CHAPTER VI ANALYSIS AND INTERPRETATION OF DATA

SECTION - 1 - Comparison of Achievement Scores
  o Comparison of Experimental and Control group
    Achievement scores with respect to Awareness of
    students of IX standard on basics of Biology and
    Effectiveness of AOM Learning Package in Biology

SECTION - 2 - Variability in Instructional Objectives
  o Variability in instructional objectives of experimental group
  o Variability in instructional objectives of control group
  o Comparison of Variability of instructional objectives
    between experimental and control group under study

SECTION - 3 - Pairwise comparison of Instructional Objectives
  o Pairwise comparison of Instructional objectives within the
    experimental group
  o Pairwise comparison of Instructional objectives within the
    control group

SECTION - 4 - Task Analysis
ANALYSIS AND INTERPRETATION

The present study is concerned with developing and determining the effectiveness of Advance Organizer Model learning package on the achievement of instructional objectives at secondary level (Standard IX). At the first stage of the experiment, the investigator administered a pre-test in order to compare the two groups (experimental and control group) on basics of knowledge in biology. After administering the pre-test the experimental group was taught using AOM learning package and the control group was using lecture method. The prepared learning package consisted of eleven lesson plans.

After completing the teaching programme data regarding the effectiveness of learning package was collected by administration of appropriate tools and techniques and was analyzed statistically. The analysis and interpretation of data have been carried out and presented under the following sections.
SECTION-1

COMPARISON OF ACHIEVEMENT SCORES

TABLE 6.1

a) Comparison of Achievement scores between Experimental and Control group under study

<table>
<thead>
<tr>
<th>Achievement score</th>
<th>Study group</th>
<th>Range</th>
<th>Mean</th>
<th>SD</th>
<th>Std. Error of mean</th>
<th>95% Confidence Interval for Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower Bound</td>
<td>Upper Bound</td>
</tr>
<tr>
<td>Pre-test</td>
<td>Experimental</td>
<td>1-22</td>
<td>11-32</td>
<td>5.18</td>
<td>0.73</td>
<td>9.85</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>3-20</td>
<td>11-86</td>
<td>4.11</td>
<td>0.58</td>
<td>10.69</td>
</tr>
<tr>
<td>Post-test</td>
<td>Experimental</td>
<td>15-45</td>
<td>32-44</td>
<td>8.86</td>
<td>1.25</td>
<td>29.92</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>6-26</td>
<td>13-12</td>
<td>4.52</td>
<td>0.64</td>
<td>11.84</td>
</tr>
</tbody>
</table>

The Mean + SD of achievements score during Pre-test in the experimental group is 11.32 + 5.18 and that in the control group is 11.86 + 4.11. The respective standard error of mean is 0.73 and 0.58. The mean values of both the group are well within the 95% confidence interval, that is, (9.85, 12.79) and (10.69, 13.03) respectively.
During the post-test, it is observed that, in the experimental group the mean + SD is 32.44 + 8.86. Thus, there is an increase of 186.57 percent of achievement score from the pre-test. In the control group the mean + SD is 131.12+4.52 which showed an increase by only 10.26 percent of achievement score from the base. The respective standard error of mean is 1.25 and 0.58. the mean values of both the groups are well within the 95% confidence interval, that is, (29.92, 34.96) and (11.84, 14.40) respectively. However, it may be observed from the data that the standard error of mean in the experimental group is more than one because of larger standard deviation observed during the post-test.

Table 6.2
a) Comparison of Achievement scores between Experimental and Control group under study

<table>
<thead>
<tr>
<th>Achievement score</th>
<th>Mean</th>
<th>SD</th>
<th>Std.Error Mean</th>
<th>t-value</th>
<th>df</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Experiment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-test</td>
<td>11.32</td>
<td>5.18</td>
<td>0.73</td>
<td>18.189</td>
<td>49</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Post-test</td>
<td>32.44</td>
<td>8.86</td>
<td>1.25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Control</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-test</td>
<td>11.86</td>
<td>4.11</td>
<td>0.58</td>
<td>2.59</td>
<td>49</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Post-test</td>
<td>13.12</td>
<td>4.52</td>
<td>0.64</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The comparison of achievement scores with the experimental group reveals that the differences in mean from pre-test to post-test, that is, 11.32 + 5.18 and 32.44 + 8.86 within the group is statistically highly significant at .01 level. In the control group also from pre-test to post-test the difference in mean, that is, 11.86 + 4.11 and 13.12 + 4.52 is statistically significant (p<0.013). It may be observed here that, though the difference in the mean values from pre-test to post-test is only 10.26 percent the increase in scores statistically significant. This may probably due to the smaller standard deviation in the observed data of the control group.

