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EFFECTIVENESS OF MULTIMEDIA INSTRUCTION IN BETTER ACQUISITION OF CONCEPTS, ACHIEVEMENT AND RETENTION IN BIOLOGY AMONG SENIOR SECONDARY LEVEL LEARNERS

Swati Shukla [1]✉, Dr. Daljeet Kaur [2]

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Abstract:
Study was undertaken to examine the effectiveness of video based multimedia instruction as a teaching strategy for acquisition of concepts, achievement and retention of biology. Sample of the study comprised of 50 senior secondary students (boys and girls) studying biology as their elective subject in their curriculum, from two schools of Dehradun, assigned into two groups, animation + on screen text + narration (experimental group) or narration + other teaching aids (control group). The pretest, posttest and control group design was adopted. A multiple choice objective test consisting of 53 items, termed as Achievement Test in biology by S.C. Gakhar and Dr. Himadri was used for collecting data. Reliability of the test as reported by the authors is 0.79 and the validity of the test established is 0.92. Analysis of variance (ANOVA) test was used in determining the differences among the two groups. Findings of this study showed that the consistent use of animation + narration + on screen text in the instructional interface resulted in a significantly better learning outcome when compared with those using narration + other teaching aids only. Generally students taught by those using multimedia instruction performed better in achievement test, than their colleagues in conventional teaching method group and had better retention as well.

1.0. Introduction

Biology is a natural science dealing with study of living world. It is a crucial subject for many fields of science contributing immensely to the technological growth of the nation (Ahmed,2008). This includes medicine, pharmacy, nursing,

[1] [First Author] ✉ [Corresponding Author] PGT Biology, Nancy International School, Dehradun, Uttarakhand & Research Scholar, School of Education, IGNOU, India; **Email: biochem.2006@yahoo.com**
[2] [Second Author] Former Principal, Patrician College for Women & Presently, Research Counsellor, Special Education, NIVH, Dehradun, Uttarakhand, India; **Email: principaldaljeetkaur@gmail.com**

agriculture, forestry, biotechnology, nanotechnology and many other areas related to science. (Ahmed and Abimbola, 2011).

Biology is one of the optional subjects at senior secondary level of Science Education. Students' difficulties in learning biology have been studied by various researchers across the world (Johnstone and Mahmoud, 1980; Finely et al., 1982; Tolman, 1982; Anderson et al., 1990; Seymour and Longdon, 1991; Lazarowitz and Penso, 1992; Bahar et. al.,1999). Many abstract concepts in biology, including water transport in plants, protein synthesis, respiration and photosynthesis, gaseous exchange, energy, cells, mitosis and meiosis, organs, physiological processes, hormonal regulation, oxygen transport, genetics, Mendel's genetics, genetic engineering, and the nervous system can be perceived as difficult to understand by secondary and senior secondary school students. Tekkaya et al. (2001) also found that hormone regulation, genes and chromosomes, mitosis and meiosis, the nervous system, and Mendel's genetics were considered difficult concepts by secondary school students. Experiencing difficulties in many topics of biology has a negative effect on student's motivation and achievement (Ozcan, 2003). Seeing learners' difficulties in many topics of biology have prompted researchers to investigate why they experience such difficulties and how to overcome these difficulties.

Conventional methods of classroom teaching have been found to be lacking variety; are complicated and less participative in nature thus often unable to arouse curiosity and interest of learners especially in science subjects like biology. Mayer (2001) suggested that students learn at a higher level from well-designed multimedia presentations than from verbal or text presentations. Imparting instruction through Multimedia Presentations offers tremendous opportunities in better acquisition of biological concepts allowing the teacher to present more information, examples, illustrations, and problems for students to solve than those in conventional instructional method. It also facilitates a teacher to seek information and construct knowledge in a variety of ways, and it relies on lateral thinking as a basis for understanding by using images and videos of real world experiences to help illustrate abstract knowledge and concepts. Multimedia is becoming an important tool for teachers in the biological sciences, as it has the potential of providing novel learning environment and pedagogy applications to nurture students' interest, involve students in the learning process, advance critical thinking/problem-solving skills, and develop conceptual understanding of biological topics (Bockholt et al. 2003). It provides meaningful connections between text and graphics allowing for deeper understanding and better mental models than from either of the methods alone(Mayer,2003); and can incorporate 3-D visualization of many anatomical and biochemical structures as well as more interactive animations of the processes, which can significantly enhance the understanding of learners biological concepts(Stith, 2004). Well-designed multimedia presentations help learners build more accurate and effective mental models than those from text alone (Shank 2005). Research findings of many recent studies have indicated that the use of Multimedia in class room teaching improved learning and retention of material presented and students performed better than the ones taught through conventional method in many subjects including English (Sharma, 2013), biology (Satyaprakasha and Sudhanshu, 2014; Singh, 2010 and

Udayakumar 2013), science (Krishnakumar 2013; Owolabi and Oginni, 2014) and physics (Erdemir, 2011).

