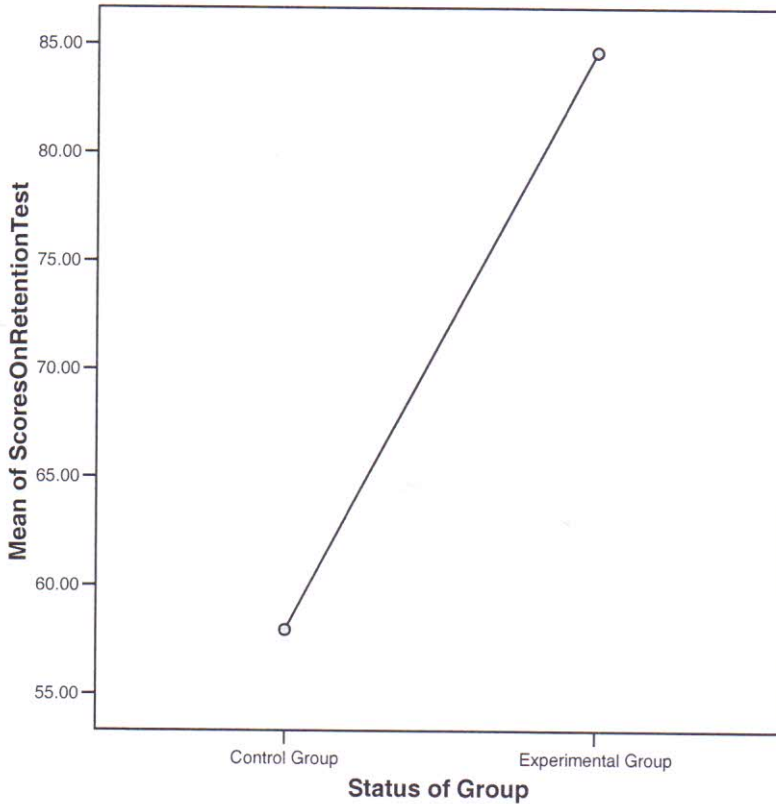
Showing the scores on retention test of both the groups

Status of Group	N	Mean	Std. Deviation	Std. Error Mean	t-value	p-value
Control Group	40	57.9750	2.88664	.45642	27.706	0.000
Experimental Group	40	84.6500	5.36154	.84773		

It is apparent from above table that there is a significant difference between the scores of both the groups. The experimental group is significantly better than control group, so the null hypothesis: “There is no significant difference between the performance of the control and experimental groups on retention test” is rejected and it is concluded that the experimental group is significantly better.

Figure – 7

Showing the mean plots of control and experimental groups on retention test



Ho: There is no significant difference between the performance of low achievers of control and experimental groups on retention test

Table – 8

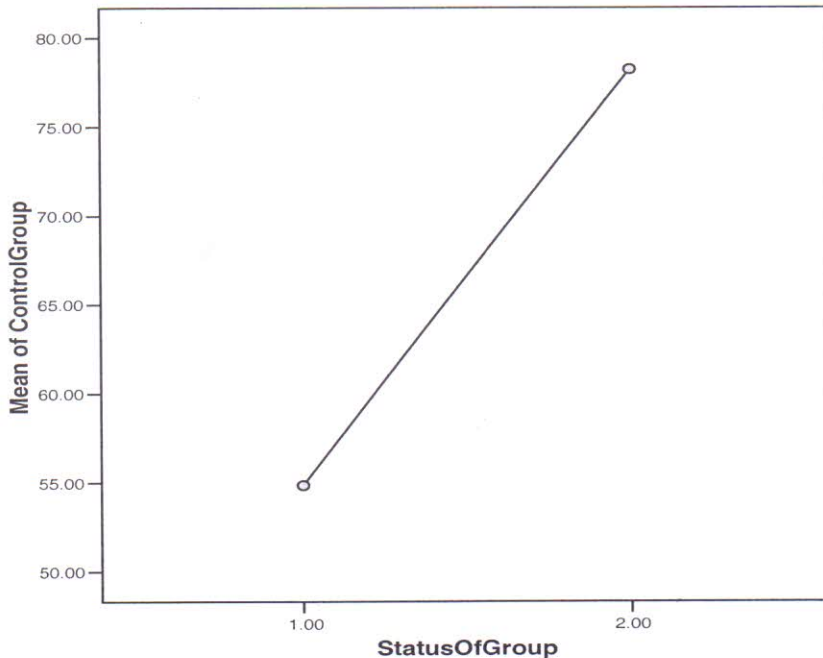
Showing the difference between the mean scores of low achievers of control and experimental groups on retention test

