CHAPTER - IV
RESEARCH DESIGN AND METHODS OF PROCEDURES

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- Features of Research Design
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- Design of the study
- Tools used for the study
- Experiment
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CHAPTER - IV

RESEARCH DESIGN AND METHODS OF PROCEDURES

4.01 INTRODUCTION

This chapter gives an idea of the design of study how to preceded, research tool used for the study, nature and selection of sample, procedure to just follow from other research studies.

According to Claire Selltiz (1962) “A research design is the arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure”. In fact, the research design is the conceptual structure with in which the research is conducted. It constitutes to the blue print for the collection, measurement and analysis of data. As such research design includes an outline of what the researcher will do from writing the hypothesis to the final analysis of the data collected.

4.02 FEATURES OF RESEARCH DESIGN

It is a plan that specifies the sources and types of data relevant to the research problem. It is a strategy specifying the approach to be used for gathering and analyzing the data, it also includes the budget of time and cost.

In short we can say, that a research design contains

- A clear statement of the problem
- Procedure and techniques to be used for data collection
- Sample to be studied
- Method to be used for the analysis of the data
The study aims to find out the “Effectiveness of Concentration Based Activity (CBA) on the development of Process Competencies (Knowledge, Attitude, Process Skills) found in secondary school students. After collection of adequate theoretical prospective from the related literature appropriate hypothesis were formed regarding influence of variables like Concentration Based Activity (CBA) and Process Competencies. The following hypotheses were framed at the outset, so that they could be experimentally verified. The detailed outline of which is presented.

4.03 METHODOLOGY

The main experimental designs are quasi- experiments in education under which Non equivalent Pretest Treatment Post Test design took by the researcher. One division exposed to CBA and another division traditional teaching.

4.04 HYPOTHESES

The following hypotheses are formulated for the present study.

1. There is significant differences in the mean pre-test scores of Process Competencies of experimental and control groups

2. There is significant differences in the mean pre-test scores and post test scores of Process Skills of experimental group

3. There is significant differences in the mean pre-test scores and post test scores of Scientific Attitude of experimental group

4. There is significant differences in the mean pre-test scores and post test scores of Achievement in Biology Science of experimental group

5. There is significant differences in the mean post-test scores of Process Skills of experimental and control groups

6. There is significant differences in the mean post-test scores Scientific Attitude of experimental and control groups

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7. There is significant differences in the mean post-test scores of Achievement of Biology Science of experimental and control groups

8. There is significant difference in the mean gain scores of Process Skills of experimental and control groups.

9. There is significant difference in the mean gain scores of Achievement in Biology Science of experimental and control groups

10. There is significant difference in the mean gain scores of Scientific Attitude experimental and control groups

11. There is significant differences in the mean pre-post test scores of Process Skills of experimental and control groups

12. There is significant differences in the mean pre-post test scores of Scientific Attitude of experimental and control groups

13. There is significant differences in the mean pre-post test scores of Achievement in Biology Science of experimental and control groups

14. There is significant differences in the development of process competencies between the pupils taught through Concentration Based activities (CBA)

4.05 EXPERIMENTAL DESIGNS

Experimental design is the blue print of the procedures that enable the researcher to test hypothesis by relating independent and dependent variable.

The main experimental designs are crude design and quasi- experiments in education. Under this I select quasi- experimental designs.

In Quasi – experimental designs, random assignment of members to the experimental and control groups is not made but random selection of experimental
and control groups among the groups available is made and as such the initial equivalence of groups in not assured.

(i) Non equivalent Pretest Treatment Post Test design

Test design

\[ \text{Gain} = T_2 - T_1 = \text{DE} \]

\[ \text{Gain} = T_2^l - T_1^l = \text{DC} \]

Two groups as they exist (say section A and B) are selected and one group is taken to be the experimental group and other the control group. Pre-test is administered to both the group. Treatment is given to the experimental group. The control group does not receive any treatment. After the treatment, post-test are conducted. The differences in the post test and pre-test measures are calculated separately for the two groups. The significance of difference between the difference measures of the two groups is computed. If the difference is significant, then conduce that the treatment is effective.

