CHAPTER - 5
MAIN FINDINGS, EDUCATIONAL IMPLICATIONS
AND SUGGESTIONS FOR FURTHER STUDIES

5.1 MAIN FINDINGS

A. MULTIMEDIA APPROACH and TOTAL ACADEMIC ACHIEVEMENT OF STUDENTS


   a. Comparison of Pre-Test Scores of Experimental Group-I and Control Group.

   Since the table value for df 58 is 2.00 at 0.05 level of significance, the obtained critical ratio ‘t’ 0.192 is not significant at 0.05 level for df 58. It means that the difference between the means of the pre-test scores of the pupils in experimental group-I and control group did not differ significantly in their initial academic achievement. So, it is concluded that before experiment, the two groups were of the same academic ability with reference to the knowledge of the concepts of science.

   b. Comparison of Post-Test Scores of Experimental Group-I and Control Group.

   Since the table value for df 58 is 2.00 at 0.05 level of significance, the obtained critical ratio 2.277 is significant at 0.05 level. It means that there is significant difference between the means of the post-test scores of the pupils in experimental group-I and control group in the subject of Science. Also, the mean of the post-test scores of experimental group-I is greater than that of control group, pupils in the experimental group-I have performed better than the pupils in the control group in their academic achievement. Hence, it is inferred that teaching with the help of multimedia approach (using multimedia package-I) has a higher effect on the student’s academic achievement than the traditional method of teaching science to secondary school students.

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c. Comparison of Retention Test Scores of Experimental Group-I and Control Group.

The table value for df 58 is 2.66 at 0.01 level of significance, the obtained critical ratio 2.52 is significant at 0.05 level. It means that there is significant difference between the means of the delayed post-test (i.e. retention test) scores of the pupils in experimental group-I and control group. Since the mean of the retention test scores of experimental group-I is greater than that of control group, pupils in the experimental group-I (using multimedia package -I) have performed better than the pupils in the control group in terms of their retention scores.

Hence, it is concluded that teaching with the help of multimedia approach (using multimedia package-I) had a higher effect on the student’s retention than the traditional method of teaching science to secondary school students.

2. Comparison of Achievement and Retention Scores of Experimental Group-II and Control Group.

a. Comparison of Pre-Test Scores of Experimental Group -II and Control Group.

Since the table value for df 58 is2.00 at 0.05 level of significance, the obtained critical ratio 0.454 is not significant. It means that the difference between the means of the pre-test scores of the pupils in experimental group-II and control group in the subject of Science did not differ significantly in their initial academic achievements. So, it is concluded that before the experiment, the two groups were more or less of the same academic ability.

b. Comparison of Post-Test Scores of Experimental Group -II and Control Group.

The obtained critical ratio 5.066 is significant at 0.01 level and indicates that pupils of the two groups differ significantly in their academic achievement, after the experiment in the subject of Science. Since the mean post-test scores of experimental group-II is much greater than that of control group, the pupils in the experimental group-II are superior to the pupils in the control group in terms of their academic achievement. Hence, it is concluded that teaching methodology with the
help of multimedia approach (using multimedia package-II) had a higher effect on the student’s academic achievement as compared to the traditional method of teaching science to secondary school students.

c. Comparison of Retention Test Scores Experimental Group -II and Control Group.

Since the table value for df 58 is 2.00 at 0.05 level of significance and the obtained critical ratio is 6.03 which is significant. Therefore it implies that that the difference between the means of the delayed post-test scores of the pupils in experimental group-II and control group differ significantly in their retention scores. It means that there is significant difference between the means of the delayed post-test (i.e. retention test) scores of the pupils in experimental group-II and control group in the subject of Science. Since the mean of the retention test scores of experimental group-II is greater than that of control group, it is inferred that pupils in the experimental group-II (using multimedia package-II) have performed better than the pupils in the control group in terms of their retention scores.

Therefore, it is concluded that teaching with the help of multimedia approach (using multimedia package-II) had a higher effect on the student’s retention than the traditional method of teaching science to secondary school students.

3. Comparison of Achievement and Retention Scores of Experimental Group-I and Experimental Group-II.

a. Comparison of Pre-Test Scores of Experimental Group-II and Experimental Group-I.

Since the table value for df 58 is 2.00 at 0.05 level of significance, therefore the obtained critical ratio 0.208 is not significant. It means that the difference between the means of the pre-test scores of the pupils in experimental group-I and experimental group-II in the subject of science did not differ significantly in their initial academic achievement. So, it is concluded that before the experiment, the two groups were of the same academic ability.

b. Comparison of Post-Test Scores of Experimental Group-I and Experimental Group-II.

Since the table value for df 58 is 3.102 at 0.01 level of significance, the
obtained critical ratio 3.102 is significant at 0.01 level. It means that there is significant difference between the means of the post-test scores of the pupils in experimental group-II and experimental group-I in the subject of Science. Since the mean of the post-test scores of experimental group-II is greater than that of experimental group-I, pupils in the experimental group-II have performed better than the pupils in the Experimental group-I in their academic achievement. Hence, it can be tentatively concluded that teaching with the help of multimedia approach (using multimedia package-II) has a higher effect on the student’s academic achievement than the multimedia approach (using multimedia package-I) of teaching science to secondary school students.

c. Comparison of Retention Test Scores of Experimental Group-I and Experimental Group-II.

Since the table value for df 58 is 3.776 at 0.01 level of significance and the obtained critical ratio is 2.234 which is significant. Therefore it implies that the difference between the means of the delayed post-test scores of the pupils in experimental group-I and experimental group-II differ significantly in their retention scores. It means that there is significant difference between the means of the delayed post-test (i.e. retention test) scores of the pupils in experimental group-I and experimental group-II in the subject of Science. Hence, it is concluded that teaching with the help of multimedia approach (using multimedia package-II) has a higher effect on the student’s retention than the multimedia approach (using multimedia package-I) of teaching science to secondary school students.