As evident from various researches, educators perceive that there is a need demanding to reconsider the techniques and methods of instruction at secondary and senior secondary school levels. To address these challenges there is a need for an instructional system supported by technology for meaningful learning.

Since teaching and learning can be made easier, faster and far more interesting with the help of multimedia, it has a tremendous use in the teaching and learning process. Advancement in instructional delivery technology has direct impact on teaching process. Multimedia has great potential to play vital role in education.

Instruction through Multimedia is finding a prominent place in the classrooms world over.

Multimedia, as defined by Neo and Neo (2001), is the combination of various digital media types, such as text, images, sound, and video, into an integrated multisensory interactive presentation to convey information to an audience.

Multimedia allows teachers to integrate text, graphics, animations, and other media into one package to present complete information to their students to achieve specified course objectives. Multimedia permits the demonstration of complex processes in a highly interactive, animated fashion such that instructional material can be interconnected with other related topics in a more natural way (Crosby and Stelovsky, 1995).

In 21st century, such integrated and motivating approach should be encouraged to help students learn better, understand and retain biology concepts. Biology education helps to shape a modern and scientific outlook of the world. Ultimately teacher is responsible for deciding his/her own class room objectives and for the attainment of these learning outcomes, accordingly he/she chooses materials and methods. Maul (1953) Fitzpatrick (1960) and Brandwein (1955) also felt that the teacher has the final responsibility of determining educational objectives and selecting tools to achieve the desired learning outcomes. To bring about desired learning outcomes; teacher has to plan, select material and method and guides the class.

While scanning the existing findings, it was realized by the researcher that further exploration is needed in biology education at senior secondary level to arrive at definite conclusion. The present study is focussed in this direction.

2.0. Research questions

The research questions to be investigated in this study were:

1. What are the differences in the mean achievement scores in biology of senior secondary school students exposed to video based multimedia packages and to those exposed to the lecture method?

2. What are the differences in the mean retention scores in biology of senior secondary school students exposed to video based multimedia instructional packages and to those exposed to lecture method?

3.0. Objectives of the study

1. To compare the effect of Multimedia instruction and conventional teaching method in acquisition of concepts in biology.

2. To investigate the effect of multimedia instruction on students' achievement and retention in biology.

4.0. Research Hypotheses

Hypothesis1: There will be no significant difference in the mean achievement scores of senior secondary biology students exposed to multimedia instructional packages and those exposed to conventional teaching method.

Hypothesis2: There will be no significant difference in the mean retention scores of senior secondary biology students exposed to the multimedia instructional packages and those exposed to conventional teaching method.

5.0. Methodology for Research

5.1. Participants: Sample includes 50 senior secondary level students studying biology as an elective subject from two different schools of Dehradun. They were randomly divided into two groups – experimental and control group.

5.2. Tool for Data Collection: Achievement Test in biology by S. C. Gakhar and Dr Himadri (English version) was used for collecting data for this study. The test was developed to measure the achievement in biology of senior secondary level students. The test consisted of 53 items, which were multiple choice types with four options. Out of these respondent had to choose the most appropriate option.

Reliability of the test as reported by the authors is 0.79 and the validity of the test established is 0.92. One mark is there for each correct answer. There is no negative marking for wrong answer.

5.3. Research Design: The research design adopted for the study was pretest, posttest (Experimental) and control.

5.4. Pre-test: Biology Achievement Test was administered to all the participants as pre test to measure their achievement level in Biology.

5.5. Experimental Group: Animation + On-Screen Text + Narration: Students in this group watched the video, which showed animations narrating the explanations of concepts + verbal explanations + on screen text to illustrate different topics of their syllabus in biology.

5.6. Control Group: Conventional Teaching Method: The control group was exposed to lecture method only. The researcher presented the same lesson as presented to experimental group using charts, drawings, and pictures to explain the concept of the given topic. The students listened and wrote some key points during lecture.

5.7. Post-test: After two weeks treatment, Biology Achievement Test was administered again on both the groups as post test to measure the concept acquisition in the form of achievement in biology. One week after the achievement test, Biology Achievement Test was reshuffled and administered as a retention test on both the groups.

5.8. Method: Before the commencement of the experiment, the students in the experimental group were told to pay attention to the presentations during sessions and that their scores in the post biology achievement test will form part of their continuous assessment for that month.

During each session, the researcher in classroom set up the equipments – laptop and the digital projector and then slotted in the DVD on which the presentations had been saved. This was then projected on the white board screen. Once the session started, the researcher sat at the back of the classroom and also watched the video. After the presentation the researcher verbally explained the facts with on screen text.