<table>
<thead>
<tr>
<th>Achievement score</th>
<th>Study group</th>
<th>Mean</th>
<th>SD</th>
<th>F-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>Experiment</td>
<td>11.32</td>
<td>5.18</td>
<td>2.211</td>
<td>&gt;0.10</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>11.86</td>
<td>4.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-test</td>
<td>Experiment</td>
<td>32.44</td>
<td>8.86</td>
<td>23.152</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>13.12</td>
<td>4.52</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The variances between the experimental and control groups during the pre-test was not found statistically significant (F=2.211, P>0.14). But for the post-test it was observed that the variances between the experimental and control group were statistically significant (F=23.152,
p<.01). Probably, the reason for such significance may be because of larger standard deviation in the experimental group as compared to the control group.

Table 6.4

d) Comparison of achievement score between the experimental and control group during pre-test and post-test

<table>
<thead>
<tr>
<th>Achievement score</th>
<th>Study group</th>
<th>Mean</th>
<th>SD</th>
<th>Test statistics</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>Experiment</td>
<td>11.32</td>
<td>5.18</td>
<td>0.578*</td>
<td>&gt;0.565</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>11.86</td>
<td>4.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-test</td>
<td>Experiment</td>
<td>32.44</td>
<td>8.86</td>
<td>8.163**</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>13.12</td>
<td>4.52</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: *t-value; **z-value

For testing the difference in mean achievement score of students between the experimental and control group during the pre-test, the independent sample student’s t-test is used, as the variances are not statistically significant. It is found that the mean difference is not statistically significant (t=0.578, p>0.5654) but for the post ‘t’ value was found statistically significant.
**SECTION-2**

**VARIABILITY IN INSTRUCTIONAL OBJECTIVES**  
Table 6.5

*a) Friedman test to compare the variability in knowledge, Understanding, application and skill in the experimental group*

<table>
<thead>
<tr>
<th></th>
<th>Range</th>
<th>Mean</th>
<th>SD</th>
<th>Chi-square value</th>
<th>df</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>7-14</td>
<td>11.36</td>
<td>1.99</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Understanding</td>
<td>3-16</td>
<td>11.44</td>
<td>3.63</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Application</td>
<td>1-13</td>
<td>7.56</td>
<td>3.54</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skill</td>
<td>0-4</td>
<td>2.23</td>
<td>1.26</td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>0-16</td>
<td>8.15</td>
<td>4.68</td>
<td>119.772</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As the data on the knowledge, understanding, application and skill is non-normal (Table-6.5) a non-parametric test, namely, Friedman test is used to compare the variability within the experimental group and it is found that the chi-square value was found statistically significant at .01 level and $X^2 = 119.772$ at degrees of freedom.
Table 6.6

*b) Friedman test to compare the variability in knowledge, understanding, application and skill in the control group*

<table>
<thead>
<tr>
<th></th>
<th>Range</th>
<th>Mean</th>
<th>SD</th>
<th>Chi-square value</th>
<th>DF</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>3-12</td>
<td>8.04</td>
<td>2.027</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Understanding</td>
<td>0-98</td>
<td>3.88</td>
<td>2.409</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Application</td>
<td>0-5</td>
<td>0.86</td>
<td>1.130</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skill</td>
<td>0-1</td>
<td>0.05</td>
<td>0.182</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>0-12</td>
<td>3.21</td>
<td>3.554</td>
<td>137.409</td>
<td>3</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Similarly, even in the control group, it is observed that (Table 6.6), as the data on the knowledge, understanding, application and skill is non-normal a non-parametric test, namely, Friedman test is used to compare the variability within the control group and it is found that the chi square ($X^2 = 137.4092$) value is statistically significant.
Table 6.7