4. Comparison of Gain in Performance of Experimental Groups over Control Groups

The difference in the pre-test and post-test scores of pupils in the experimental and control groups were calculated and tested for significance after computing critical ratio. The obtained values are given below.

a. Comparison of Gain in Performance of Experimental Group-I over Control group.

The values of significance for df 58 at 0.05 level = 2.00 and at 0.01 level =2.66. The calculated value of ‘t’ is 2.707. So the difference between the mean gain
scores is significant ($t=2.707; p<0.05/0.01$). The significantly higher mean value indicates that the pupils in the experimental group-I are better than that of pupils in the control group in their academic achievement. Since the mean gain scores of the control group is less than that of experimental group-I, this difference is in favour of experimental group-I. Consequently it is inferred that learning through multimedia approach is more effective in the subjects of science than learning through traditional method.

b. Comparison of Gain in Performance of Experimental Group-II over Control group.

The calculated ‘t’ value as 7.420 for df 58. The critical value of the ‘t’ for df 58 at 0.05 level = 2.00 and at 0.01 level = 2.66. So the difference between the mean gain scores is significant ($t=7.420; p<0.05/0.01$). The significantly higher mean value indicates that the pupils in the experimental group-II (using multimedia package-II) are better than that of pupils in the control group in their academic achievement. Since the mean scores of the control group is less than that of experimental group-II, this difference is in favour of experimental group. So it is concluded that learning through multimedia approach (using multimedia package-II) is more effective in the subject of Science than learning through traditional method.

c. Comparison of Gain in Performance of Experimental Group-II over Experimental group-I.

The values of significance for df 58 at 0.05 level = 2.00 and at 0.01 level = 2.66. From the table it is clear that the calculated critical ratio is 4.509 of the mean gain scores of the pupils in the experimental group-II and experimental group-I. So the difference between the mean gain scores is significant ($t=4.509; p<0.05/0.01$). The significantly higher mean value indicates that the pupils in the experimental group are better than that of pupils in the control group in their academic achievement. Since the mean gain scores of the control group is less than that of experimental group, therefore this difference is in favour of experimental group. Therefore it is concluded that learning through multimedia package-II is more effective in the subject of Science than learning through multimedia package-I.
5. Comparison of Effect of Multimedia Package-I and Multimedia Package-II with Traditional Method for Secondary School Science Students Using ANCOVA with regard to Total Achievement Scores

a. Effect of Multimedia Package-I over Traditional method for Secondary school science students with regard to total achievement (Experimental Group-I x Control Group)

For group I and control group, the post ANCOVA calculated value of \( t = 3.0163 \) whereas, the table value of \( t \) for \( df = 58 \) at 0.05 level is 2.00 and at 0.01 level is 2.66. So the value is significant at 0.01 level (\( t = 3.0163; p<0.01 \)).

The significant ‘\( t \)’ value indicates that the two means differ significantly. The difference in adjusted means for post-test scores of experimental group I and control group were tested for significance separately for df 58.

The difference between the adjusted post-test means of the experimental group I and control group in the achievement test is found to be significant at 0.01 level (\( t = 3.0163 \ p<0.01 \)). This shows that experimental group I where the mean post-test score is higher (My.= 56.79) is better than the control group in their achievement. It can be therefore concluded that the students who learned with the help of multimedia package I have achieved better achievement test scores than those taught through traditional method.

The above analysis leads to the conclusion that learning with the help of multimedia package-I is more effective than the traditional method of teaching science to secondary school students.

b. Effect of Multimedia Package-II over Traditional method for Secondary school science students with regard to total achievement (Experimental Group-II x Control Group)

For group II and control group, the post ANCOVA calculated value of \( t = 7.345 \) whereas, the table value of \( t \) for \( df = 58 \) at 0.05 level is 2.00 and at 0.01 level is 2.66. So the value is significant at 0.01 level (\( t = 7.345; p<0.01 \)). The significant \( t \) value indicates that the two means differ significantly. The difference in adjusted means for post-test scores of experimental group II and control group were tested for significance separately for df 58. The difference between the adjusted post-test means of the experimental group II and control group in the achievement test is
found to be significant at 0.01 level (t=7.345; p<0.01). This shows that experimental group II where the mean post-test score is higher (My.x=66.67) is better than the control group in their academic achievement. Therefore, it can be concluded that the students who learned with the help of multimedia package II have achieved better achievement test scores than those taught through traditional method.

The above analysis leads to the major conclusion that learning with the help of multimedia package II is more effective than the traditional method of teaching science to secondary school students.

c. Effect of Multimedia Package-II over Multimedia Package-I for Secondary school science students with regard to total achievement.

(Experimental Group-II x Experimental Group-I)

For experimental group-I and experimental group-II, the post ANCOVA calculated value of t = 4.518 whereas, the table value of t for df = 58. at 0.05 level is 2.00 and at 0.01 level is 2.66. So the value is significant at 0.01 level. The difference between the adjusted post-test means of the experimental group II and experimental group I in the achievement test is found to be significant at 0.01 level (t= 4.518; p<0.01). This shows that experimental group II having higher mean post-test score (My.x=.66.97) is better in achievement than the experimental group I.

It is therefore inferred that students who learned with the help of multimedia package II have surpassed the students who learned with the help of multimedia package I in achievement.