The study lasted for two weeks. In each of the groups there were 10 sessions (5 days per week). Each session lasted for 1 hour. The examples of frames used were presented in figures (i.e. animation + on screen text + narration). These frames illustrated different topics of their syllabus in biology.

The students in the experimental group were instructed to jot down in their biology notebooks, key points seen or heard while watching the video during the experimental sessions.

In the control group the researcher presented the subject matter through lecture and teaching aids. Drawings on charts were used to explain various concepts of human physiology. Students in the control group were also told to note down the key points.

At the end of each presentation the researcher collected the biology notes of each student and appended her signature. In the end, the quality of notes taken by each student during the experimental sessions (in terms of content) was rated.

6.0. Results

6.1. Statistical Analysis of data: The scores obtained were interpreted based on the hypotheses framed. Analysis of variance (ANOVA) test was used for computing the relationship between independent variable (i.e. experimental and control) and dependent variable (i.e. achievement and retention scores in biology) and interpreted through F- distribution table at 0.05 level of critical value.

Table 1
Research design layout (raw scores)

Group	Pre Test	Treatment	Achievement Test	Retention Test.
Control group	1139	No treatment (conventional teaching method)	1599	1633

Experimental group	1139	A + N + T	2501	2412

Where: A + N + T = Animation + Narration + Text

Now, the results are presented based on the research hypotheses:

Hypothesis 1: There will be no significant difference in the mean achievement scores of senior secondary school biology students exposed to video based instructional packages and between those exposed to conventional teaching method.

Calculation for F-Test

$\sum x = 1139 + 2501 + 1599 = 5239$

Mean achievement scores:

$X_1 = 22.78$; $X_2 = 50.02$; $X_3 = 31.98$

Sample Mean $X = 5239/150 = 34.92$

Now, $n (X_1 - X)^2 + n (X_2 - X)^2 + n (X_3 - X)^2$

$= 50 (22.78 - 34.92)^2 + 50 (50.02 - 34.92)^2 + 50 (31.98 - 34.92)^2$

$= 50 (147.37) + 50 (228.01) + 50 (8.64)$

$= 7368.5 + 11400.5 + 432$

$= 19201$

Sum of Square = 190587

Mean value between groups (MSB) = 19201/2 = 9600.5

df within group = 147

Mean Sq value within group (MSW) = 190587/147 = 1296.51

F = Variation between sample Mean (MSB)/Variation Within the sample (MSW)

= 9600.5/1296.51 = 7.40.

= 7.40

Table 2
ANOVA test result (Hypothesis 1)

Source of variation	Sum of Square	df	Mean sq	F - Ratio	Fα (0.05)
Pre – test	28213	2			
Post - test	114453	2	9800.5	7.40	3.195
CTM	47927	2			
TOTAL	190587				

Since the calculated F value from the data is greater than the critical value of F – distribution table (0.05), the hypotheses is rejected

Hypothesis 2: There will be no significant difference in the mean retention scores of senior secondary school biology students exposed to the video based instructional packages and between those exposed to conventional teaching method.

Calculation for F-Test

$\sum x = 1139 + 2412 + 1633 = 5184$

Mean Retention scores

$X_1 = 22.78$; $X_2 = 48.24$; $X_3 = 32.66$

Sample Mean $X = 5184/150 = 34.56$

Now, $n (X_1 - X)^2 + n (X_1 - X)^2 + n (X_3 - X)^2$

$= 16475.5$

Mean Square value between groups (MSB) = 16475.5/2 = 8237.5

df within group = 147

Sum of Square = 189622

Mean Square value within group (MSW) = 189622/147 = 1289.94

F = Variation between sample Mean (MSB)/ Variation Within the sample (MSW)

=8237.5/1289.94 = 6.38

= 6.38

Table 2
ANOVA test result (Hypothesis 1)

Source of variation	Sum of Square	df	Mean Sq	F ratio	Fα (0.05)
Pre – test	28213	2			
Post - test	113409	2	8494.5	6.38	3.195
CTM	48000	2			
TOTAL	189622				

Since the calculated F value from the data is greater than the critical value of F distribution table (0.05), the hypotheses is rejected.

6.2. Discussion and Interpretation

1. Instruction through Multimedia, significantly increased achievement and retention scores in biology among boys and girls in the experimental group.

2. Multimedia instruction significantly promoted better understanding of concepts in biology among boys and girls in the experimental group.

In both the tests of recall and transfer of knowledge, students who were in the group of animation, narration, and on-screen text had the higher mean score. The findings of this study showed that the consistent use of multimedia packages in an instructional interface resulted in a significantly better learning outcome when compared to conventional teaching method.