In this study it is observed by using the Mann Whitney test (Table 6.7) that the comparison of the variability of knowledge, understanding, application, and skill between the experimental and the control group that, all the four parameters are statistically highly significant. This reveals that, the Mean + SD of knowledge, understanding application and skill in the experimental group is 11.36 + 1.99, 11.44 + 3.63, 7.56 + 3.54, and 2.23 + 1.26 respectively, where as for the control group the respective values are 8.04 + 2.03, 3.88 + 2.41, 0.86 + 1.13, and 0.05 + 0.18 which are much lower than the experimental group probably which has led to the statistical significance.
A pair wise comparison (Table 6.8) between the knowledge, understanding, application and skill shows that except between knowledge and understanding in all other cases it was statistically significant.
TABLE 6.9

b) Pair wise comparison within the control group using wilcoxon signed rank test.

<table>
<thead>
<tr>
<th>Pair</th>
<th>Knowledge versus understanding</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Knowledge versus understanding</td>
<td>6.044</td>
<td>&gt;0.001</td>
</tr>
<tr>
<td>2</td>
<td>Knowledge versus application</td>
<td>6.161</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>3</td>
<td>Knowledge versus Skill</td>
<td>6.165</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>4</td>
<td>Understanding versus Application</td>
<td>5.589</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>5</td>
<td>Understanding versus Skill</td>
<td>5.922</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>6</td>
<td>Knowledge versus Understanding</td>
<td>5.114</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

A pair wise comparison (Table 6.9) between the knowledge, understanding, application and skill shows that Z-values computed in all paired analysis was found significant at 0.0001 levels.
SECTION-4
TASK ANALYSIS

Task Analysis

Analysing the definite terminal behaviour of a particular question is termed as Task Analysis. The task analysis has been carried out in order to find out how far the terminal behaviour has been attained in each of the educational objective taken up for the study and for this purpose the performance with respect to each item of the achievement test has been analysed. The results are presented graphically with percentage distribution.

The following is the list of terminal behaviour for each Instructional objective

Table -6.10

Details of objective and terminal behaviour

<table>
<thead>
<tr>
<th>/Objectives</th>
<th>Terminal Behaviour</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Knowledge</td>
<td>Recall, Recognize,</td>
</tr>
<tr>
<td>2. Understanding.</td>
<td>Identifies, Relates, Explains, Defines,</td>
</tr>
<tr>
<td></td>
<td>Classifies, Compares, Distinguishes,</td>
</tr>
<tr>
<td></td>
<td>Differentiates, Cites examples, Associates,</td>
</tr>
<tr>
<td></td>
<td>Establishes Relationship &amp; Lists out.</td>
</tr>
<tr>
<td>3. Application.</td>
<td>Analyses, predicts, Reasons out, Infer,</td>
</tr>
<tr>
<td></td>
<td>Interpret, draws conclusion, gives reasons interprets</td>
</tr>
</tbody>
</table>
**Item wise Analysis**

**Item no.1**
A group of cells which are similar in origin, in form, and function are called

- a) Tissue
- b) Organ
- c) Organelle
- d) Organ system

**Type**
Multiple choice

**Objective**
Knowledge

**Specification**
Recognizes

---

**Item no.2**
Which of the following is an Invertebrate?

- a) Snake
- b) Silver Fish
- c) Earth worm
- d) Whale

**Type**
Multiple choice

**Objective**
Knowledge

**Specification**
Recognizes
**Item no.3**  
The group of organisms which have numerous pores as water inlets

a) Coelenterate    c) Annelids  
b) Porifera       d) Echinodermata

**Type**  
Multiple choice

**Objective**  
Knowledge

**Specification**  
Recognizes

---

**Item no.4**  
Coelenterates are called ‘diploblastic animals’ since their body wall is made up of

a) Two Layers    c) No Layers  
b) One Layers     d) Jelly Layer

**Type**  
Multiple choice

**Objective**  
Knowledge

**Specification**  
Recognizes

---

**Item no.5**  
Platyhelminthes are described as
acoelomate because

a) Body cavity is absent
b) Body cavity is present
c) Body cavity is filled with water
d) Body cavity is filled with blood