Groups	N	Mean	Std. Deviation	Std. Error Mean	t-value	p-value
Control group	14	54.8571	1.61041	.43040	27.214	0.000
Experimental group	14	78.2143	2.77845	.74257		

The above-noted table reflects that the difference between the performance of low achievers of control group and experimental group on retention test is statistically significant at .000 level in favour of experimental group. Hence the null hypothesis: "There is no significant difference between the performance of low achievers of control and experimental groups on retention test" is rejected. Therefore, the performance of low achievers of experimental group was significantly better than those of control group.

Figure – 8

Showing the mean plots of low achievers of control and experimental groups on retention test



Ho: There is no significant difference between the performance of high achievers of control and experimental groups on retention test

Table – 9

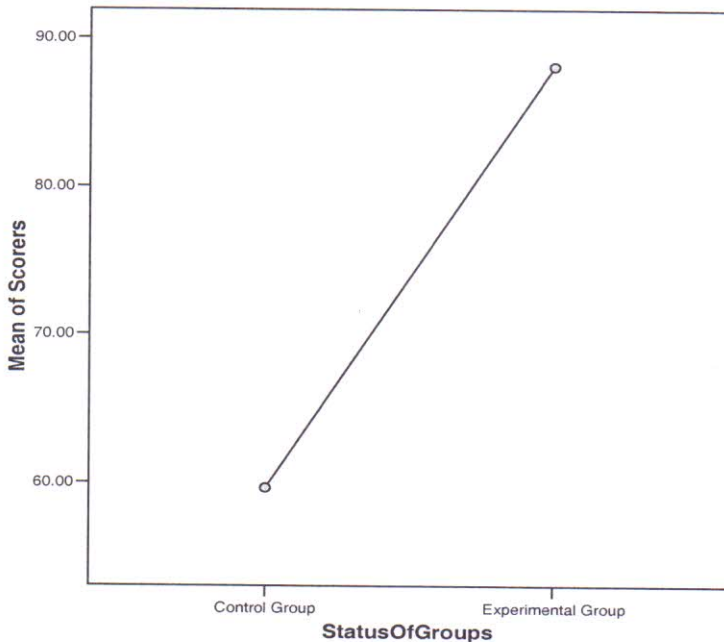
Showing the difference between the mean scores of high achievers of control and experimental groups on retention test

Groups	N	Mean	Std. Deviation	Std. Error Mean	t-value	p-value
Control Group	26	59.6538	1.80980	.35493	50.009	0.000
Experimental Group	26	88.1154	2.26851	.44489		

The above-noted table reveals that the difference between the performance of high achievers of control group and experimental group on retention test is statistically significant at .000 level in favour of experimental group. Hence, the null hypothesis: “There is no significant difference between the performance of high achievers of control and experimental groups on retention test” is rejected. Therefore, the high achievers of experimental group performed significantly better than the high achievers of control group.

Figure – 9

Showing the mean plots of high achievers of control and experimental groups on retention test



Ho: There is no significant difference among the scores of pre, post and retention tests of control group

Table – 10
Showing ANOVA on pre, post and retention tests of control group

Source of variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	20893.817	2	10446.908	1190.183	.000
Within Groups	1026.975	117	8.778		
Total	21920.792	119			

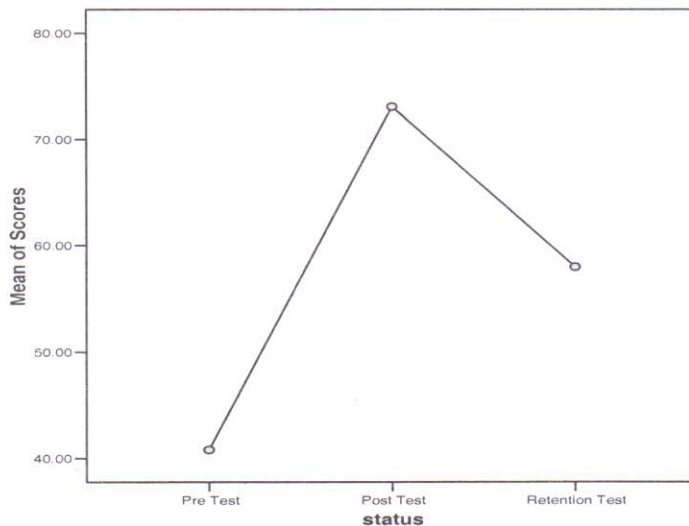
The above-noted table reveals, that there is a significant difference on control group among various tests.