The above analysis leads to the conclusion that

- Learning with the help of multimedia package-I and multimedia package -II is more effective than the traditional method of teaching science to secondary school students.
- It is also concluded that among the two packages used in the present study, multimedia package- II based on interactive multimedia software was more effective than multimedia package-I which is merely based on computer assisted power point presentation of the content.
6. Comparison of Effectiveness of Multimedia Package I and Multimedia Package II with Traditional method for Secondary school science students using ANCOVA (Retention Test Scores)

a. Effect of Multimedia Package I over Traditional method for Secondary school science students with regard to total achievement in retention test (Experimental Group-I x Control Group)

The post ANCOVA ‘t’ value obtained was 6.42. The table value for significance for df = 58 is 2.00 at 0.05 level and 2.66 at 0.01 level (t=6.42; p< 0.01). The significant ‘t’ value points to a significant difference between the two groups, i.e., the Experimental Group I and the control group differ significantly in their retention capacity. The adjusted mean of retention test scores of Exp. Gp-I is greater than that of control group. So it is apparent that the students taught by the multimedia package- I have better retention capacity than the students taught by conventional traditional method of teaching science to secondary school students.

b. Effect of Multimedia Package II over Traditional method for Secondary school science students with regard to total achievement in retention test (Experimental Group-II x Control Group)

The post ANCOVA ‘t’ value obtained was 4.835. The table value for significance for df = 58 is 2.00 at 0.05 level and 2.66 at 0.01 level (t= 4.835; p< 0.01). The significant t value points to a significant difference between the two groups, i.e., the Experimental Group II and the control group differ significantly in their retention capacity. The adjusted mean of retention test scores of Exp. Gp-II is greater than that of control group. So it is evident that the students taught by the multimedia package- II have better retention capacity than the students taught by conventional traditional method of teaching science to secondary school students.

c. Effect of Multimedia Package II over Multimedia Package I with regard to total achievement in retention test (Experimental Group-II x Experimental Group-I)

The t value obtained was 2.166. The table value for significance for df =58 is 2.00 at 0.05 level and 2.66 at 0.01 level (t= 2.166 p< 0.05). The significant ‘t’ value points to a significant difference between the two groups, i.e., Experimental Group-II and Experimental Group-I differ slightly in their retention capacity.
The above analysis leads to the conclusion that

- The significant ‘t’ value points to a significant difference between the two groups, i.e., the Experimental Group II and the experimental group I differ significantly in their retention capacity.

- The adjusted mean of retention test scores of Exp. Gp-II is greater than that of experimental group I. So it is evident that the students taught by the multimedia package- II have better retention capacity than the students taught by multimedia package- I of teaching science to secondary school students.

B. MULTIMEDIA APPROACH and ‘ACADEMIC ACHIEVEMENT and RETENTION’ according to DIFFERENT INSTRUCTIONAL OBJECTIVES

7. Comparison of Effect of Multimedia Approach (using Multimedia Package-I and Multimedia Package-II) with Traditional Method on Academic Achievement and Retention according to Different Instructional Objectives


i. The difference between the post-test means of the experimental group-I and control group in the achievement test under the category of objective knowledge is found to be significant at 0.01 level. This shows that experimental group-I performed well than control group in their achievement. It may be concluded that students who learned with the help of Multimedia Package-I showed better achievement test scores under the category of instructional objective-‘Knowledge’ as compared to the students who learned with the traditional method.

ii. The difference between the post-test mean scores of the experimental group-II and control group in the achievement test is found to be
significant at 0.01 level. This shows that experimental group-II where the mean post-test score is higher (Mean= 18.76) is better than the control group in their academic achievement. It may be therefore concluded that students who learned with the help of multimedia package II have accomplished enhanced achievement test scores than those taught through traditional method under the category of instructional objective-'Knowledge'.

iii. There is no significant difference between the pre-test mean scores of the experimental group I, experimental group-II and control group in the achievement test even at 0.05 level of significance. This shows that the three groups do not differ significantly in their pre achievement level and indicates that groups are equally good in the performance irrespective of the multimedia packages under the category of instructional objective-'Knowledge'.

iv. The difference between retention test mean scores of the experimental group I and control group under the category of objective creativity is found significant as the calculated ‘t’ value (t =2.084) is greater than the critical value of ‘ t’ at 0.05 level of significance. This shows that these two groups differ significantly in their retention level. It can thus be concluded that students who learned with the help of Multimedia Package –I showed better retention test scores under the category of instructional objective knowledge as compared to the students who learned with the traditional method.

v. The difference between the retention test mean scores of the experimental group-II and control group is found to be significant at 0.01 level (t= 6.929). This shows that experimental group-II where the mean retention test score is higher is good in performance than the control group in their retention level. Hence, it may be concluded that students who learned with the help of multimedia package-II show a clear advantage in retention scores than those taught through traditional method under the category of instructional objective-'Knowledge'.
The analysis leads to the conclusion that multimedia package-I and multimedia package-II are more effective than traditional method in the teaching of science to the secondary school science students under the category of objective knowledge. It is also concluded that among the two packages, the multimedia package-II had a higher effect than the multimedia package-I on academic achievement and retention.

b. Comparison of the effectiveness of Multimedia Package-I and Multimedia Package-II with Traditional Method for Teaching Science to Secondary School Students under the category of Instructional Objective-‘Understanding’.

i. The difference between the post-test means of the experimental group I and control group under the category of objective understanding is significant as the ‘t’ value is greater than the values (t=2.3; p<0.01). This shows that these two groups differ significantly in their achievement. It can be therefore concluded that the students who learned with the help of Multimedia Package –I showed better achievement test scores under the category of instructional objective-‘Understanding’ as compared to the students who learned with the traditional method.

ii. The difference between the post-test means of the experimental group-II and control group in the achievement test is found to be significant at 0.01 level (t=5.109; p<0.01). This shows that experimental group-II where the mean post-test score is higher (Mean= 22.10) under the category of the instructional objective-‘Understanding’ is better than the control group in their achievement. It is therefore concluded that the students who learned with the help of multimedia package-II have accomplished enhanced achievement test scores than those taught through traditional method under the category of instructional objective-‘Understanding’.

iii. There is no significant difference between the pre-test mean scores of the experimental group-I, experimental group-II and control group in the achievement test even at 0.05 level of significance under the category of the instructional objective-‘Understanding’. This shows that the three
groups do not differ significantly in their pre achievement level and indicates that groups are equally good in the performance irrespective of the multimedia packages under the category of instructional objective – ‘Understanding’.