Data on the assessment of the quality of notes taken by the students showed that students' in the animation + text + narration group, on the average, made more quality notes than their colleagues in control group. This could be due to the fact that points missed from narration could be read from on- screen text and vice versa. This double opportunity of viewing and listening would not have been available to students who were in the control group. It appeared that the more the sources of information, the better are the outcomes. The notes were responsible for the observed differences in the learning outcome. Educational psychologists e.g. Sprinthall, Sprinthall, and Oja (1998) said that notes taken while reading or

listening to instructions in the classroom can enhance retention of information. They maintained that persons remember more after taking notes, even if they lose the notes, compared to those who simply sit and listen (probably because the act of writing also engages procedural memory). The implication of this is when students are listening in the class to computer-based instruction they should be encouraged to take notes.

This study revealed that learners who were exposed to computer-based multimedia instruction performed better in both recall and transfer of items than their colleagues who were taught under traditional method. The multimedia instruction tends to be more effective than the conventional instruction, may be explained from the assumption that it is multi-sensory. It stimulates both the visual and auditory senses of the learner and helps the teacher turn the classroom into a dimension of sight and sound.

It is, however, not in consonance with Koehler, Yadav, Phillips and Cavazos-Kottke (2000) who concluded that the use of video does not improve learning. The findings also contradict those of Grobe and Struges cited in Saibu (2002) who found that those students who were taught through the conventional teaching method achieved a mean post test score slightly higher than those taught by the audio tutorial (narration) method.

No matter how highly organized lecture method might be the use of multimedia instruction in many schools tends to provoke the interest of students in biology (and in most other school subjects) more than traditional method of instruction.

Therefore, multimedia has the property in aiding the learning of abstract subject matter. Findings of this study are in confirmation to this idea. This result is also in conformance with the findings of Kuti (2006) where technological aids were adopted for effective teaching and learning of biology. The results also coincided with the findings of Gambari and Zubairu(2008) and of Achebe(2008); Moreno and Mayer(2000); Tabbers et al. (2004); and Starbek et al. (2010), who found that students taught genetics with multimedia packages acquired better knowledge, retention, and improved comprehension skills than the other groups. The results approved the findings of Okwo and Asadu (2002), who reported that three media (video, audio + picture, and audio) were found to be equally effective with no significant difference effect among the means when used for teaching physics.

7.0. Educational implications of the study

The positive effectiveness of multimedia teaching on achievement and retention in biology, scientific attitude and concept acquisition leads to the following educational implications.

1. The results in terms of improved achievement and retention scores indicated that the students of the experimental group had acquired the skills, interest and strong motivation to learn, better than the students of the control group. This result clearly revealed that properly structured multimedia classes can provide opportunities for the students to interact take interest and motivate to learn science and other subjects and would lead to the improvement of achievement motivation also.

2. The results in terms of promoting scientific attitude indicated that the students of the experimental group acquired the scientific attitude like receiving, organizing and obtaining the value, believing the facts and proofing the concepts, better than the control group (after checking their notes by the researcher). The results clearly revealed that properly structured multimedia classes can provide opportunities for the students in understanding the concepts and believing the facts, and would be leading to scientific attitude.

3. This method can be effective for all students with different learning abilities as individual differences can be overcome in multimedia teaching.

4. Pre-service as well as in-service teachers can be trained in multimedia teaching to implement it effectively in their classroom.

5. On experimental basis, multimedia teaching can be adopted in some schools for all subjects to improve school effectiveness.

6. Improvement can be brought about for the students having histories of poor academic achievement using multimedia teaching.

7. Frequent use of multimedia teaching classes help students to develop interest, affection, proper attitudes towards the class, subject teacher and also peers.

8.0. Limitations and recommendations for future research

This method of multimedia instruction is believed to positively influence students' learning outcome in biology. Two limitations were identified in this study. The first limitation was that the sample in this study was not randomly selected and was confined to senior secondary level students. Results should not be generalized to other classes or group of students in a different academic year or other educational programs. The second limitation was that students' performance evaluation varied from year to year depending on the teacher, and affected students' grades subjectively.

By analysis of demographic profile of participants, results may be generalized to other classes or groups of students in a different academic year.

To address the second limitation, further research should improve students' performance evaluation by: increasing the number of observers to cover more areas of evaluation; providing teaching assistants with special training to ensure that evaluation criteria are being followed; and assigning the same person in charge of evaluations for the two years to follow evaluation criteria more consistently between the two groups.

9.0. Recommendations for future Research

- Relate to demographic data using students' educational and social backgrounds to identify relationships with test scores and performance grades
- Verify the pre test scores by using an ANCOVA model or by estimating a repeated measures of ANOVA model, with the two-group comparison as well as between two subjects effect.

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