Table – 11
Showing the multiple comparisons

S.No.	Pairs	Mean difference	p-value
1.	Post test vs Pre test	32.30	.000
2.	Post test vs Retention test	15.125	.000
3.	Retention test vs Pre test	17.175	.000

It is evident from above table that the scores of post test are significantly better than pre test, post test are significantly better then retention test and retention test is significantly better than pre test. It can be concluded that control group performed significantly better on post test, and significantly lower on pre test.

Figure – 10
Showing the mean plots of scores of control group on pre, post and retention test.



Ho: There is no significant difference among the scores of pre, post and retention tests of experimental group

Table – 12
Showing ANOVA on pre, post and retention tests of experimental group

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	55816.267	2	27908.133	1225.833	.000
Within Groups	2663.700	117	22.767		
Total	58479.967	119			

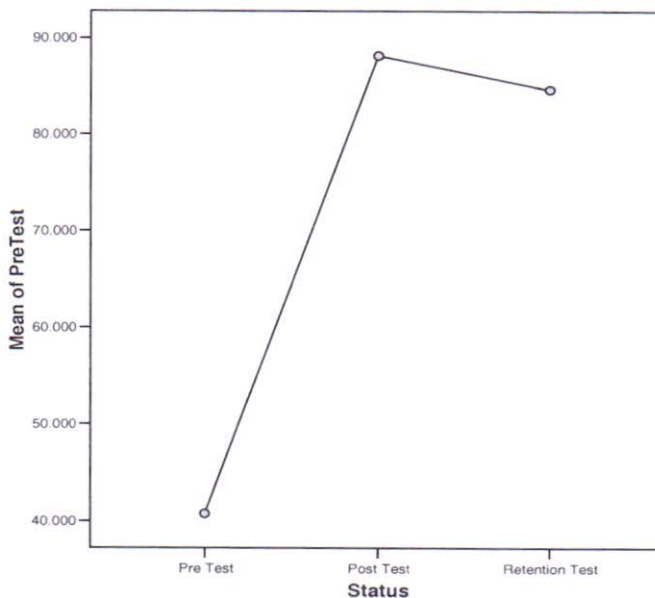
The above-noted table reveals that there is a significant difference on experimental group among various tests.

Table – 13
Showing the multiple comparisons

S.No.	Pairs	Mean Difference	p-value
1.	Post test vs Pre test	47.400000	0.000
2.	Post test vs Retention test	3.500000	0.000
3.	Retention vs Pre test	43.900000	0.000

It is evident from above table that the scores of post test are significantly better than pre test, post test are significantly better then retention test and retention test is significantly better than pre test. It can be concluded that experimental group performed significantly better on post test, and significantly lower on pre test.

Figure – 11
Showing the mean plots of scores of experimental group on pre, post and retention tests



Discussion

Both the groups, control and experimental, were compared on the variable of pre test score. The results obtained from the statistical analysis showed that no significant difference existed between the two groups regarding pre test scores in biology as the t-value obtained was not statistically significant at 0.05 level. Therefore, the null hypothesis, "There is no significant difference between the performance of control group and experimental group on pre test" was accepted and both the groups could be treated as equal.

There was no significant difference between the performance of high achievers of control group and experimental groups on pre test as t – value obtained was not statistically significant at 0.05 level. Therefore, "The null hypothesis, there is no significant difference between the performance of high achievers of the control and experimental groups on pre test" was accepted. Therefore, high achievers of both groups could be treated as equal.

The achievement of low achievers of control and experimental groups on pre test was not statistically significant at 0.05 level. Therefore, the null hypothesis: "There is no significant difference between the achievement of low achievers of the control and experimental groups on pre test" was accepted and the low achievers of both groups could be treated as equal.