iv. The difference between retention test mean scores of the experimental group-I and control group under the category of instructional objective – ‘Understanding’ is found to be significant as the calculated ‘t’ value (t =2.12) is greater than the critical value of ‘t’ at 0.05 level of significance. This shows that these two groups differ significantly in their retention level. It is thus concluded that the students who learned with the help of Multimedia Package-I showed better retention test scores under the category of instructional objective- ‘Understanding’ as compared to the students who learned with the traditional method.

v. The difference between the retention test mean scores of the experimental group-II and control group is found to be significant at 0.01 level (t= 4.65). This shows that experimental group-II where the mean retention test score is higher is good in performance than the control group in their retention level. Hence, it is concluded that the students who learned with the help of multimedia package-II show a clear advantage in retention scores than those taught through traditional method under the category of instructional objective- ‘Understanding’.

The analysis leads to the conclusion that multimedia package-I and multimedia package-II are more effective than traditional method in the teaching of science to the secondary school science students under the category of instructional objective- ‘Understanding’. It is also concluded that among the two packages, the multimedia package-II is better than the multimedia package-I in its effectiveness.


i. The difference between the post-test means of the experimental group-I and control group under the category of objective understanding is
significant as the ‘t’ value is greater than the values (t=2.35; p<0.01). This shows that these two groups differ significantly in their achievement. It is therefore concluded that the students who learned with the help of Multimedia Package-I showed better achievement test scores under the category of instructional objective-‘Application’ as compared to the students who learned with the traditional method

ii. The difference between the post-test means of the experimental group-II and control group in the achievement test is found to be significant at 0.01 level (t=2.13; p<0.01). This shows that experimental group-II under the category of the instructional objective-‘Understanding’ is better than the control group in their academic achievement. It is therefore concluded that the students who learned with the help of multimedia package-II have accomplished enhanced achievement test scores than those taught through traditional method under the category of instructional objective-‘Application’.

iii. There is no significant difference between the pre-test mean scores of the experimental group-I, experimental group-II and control group in the achievement test even at 0.05 level of significance under the category of the instructional objective -‘Application’. This shows that the three groups do not differ significantly in their pre achievement level and indicates that groups are equally good in the performance irrespective of the multimedia packages under the category of instructional objective-‘Application’.

iv. The difference between retention test mean scores of the experimental group-I and control group under the category of instructional objective-‘Application’ is found to be significant as the calculated ‘t’ value (t =2.10) is greater than the critical value of ‘ t’ at 0.05 level of significance. This shows that these two groups differ significantly in their retention level. Hence, it is concluded that students who learned with the help of Multimedia Package –I showed better retention test scores under the category of instructional objective -‘Application’ as compared to the students who learned with the traditional method.
v. The difference between the retention test mean scores of the experimental group-II and control group is found to be significant at 0.01 level (t= 3.46). This shows that experimental group-II where the mean retention test score is higher, is good in performance than the control group in their retention level. Therefore, it is concluded that the students who learned with the help of multimedia package-II show a clear advantage in retention scores than those taught through traditional method under the category of instructional objective -‘Application’.

The analysis leads to the conclusion that the multimedia approach (including either multimedia package-I or multimedia package-II) is more effective than traditional method in the teaching of science to the secondary school science students under the category of instructional objective-‘Application’. It is therefore, concluded that among the two packages, the multimedia package-II has a higher potential than the multimedia package-I in enhancing the academic achievement and retention among the learners.

d. **Comparison of the effectiveness of Multimedia Package-I and Multimedia Package-II with Traditional Method for Teaching Science to Secondary School Students under the category of Instructional Objective-‘Creativity’**.

i. There is no significant difference between the pre-test mean scores of the experimental group I, experimental group-II and control group in the achievement test even at 0.05 level of significance under the category of the instructional objective-‘Creativity’. This shows that the three groups do not differ significantly in their pre achievement level and indicates that groups are equally good in the performance irrespective of the multimedia packages under the category of instructional objective-‘Creativity’.

ii. The difference between the post-test means of the experimental group-I and control group under the category of instructional objective-‘Understanding is significant as the ‘t’ value is greater than the table value (t=2.05; p<0.05). This shows that these two groups differ significantly in their achievement. It can be therefore concluded that the students who learned
with the help of Multimedia Package –I showed better achievement test scores under the category of instructional objective-‘Creativity’ as compared to the students who learned with the traditional method.

iii. The difference between the post-test means of the experimental group-II and control group in the achievement test is found to be significant at 0.01 level (t=6.554; p<0.01). This shows that experimental group-II under the category of the instructional objective-‘Creativity’ is better than the control group in their academic achievement. It is therefore concluded that the students who learned with the help of multimedia package-II have accomplished enhanced achievement test scores than those taught through traditional method under the category of instructional objective-‘Creativity’.

iv. The difference between retention test mean scores of the experimental group -I and control group under the category of instructional objective-‘Creativity’ is found to be significant as the calculated ‘t’ value (t =4.565) is greater than the critical value of ‘t’ at 0.05 level of significance. This shows that these two groups differ significantly in their retention level. Hence it is concluded that the students who learned with the help of Multimedia Package-I showed better retention test scores under the category of instructional objective-‘Creativity’ as compared to the students who learned with the traditional method.

v. The difference between the retention test mean scores of the experimental group-II and control group is found to be significant at 0.01 level (t=8.264). This shows that experimental group-II where the mean retention test score is higher, is good in performance than the control group in their retention level. Hence, it is empirically concluded that the students who learned with the help of multimedia package-II show a clear advantage in retention scores than those taught through traditional method under the category of instructional objective-‘Creativity’.