**Type**
Multiple choice

**Objective**
Knowledge

**Specification**
Recognizes

---

**Item no.6**
The group of organisms which are long cylindrical and unsegmented bodies

a) Platyhelminthes
b) Aschelminthes
c) Echinoderms
d) Molluscs

**Type**
Multiple choice

**Objective**
Knowledge

**Specification**
Recognizes
Item no.7 An animal having segmented body is
a) Earth worm c) Tape worm
b) Round worm d) Liverfluke
Type Multiple choice
Objective Knowledge
Specification Recognizes

Percentage of students who attempted the question

Item no.8 The Phylum in which animals have segmented body, jointed legs and compound eyes
a) Annelida c) Mollusca
b) Arthropod d) Echinodermata
Type Multiple choice
Objective Knowledge
Specification Recognizes

Percentage of students who attempted the question

An animal having a soft, unsegmented
**Item no. 9**

- **Body with a hard calcareous shell**
  - a) Freshwater mussels
  - b) Scorpion
  - c) Starfish
  - d) Millipede

**Type**

Multiple choice

**Objective**

Knowledge

**Specification**

Recognizes

---

**Percentage of students who attempted the question**

- Experimental group: 80%
- Control group: 50%

---

**Item no. 10**

- **Tube feet is the locomotory organ of**
  - a) Star Fish
  - b) Jelly Fish
  - c) Crop Fish
  - d) Silver Fish

**Type**

Multiple choice

**Objective**

Knowledge

**Specification**

Recognizes

---

**Percentage of students who attempted the question**

- Experimental group: 50%
- Control group: 20%
**Item no.11**

Fluid
Connective tissue:

: Nervous Tissue

**Type**
Analogy

**Objective**
Understanding

**Specification**
Recalls and associates

---

**Item no.12**

Flat Platyhelminth:

Aschelminth worm:

:_____ es

**Type**
Analogy

**Objective**
Understanding

**Specification**
Recalls and associates
**Item no. 13**

Ostia: Inlet : _______ : Outlet

**Type**
Analogy

**Objective**
Understanding

**Specification**
Recalls and associates

---

**Item no. 14**

Tentacles Capturing : Digesting : the food : _______ the food

**Type**
Analogy

**Objective**
Understanding

**Specification**
Recalls and associates
**Item no.15**  
Coelentrates Coelomate :  
: : :  
Acoelomate  

**Type**  
Analogy  

**Objective**  
Understanding  

**Specification**  
Recalls and associates

---

**Item no.16**  
Aschelminthes Sand worm  
(Nerites)  

**Type**  
Matching  

**Objective**  
Understanding  

**Specification**  
Establishes relationship

---

Percentage of students who attempted the question

![Graph showing percentage of students who attempted the question for Item no.15 and Item no.16.](image-url)
Item no. 17  
Annelida  
Cockroach

Type  
Matching

Objective  
Understanding

Specification  
Establishes relationship

---

Item no. 18  
Arthropoda  
Filaria worm

Type  
Matching

Objective  
Understanding

Specification  
Establishes relationship
Item no. 19

Mollusca

Sea Cucumber

Type

Matching

Objective

Understanding

Specification

Establishes relationship

---

Item no. 20

Echinodermata

Octopus

Type

Matching

Objective

Understanding

Specification

Establishes relationship

---

Percentage of students who attempted the question
**Item no.21**  
What is the difference between Vertebrate and Invertebrate?

**Type**  
Short answer

**Objective**  
Knowledge

**Specification**  
Recalls

---

**Item no.22**  
Can You consider a cluster of eggs as a tissue? Give reason

**Type**  
Short answer

**Objective**  
Application

**Specification**  
Analyses
**Item no.23**  
Mention the different phylums under Invertebrates

**Type**  
*Short answer*

**Objective**  
*Knowledge*

**Specification**  
*Recalls*

---

**Percentage of students who attempted the question**

---

**Item no.24**  
How would you make out that a worm like animal which has accidentally got into your house is round worm or flat worm?