The achievement of the experimental group was significantly different from that of the control group on posttest. The difference between the two means was statistically significant at 0.000 level. Thus, the null hypothesis: "There is no significant difference between the achievement of the control and experimental groups on post test" was rejected at 0.000 level and it is concluded that experimental group is significantly better than control group.

Low achievers of experimental group performed better as compared to low achievers of control group on post test. The result was significant at 0.000 level in favour of experimental group. Hence, the null hypothesis: "There is no significant difference between the achievement of low achievers of control and experimental groups on post test" was rejected. Therefore, the achievement of experimental group could be treated as better.

High achievers of experimental group performed better as compared to high achievers of control group on post test. The result was significant at 0.000 level in favour of experimental group. Hence, the null hypothesis: "There is no significant difference between the achievement of high achievers of control and

experimental groups on post test” was rejected. Therefore, the achievement of experimental group could be treated as better.

The achievement of the control and experimental groups was statistically significant on retention test at 0.000 level in favour of experimental group. Therefore, the experimental group could be treated as better group. Hence the null hypothesis: “There is no significant difference between the achievement of control and experimental group on retention test” was rejected.

The achievement of low achievers of control and experimental groups was statistically significant on retention test at 0.000 level in favour of experimental group. Therefore, the achievement of experimental group could be treated as better than the control group. Hence, the null hypothesis: “There is no significant difference between the achievement of low achievers of control and experimental group on retention test” was rejected.

The difference of achievements of high achievers of control and experimental groups was statistically significant on retention test at 0.000 level and was in favour of experimental group. Therefore, the achievement of experimental group could be treated as better than the control group. Hence, the null hypothesis: “There is no significant difference between the achievements of high achievers of control and experimental group on retention test” was rejected.

Applying the ANOVA on the variable of scores in pre, post and retention test compared control group. The results obtained from the statistical analysis showed that significant difference existed on the scores of three tests as the F value obtained was statistically significant at 0.000 level. Therefore, the null hypothesis: “There is no significant difference among the scores of pre, post and retention tests of control group” was rejected at 0.000 level and it was concluded that post test is significantly better than pre test and retention test, retention test is significantly better than pre test, so post test is significantly better and pre test is significantly lower among the groups.

Applying the ANOVA on the variable of scores in pre, post and retention test compared experimental group. The results obtained from the statistical analysis showed that significant difference existed on the scores of three tests as the F value obtained was statistically significant at 0.000 level. Therefore, the null hypothesis: “There is no significant difference among the scores of pre, post and retention tests of control group” was rejected at 0.000 level it was concluded that post test is significantly better than pre test and retention test, retention

test is significantly better than pre test, so post test is significantly better and pre test is significantly lower among the groups.

Conclusions

The application of instructional technology as supplementary strategy in teaching of biology was found to be more effective because the instructional technology increased and enhanced the motivation level of the students. During the treatment, the students of the experimental group were found to be more attentive because the concepts were explained with the help of concrete examples and instructional technology, played a significant role in teaching learning process.

Instructional technology as supplementary strategy was found more effective for both low achievers and high achievers. Since the biology deals with the study of living organisms, the equal effectiveness for low achievers and high achievers can be attributed to the fact that high achievers have a sharp memory and they can memorise the factual information without any solid example.

When biology is taught through concrete examples and instructional technology, the achievement level of low achievers is found to be much higher than teaching biology without any teaching aids. Therefore, the instructional technology proved to be equally effective for both low achievers and high achievers.

Instructional technology as supplementary strategy was found more effective as compared to traditional teaching regarding retention of learning. Retention of the students of experimental group was found significantly better than that of the students of control group as a whole and in case of low achievers and high achievers. Both the groups were having significant difference between the scores of post test and pre test as well as between the retention test and pre test, but there is no significant difference between the scores of retention test and post test.

Recommendations

In the light of findings revealed and conclusions drawn from the study, the following recommendations are made:

1. Since the use of instructional technology proved to have significant positive effect on the achievement of students. The teachers be provided proper training in the use of instructional technology and be motivated to use it in the classroom regularly.

2. The head of the institutions must regularly arrange the field trips and ensure the provision of films so that the students may be able to study the nature very closely and in original manner.
3. Since the video films were available according to needs of teaching units, therefore, video films were prepared. The institutes of instructional technology be approached for the production of video films for other units of biology at secondary level.

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