The analysis leads to the conclusion that the multimedia approach (including either multimedia package-I or multimedia package-II) is more
effective than traditional method in the teaching of science to the secondary school students under the category of instructional objective-‘Creativity’. It is concluded that among the two packages, the multimedia package-II has a higher potential than the multimedia package-I in enhancing the academic achievement and retention among the learners.

C. MULTIMEDIA PACKAGES and ‘ACADEMIC ACHIEVEMENT and RETENTION’ at VARYING LEVELS of INTELLIGENCE

8. Comparison of Effect of Multimedia Package-I and Multimedia Package-II with Traditional Method on Academic Achievement and Retention of Secondary School Science Students at Varying Levels of Intelligence

a. Comparison of the effectiveness of Multimedia Package-I and Multimedia Package-II with Traditional Method for Teaching Science to Secondary School Students with respect to Academic Achievement and Retention of High Intelligence Group

i. The difference between the post-test means of the experimental group-I and control group in the achievement test under the category of high intelligence is found to be significant at 0.01 level. This shows that experimental group-I performed well than the control group in their academic achievement. Thus we can say that the students who learned with the help of Multimedia Package-I showed better achievement test scores at high intelligence level as compared to the students who learned with the traditional method.

ii. The difference between the post-test mean scores of the experimental group-II and control group in the achievement test is found to be significant at 0.01 level. This shows that experimental group-II where the mean post-test score is higher (Mean= 88) is better than the control group in their academic achievement. Consequently, it is concluded that students who learned with the help of multimedia package-II have accomplished enhanced achievement test scores than those taught through traditional method under the category of high intelligence group.
iii. There is no significant difference between the pre-test mean scores of the experimental group-I, experimental group-II and control group in the achievement test even at 0.05 level of significance. This shows that the three groups do not differ significantly in their mean pre-achievement scores and indicates that the groups are equally good in the performance irrespective of the multimedia packages at high intelligence level.

iv. The difference between retention test mean scores of the experimental group-I and control group under the category of high intelligence level, is found to be significant as the calculated ‘t’ value (t = 3.581) is greater than the critical value of ‘t’ at 0.01 level of significance. This shows that these two groups differ significantly in their retention level. Evidently, therefore it is concluded that the students who learned with the help of Multimedia Package-I showed better retention test scores under the category of high intelligence level as compared to the students who learned with the traditional method.

v. The difference between the retention test mean scores of the experimental group-II and control group is found to be significant at 0.01 level (t = 10.554). This shows that experimental group-II where the mean retention test score is higher is good in performance than the control group in their retention level. Hence, it is concluded that students who learned with the help of multimedia package II show a clear advantage in retention scores than those taught through traditional method at high intelligence level.

The analysis leads to the conclusion that multimedia package-I and multimedia package-II are more effective than traditional method in the teaching of science to the secondary school students under the category of high intelligence level. Hence, among the two packages, the multimedia package-II is much better than the multimedia package-I in its effectiveness.

b. Comparison of the effectiveness of Multimedia Package-I and Multimedia Package-II with Traditional Method for Teaching Science to Secondary School Students with respect to Academic Achievement and Retention of Average Intelligence Group.
i. There is no significant difference between the pre-test mean scores of the experimental group I, experimental group-II and control group in the achievement test even at 0.05 level of significance under the category of the average intelligence. This shows that the three groups do not differ significantly in their pre-achievement level and indicates that groups are equally good in the performance irrespective of the multimedia packages under the category of average intelligence.

ii. The difference between the post-test means of the experimental group-I and control group under the category of average intelligence is significant as the ‘t’ value is greater than the values (t=3.960; p<0.01). This shows that these two groups differ significantly in their achievement. It is therefore concluded that the average intelligence students who learned with the help of Multimedia Package –I showed better achievement test scores as compared to the students who learned with the traditional method.

iii. The difference between the post-test means of the experimental group-II and control group in the achievement test is found to be significant at 0.01 level (t=7.208; p<0.01). This shows that experimental group-II where the mean post-test score is higher (Mean= 66.83) at average intelligence level, is better than the control group in their achievement. Therefore is concluded that the students who learned with the help of multimedia package-II have accomplished enhanced achievement test scores than those taught through traditional method at average intelligence level.

iv. The difference between retention test mean scores of the experimental group-I and control group under the category of average intelligence is found to be significant as the calculated ‘t’ value (t =3.463) is greater than the critical value of ‘t’ at 0.01 level of significance. This shows that these two groups differ significantly in their retention level. Hence, it is concluded that students who learned with the help of Multimedia Package –I showed better retention test scores at average intelligence.
level as compared to the students who learned with the traditional method.

v. The difference between the retention test mean scores of the experimental group-II and control group is found to be significant at 0.01 level \( t \approx 8.666 \). This shows that experimental group-II where the mean retention test score is higher (Mean=60.22) has performed better than the control group in their retention scores. Hence, it proves that average intelligence students who learned with the help of multimedia package-II show a clear advantage in retention scores than those taught through traditional method.

The analysis leads to the conclusion that multimedia package-I and multimedia package-II are more effective than traditional method in the teaching of science to the secondary school average intelligence students. So, it is concluded that among the two packages, the multimedia package-II is much better than the multimedia package-I in its effectiveness for the average intelligence students also.


i. There is no significant difference between the pre-test mean scores of the experimental group I, experimental group-II and control group in the achievement test even at 0.05 level of significance under the category of the low intelligence level. This shows that the three groups do not differ significantly in their pre achievement level and indicates that groups are equally good in the performance irrespective of the multimedia packages under the category of objective knowledge.

ii. The difference between the post-test means of the experimental group I and control group under the category of objective understanding is not significant as the calculated ‘t’ value 1.031 is less than the table value of ‘t’ at 0.05 level of significance. This shows that these two groups do not
differ significantly in their achievement. It is therefore concluded that the low average students who learned with the help of Multimedia Package – I did not show better achievement test scores when compared to the students who learned with the traditional method.