**Type**  
*Short answer*

**Objective**  
*Application*

**Specification**  
*Predicts and reasons out.*

---

**Percentage of students who attempted the question**
Item no.25  Why are corals regarded as Coastal Jewels?

Type  Short answer

Objective  Application

Specification  Analyses
Item no.26  Given below is a figure of a certain animal

a) Is it Vertebrate or Invertebrate?
b) Give two reason in support of your answer given above
c) Name the phylum to which it belongs

Type  Short answer
Objective  Application
Specification  Interprets the figure

Percentage of students who attempted the question

<table>
<thead>
<tr>
<th>Percentage of students who attempted the question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental group</td>
</tr>
<tr>
<td>100%</td>
</tr>
</tbody>
</table>

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Why is the digestive system said to be incomplete in Flat Worms? Give reasons

**Item no.27**
**Type** Short answer
**Objective** Application
**Specification** Gives reason

**Item no.28** List any two important characteristics of Annelids

**Type** Short answer
**Objective** Understanding
**Specification** Lists out
**Item no.29**  
List out the economic importance of Arthropods

**Type**  
Short answer

**Objective**  
Understanding

**Specification**  
Lists out

---

**Item no.30**  
List any two important characteristics of Molluscsans

**Type**  
Short answer

**Objective**  
Understanding

**Specification**  
Lists out
**Item no.31**

Draw the diagram of the general morphology of a poriferan and label the parts.

*Type*  
*Short answer*

*Objective*  
*Skill*

*Specification*  
*Draws and labels the diagram*

---

**Item no.32**

Draw the longitudinal section of hydra and label the parts.

*Type*  
*Short answer*

*Objective*  
*Skill*

*Specification*  
*Draws and labels the diagram*
Item no.33

“Invertebrates are regarded as both friends and enemy to human being”. Justify the statement looking into the Diagram given below.

Type  Essay
Objective  Application
Specification  Analyses
After doing the task analysis of the Test paper for both control and experimental group it is found the performance of the students in the experiment group regarding the objectives knowledge, understanding, application, skill found to be higher than the control group. It indicates the AOM of teaching is found to be effective when compared to traditional method.

Regarding expression for the short answer and essay type question the students of the experimental group were able to give a descriptive answer whereas in control group it was not possible. It may be due to various illustrations that the teacher used while using AOM in the classroom. The students in the experimental group associated what they learnt in answering the question then mere rote memorization.

Tenability of the Hypotheses ...

The tenability of the hypotheses advanced for the study has been examined with the research data and the results are stated below.

Hypothesis 1

A learning package based on Advance Organizer Model is plausible for biology education at the secondary level. The preparation, execution and evaluation of Advance Organizer Model learning package reveal that a learning package is plausible for biology education at the secondary level. The learning package covered all the instructional objectives and was subdivided into eleven units. It was found quite feasible for instruction at the secondary level of education, hence the first hypothesis is accepted.
Hypothesis 2

Advance Organizer Model (AOM) Learning Package is more effective than Conventional Instruction (CI) on student achievement in Biology.

The result revealed that the prepared learning package (AOM) was more effective in improving overall achievement as well as attaining instructional objectives of knowledge, understanding, application and skill among the secondary school students. Hence the hypothesis is substantiated and accepted.

Discussion

From all these results it can be concluded that students who studied through learning package achieved better scores in biology than those who learnt through conventional lecture method. The prepared learning package is found to be more effective for improving achievement in biology at secondary level. The results indicate that Advance Organizer Model of teaching biology is quite effective and can be used as a classroom technique at the secondary level of education. The model is also replicable as it has got consistently better results during the experimental treatment on all learning dimensions of knowledge, understanding, application and skill. The learning package was feasible with the syntax, social system, principles of reaction and support system. The opinion by the experts who evaluated the learning package in terms of pedagogical principles, concept of teaching and content coverage supported the model for classroom teaching at the secondary level of education. The students also reported the package to be very interesting and easy to understand the topics. The students found the package to be highly informative and the instruction retentive through advance organizers.

The study upholds the feasibility and replicability of the Advance Organizer Model based learning package in biology for the secondary level of education.