iii. The difference between the post-test means of the experimental group II and control group in the achievement test is found to be significant at 0.01 level (t=2.781; p<0.01). This shows that experimental group II under the category of low intelligence level is better than the control group in their academic achievement. It may be therefore concluded that the students who learned with the help of multimedia package-II have accomplished improved achievement test scores than those taught through traditional method under the category of low intelligence level.

iv. The difference between retention test mean scores of the experimental group-I and control group under the category of objective application is found to be significant as the calculated ‘t’ value (t =2.619) is slightly greater than the critical value of ‘t’ at 0.05 level of significance. This shows that these two groups differ significantly in their retention level. It thus proves that students who learned with the help of Multimedia Package –I showed better retention test scores under the category of low intelligence level as compared to the students who learned with the traditional method.

v. The difference between the retention test mean scores of the experimental group-II and control group is found to be significant at 0.01 level (t= 4.068). This shows that experimental group-II where the mean retention test score is higher is good in performance than the control group in their retention level. Hence, it may be concluded that the students who learned with the help of multimedia package-II show a clear advantage in retention scores than those taught through traditional method under the category of low intelligence level.

The analysis leads to the conclusion that the multimedia approach (including either multimedia package-I or multimedia package-II) is more effective than traditional method in the teaching of science to the secondary school science students even for the students of low intelligence levels. Further, it is also concluded
that among the two packages, the multimedia package-II has a higher potential than
the multimedia package-I in enhancing the academic achievement and retention
among the learners of low intelligence level. Thus, it is concluded that Multimedia
Approach with Multimedia Package-II can help the students of low intelligence level
to perform better in their academic achievement and retention.

D. MULTIMEDIA APPROACH AND OPINION OF THE STUDENTS

9. Opinion of the Students towards the Effect of Multimedia Approach

a. Opinion of the students regarding the impact of multimedia approach on
the Quality of Learning.

i. The use of multimedia approach was found to be interesting by 91.7 percent
of the students (i.e. 75 percent strongly agree and 16.7 percent).

ii. The multimedia approach has a positive effect on the experimental/practical
work of the subject is supported by almost 93.4 percent of the students.

iii. 83.4 percent students agree with the fact that with the help of multimedia
approach learning is more convenient and easy.

iv. The major impact of the multimedia approach in comparison with the
traditional approach was on the academic performance. The academic
achievement of 88.3 percent students was improved because of the use of
multimedia approach.

v. The major impact of the multimedia approach in comparison with the
traditional approach was on the academic performance. The academic
achievement of 88.3 percent students was improved because of the use of
multimedia approach.

vi. Almost 85 percent students do not agree with the statement that multimedia
approach is not capable to satisfy the individual needs of the learners. Thus,
we can say that it is a useful tool which satisfies the individual needs of the
majority of the learners

vii. 86.7 percent of the students disagree with the statement that self paced
learning is not possible via multimedia approach. Thus, with the help of this
software majority of the students can learn according to their own pace of
learning.
viii. Similarly 79 percent students disagree with the statement that multimedia approach makes it difficult for them to retain their concepts. This clearly shows that multimedia approach has a positive impact on the retention of the subject matter among the learners.

ix. Multimedia instructional technology has helped the learners learn newer technology is supported by positive opinion of almost 85 percent of the students.

b. **Opinion of the students about the impact of multimedia approach on the Quality of Teaching.**

1. More than 90 percent students are of the opinion that multimedia approach strengthens the interaction between the student and teacher. Thus, the teaching learning environment is made more effective with the use of the multimedia approach in the classroom.

2. The instructions are systematically designed and implemented in the classroom with the help of the multimedia approach. 88.3 percent students found that continuity is thus maintained throughout the teaching.

3. Multimedia presentations have been found to have a greater impact on the teaching-learning than the normal conventional teaching strategy as 85 percent students have found these multimedia presentations easier to see and read and were also found to be sufficient by more than 70 percent of the students.

4. Almost 84 percent students disagree with the statement that multimedia approach does not have sufficient written instructions and simulations. Thus, it is clear that multimedia approach is a complete package in itself.

c. **Opinion of the students about the New Instructional Settings/Materials.**

1. Instructional material used in multimedia approach is easy to understand and convenient to comprehend is supported by almost 88.3 percent of students.

2. Since the software is easy to comprehend therefore, almost 78.3 percent of the students disagree with the statement that the style of the questioning is not appropriate.
3. The language used in the multimedia software is not easy to understand is disapproved by 85 percent majority of the students.

4. The usefulness of the software in the science experiments is appreciated by almost 90 percent of the students.

5. The various elements of the multimedia approach like text, graphics, and animations were widely acceptable by almost 85 percent of the students which have ultimately aroused their interest in the subject of the science and motivated them to learn this subject.

6. The multimedia content in terms of question bank, glossary and solved exercises in the software are very helpful in quick revision of the concepts is clearly evident with almost 95 percent of the favourable opinion and merely 5 percent of the students were in unfavourable opinion.

7. Another better outcome of the software was that a majority of the students i.e. 83.4 percent students were in favourable opinion of having no further tuitions requirement.

8. Only 16.7 percent of the students prefer the traditional approach in comparison with the 83.3 percent of the students liking the multimedia approach.

9. Only few students i.e. 13.4 percent of the students were of the view that the images used in the software were not appropriate whereas majority of the students were fascinated by the colorful images and drawings.

10. Similarly, only 11.7 percent of the students found the size of the text not readable.

d. Opinion of the students about the impact of multimedia approach on learners with respect to the Socialization.

1. Only 11.6 percent of the students are of the opinion that multimedia approach does not promote socialization while 80 percent of the students do not agree with this opinion.

2. Whereas on the other hand 85 percent of the students support the fact that since there is an active participation of the students while using multimedia approach therefore it helps in developing cooperation and group feeling among the students.
e. **Opinion of the students about the Change in Teacher’s Role/ Attitude due to the use of multimedia approach.**

i. The role of the teacher in the multimedia approach is equally important. Teacher rendering help to the student has been found to be important with favourable opinion by majority 90.7 percent of the students whereas the percentage of the students those who disagree and strongly disagree with the opinion are 4 percent and 2 percent respectively.

ii. A mere 6.0 percent of the students believe that the importance of the teacher is diminished while using the multimedia approach. In contrast to this almost 55 percent and 36 percent of the students disagree and strongly disagree respectively with the diminishing importance of the teacher while using multimedia approach.

iii. 86.6 percent of the students are of the opinion that majority of the school teachers do not have the required expertise in handling the multimedia approach, thus necessitate the training of the teachers in handling the newer technology and newer approach equally important for doing justice with the use of this technology for achieving the desired educational objectives.

iv. Teachers can bring a lot of attitudinal changes and evoke emotions as evident from the positive perception of almost 90 percent of the students whereas only few students were not in favour of the same.

f. **Opinion towards the Development of Students Abilities by using multimedia approach.**

1. Only 3.4 percent of the students think that the student's participation is more in conventional method whereas 91.6 percent of the students disagree with the same fact.

2. By adopting multimedia approach almost 85 percent of the students think that multimedia approach helps in improving the creativity among the students whereas in contrast to this merely 8.3 percent of the students were against this opinion.

3. A mere 6.7 percent of the students are of the opinion that multimedia approach increases anxiety and frustration among the learners, whereas a
majority of 86.7 percent students did not agree with the opinion.

4. Almost 88.4 percent of the students are of the opinion that multimedia approach has enhanced their confidence level.

g. **Opinion about the Impact of Multimedia approach on the Evaluation.**

i. Multimedia approach has been found to be student centric and diagnostic in nature by almost 93.3 percent of the students. Similarly, almost more than 80 percent of the students feel that this approach provides specific help for the student’s error.

ii. 88.3 percent of the students do not agree with the opinion that feedback provided by the multimedia approach is not clear and complete. Thus, highlighting the importance of the multimedia approach in providing immediate feedback.

h. **Opinion of the students regarding the Effect of Multimedia Approach on the Education System**

1. Almost 85 percent of the students agree with the opinion that multimedia approach is an effective technique and therefore the students will prefer to study other science subjects also with the help of the multimedia approach, whereas a mere 9.7 percent of the students disagree from the same opinion. 5.3 percent of the students were in a state of flux and remained undecided about the opinion.

2. Merely 11.7 percent of the students are of favourable opinion that multimedia approach cannot be useful in improving the standard of education, whereas contrary to it, 85 percent of the students are against the opinion and strongly rejected the view.

i. **Opinion of students about the Change in Student’s Role/ Attitude due to the use of multimedia approach.**

1. Out of the 90 percent of the students 50.7 percent students strongly agree where as 39.3 percent of the students agree with the opinion that with the help of multimedia approach their power of reasoning has increased. A mere 6.7 percent of the students are not in favour of the said opinion.
2. Likewise, a mere 11.7 percent of the students are of the view that they didn’t like the multimedia approach. On the contrary this methodology was liked and appreciated by almost 85 percent of the students.

3. Only few 5 percent of the students opined that multimedia approach has no effect on their retention power, whereas almost 88 percent of the students are not in the favour of this opinion. Thus, they contented for the positive effect of the multimedia approach on retaining the concepts in science for a longer time.

4. Similarly, a majority of the students i.e. almost 91.7 percent of the students supported the statement with a favourable response that a lively environment is created with the help of the multimedia approach.

j. General/Other opinion of students towards multimedia approach.

1. Multimedia approach can easily correlate with the day today life experiences of the learner are favoured by 86.7 percent of the students.

2. Like science multimedia approach can also be used in the other subjects also is favourably opined by 90 percent of the students.

3. Only 10 percent of the students believe that the multimedia approach destroys the imagination of the students whereas 83.3 percent of the students disagree with the same opinion.

4. Similarly, only 8 percent of the students are of the favourable opinion that it is difficult to take notes while using the multimedia approach, whereas, 88.3 percent of the students disagree with the same.

k. Opinion of the students towards the overall effectiveness of the multimedia approach.

In order to rate the overall effectiveness of the multimedia approach used in the subject of the science for the secondary school student’s majority of the students favoured this approach. 36.7 percent of the students rated this approach ‘outstanding’ whereas majorities i.e. 43.3 percent of the students have rated this approach as ‘excellent’. There were only 1.7 percent students who have rated this approach as ‘poor’. A mere 6.7 percent of the students have rated this approach as
‘fair’ whereas 13.3 percent of the students have rated it as ‘about average’.

1. **Opinion of the students towards the open ended question “Give further suggestion (s) for improving the multimedia software.”**

   In order to give further suggestions to modify or improve this multimedia software, some useful suggestions were given by the students. The suggestions like additional information for competitive exams should be included, more animations and videos should be included, mobile applications of the software should also be developed, software should be multilingual are given by 28.33 percent, 25 percent, 33 percent and 20 percent respectively.

**Conclusion**

The analysis of opinionnaire with regard to the use of multimedia packages revealed that the students have favourable opinion towards the use of multimedia approach in the subject of science.

**5.2 TENABILITY OF THE HYPOTHESES**

1. The first hypothesis states that "Traditional method has significant effect on academic achievement and retention of secondary school science students”.

   The findings of the study do not substantiate this hypothesis. The results of the study indicate that the mean achievement and retention scores of students in Control Group taught by traditional method are less as compared to the experimental groups. Finding numbers 1a, 1b, 2a, 2b, 4a, 4b, 5a, 5b, 6a, 6b clearly and factually proved that the experimental group-I and experimental group-II taught with multimedia package-I and multimedia-II respectively had a higher mean achievement and retention scores as compared to control group taught through traditional method.

   Thus, the above hypothesis is rejected.

2. The second hypothesis is "Multimedia approach (using Multimedia Package-I and Multimedia Package-II) has significant effect on retention and academic achievement of secondary school science students.”

   This hypothesis is substantiated by the research findings of the present study. The academic achievement in science of standard IX students in experimental
group-I and experimental group-II taught by multimedia package-I and multimedia package-II respectively is significantly higher than control group taught through conventional traditional method. The finding numbers 1b, 2b, 3b, 4a, 4b, 4c, 5a, 5b, 5c empirically support this statement. Similarly, retention scores in Science of standard IX students in experimental group-I and experimental group-II taught by multimedia package-I and multimedia package-II respectively is significantly higher than control group taught through conventional traditional method. The finding numbers 1c, 2c, 3c, 6a, 6b, 6c factually supports this statement.

Thus, the above hypothesis is accepted.

3. The third hypothesis is "Multimedia approach (using Multimedia Package-I and Multimedia Package-II) has significantly higher effect on total academic achievement and retention of secondary school science students as compared to traditional method."

This hypothesis is substantiated by the research findings of the present study. The total academic achievement and retention in science of standard IX students in experimental group-I and Experimental group-II taught by multimedia package-I and multimedia package-II respectively is significantly higher than control group taught through conventional traditional method.

The finding number 5a and 5b clearly indicates that, for (experimental group-I and control group) and (experimental group-II and control group), the difference between the adjusted post test means of the (experimental group-I and control group) and (experimental group-II and control group) in the achievement test is found to be significant at 0.01 level, $t=3.0163$ and $t=7.345$ respectively. This shows that experimental group-I and experimental group-II taught though multimedia approach had achieved better achievement test scores than those taught through traditional method.

Similarly, the finding number 6a and 6b clearly proves that, for (experimental group-I and control group) and (experimental group-II and control group), the difference between the adjusted retention test means of the (experimental group-I and control group) and (experimental group-II and control group) in the delayed post-test is found to be significant at 0.01 level, $t=6.42$ and $t=4.835$ respectively. Thus it concludes that the experimental group-I and experimental
group-II taught though multimedia approach had achieved better retention test scores than those taught through traditional method.

Thus, the above hypothesis is substantially accepted.

4. The fourth hypothesis states that, “Multimedia approach (using Multimedia Package-I and Multimedia Package-II) has significantly higher effect on academic achievement and retention of secondary school science students as compared to traditional method according to varying instructional objectives.”

The finding number 7a, 7b, 7c and 7d clearly proves that, multimedia package –I and multimedia package-II are more effective than traditional method in the teaching of biology to the secondary school science students under the category of instructional objective Knowledge, Understanding, Application and Creativity respectively.

Thus, the above hypothesis is considerably accepted.

5. The fifth hypothesis is stated as, “Multimedia approach (using Multimedia Package-I and Multimedia Package-II) has significantly higher effect on academic achievement and retention of secondary school science students as compared to traditional method at varying levels of intelligence.”

The finding number 8a, 8b and 8c clearly proves that, multimedia package –I and multimedia package-II are more effective than traditional method in the teaching of biology to the secondary school science students at varying levels of intelligence i.e. high, average and low respectively.

Thus, the above mentioned hypothesis is substantially accepted.

6. The final hypothesis states that, “There will be a favourable opinion of students about learning through multimedia approach”.

This hypothesis is clearly substantiated by the finding numbers 9a, 9b, 9c, 9d, 9e, 9f, 9g, 9h, 9i, 9j and 9k. These findings factually substantiates that the students have favourable opinion towards the use of multimedia approach in the subject of biology.

Thus, the hypothesis as stated above is significantly accepted.

5.3 EDUCATIONAL IMPLICATIONS

The scope of the study indicates that this study is a “drop in an ocean”. But as “drops make the ocean”, this study has educational implications especially for
science teaching at school level.

**Implications for the teachers**

Multimedia based technology acts as catalyst to support change in teachers’ pedagogy. With new technologies a teacher is no longer the sole source of knowledge but instead is a guide or facilitator who supports students learning.

**Implications for students**

The individualized instruction of this multimedia approach based education will allow students to advance at precisely the rate that will be advantageous for them.

Multimedia based tools will be able to break problems into small segments and to formulate questions. They will take students through each level, repeatedly and with many problems if necessary, until pupils begin to understand better. A human teacher could do the same if he or she had only one child in class.

**Implications for Teacher Education (TE)**

1. In the light of multimedia based approach in TE, changing roles of learners and teachers, high-tech classrooms, etc., it may be said that integration of multimedia based approach in TE will make TE highly interactive, individualized, flexible, accessible, more relevant and affordable and computer mediated.

2. A model of teacher training on use of multimedia technology need to be developed for effective instruction of science and other subjects at the secondary school level.

3. Human resources with proficiency in pedagogy and multimedia technology are needed to benefit from multimedia approach. Hence teacher training institutions are required to introduce courses to prepare teachers equipped with pedagogy and multimedia based skills.

4. Teacher education institutions may start new programs to produce multimedia programmers proficient to develop and implement effectively the multimedia based software in the classroom settings.
5. In-service teachers should be given multimedia literacy training through refresher courses. It is necessary to develop a culture for better utilization of multimedia in teaching learning process.

5.4 SUGGESTIONS FOR FURTHER STUDIES

1. A research study can also be undertaken to determine the effectiveness of various types of multimedia based instructions for various subject areas.

2. A study can be conducted to develop multimedia software on various topic of science according to science curriculum as prescribed by CBSE.

3. The study can be replicated on a large sample with special reference to different variables like gender, locality, management, socio-economic status and personality.

4. The study can be conducted at primary, higher secondary and college level for different subjects.

5. Further studies can also be conducted by dividing various types of multimedia elements (individually or in combinations) to see the best type of combination(s) for higher achievement and retention capacity of students belonging to different age groups.