This is the most common design being adopted in the so called experimental researches is education. Randomization of groups generally will not be possible in the existing classroom and school administrative structures so often, we are satisfied with this design. Initial differences if any exist between the two groups it can also be controlled by a statistically technique known as Co- variance Analysis.

4.06 VARIABLES OF THE STUDY

Variables are the conditions or characteristics that the experimenter manipulates, control or observes (Best and Khan,1999). Independent variable and dependent variables are dealt with in this section.
(i) **Independent variable**

Independent variables are the conditions or characteristics that the experimenter manipulates or control in his attempt to ascertain their relationship to observed phenomena (Best and Khan, 1999). Concentration Based Activity (CBA) was taken as independent variable for this study.

(ii) **Dependent variable**

Dependent variables are the conditions or characteristics that appear, disappear or change as the experimenter introduces, removes or changes€ independent variable (Best and Khan, 1999). For the present study, the dependent variable includes:

1. Process Skill
2. Scientific Attitude
3. Achievement in Biology

### 4.07 SAMPLES SELECTED FOR THE STUDY

The population comprises students of secondary school in Kerala. The sample selected was the representative of the population. The sample consists of 48 students in experimental group and 48 students in control group were equated by considering the different co-variate such as Intelligence and Socio economic Status.

### 4.08 TOOLS USED

To verify the hypotheses, formulated in the study, the following tools have been used.

1. Lesson plan (Based on Concentration Based Activity (CBA))
2. Lesson plan (Based on existing curriculum)
3. Test of Process Skills in Science
4. Scientific Attitude Inventory
5. Criterion Referenced Test

4.09 CONSTRUCTION AND STANDARDIZATION OF TOOLS

1. Test of Process Skill in Science

(i) Planning

For the selection planning is the key to effective testing. Careful planning will remove all the deficiencies of a test.

(ii) Preparation

The investigator prepared a pool of 100 items in Malayalam representing the test of process skill in science

(iii) Pilot Study

The prepared test items were given to small group of 32 students in order to identify anomaly in the language, clarity, etc. After scrutiny by experts 14 items deleted and some are modified.

(iv) Try out

The draft was tried out on a stratified representative sample of 370 pupils of standard IX.

(v) Item discrimination

Item discrimination refers to the degree to which an item differentiates correctly among test takers in the behavior that test is designed to measure. It is desirable for each item to have as high on index of discrimination as possible. Ebel has suggested the following “rules of thumb” for interpreting item discrimination index for standardized tests.

<table>
<thead>
<tr>
<th>D- value</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.40 and up</td>
<td>- Very good item</td>
</tr>
<tr>
<td>0.30-0.39</td>
<td>- Reasonably good items, but possibly</td>
</tr>
</tbody>
</table>
Subject to improvement

0.20-0.29 - Marginal items usually needing and

Being subject to improvement

Below 0.19 - Poor item, to be rejected or improved by revision.

It should be noted that items with 0 or negative D-value probably were inadvertently unsuited or else are intrinsically ambiguous. These interpretations are relevant only for the ability of the item to measure

(v) Individual difference

From responses discarded incomplete ones and selected responses, then scored for item analysis. The procedure suggested by Edward (1957) was used to find out the discriminating power of the item. The response sheets of 100 subjects were arranged in rank order of total scores obtained by them. The score obtained by the top 27% students and bottom 27% were taken on the high group and low group respectively.

(vi) Why 27 percentage

The answer is that 27% provides the best compromise between two desirable but inconsistent aims as to make the extreme groups as large as possible and to make extreme groups as different as possible (Kelley 1969).

Although upper and lower groups of 27% are best, they are not really much better than groups of 25 percent would be. If one likes to work with simple fractions like one fourth or one third, instead of an odd percentage like 27% he should feel free to use upper and lower fourths or thirds. However he should grand against the intuitive feeling that 33% is better than 27% because it involves groups of larger size or that 25% is better 27% because the difference between the groups is greater in each case the supposed advantage is slightly more than offset by the opposing disadvantage. The optimum values are 27%.
Then the ‘t’ value for each item was calculated using the formula,

\[
t = \frac{\bar{X}_H - \bar{X}_L}{\sqrt{\frac{\sum (X_H - \bar{X}_H)^2 + \sum (X_L - \bar{X}_L)^2}{n(n-1)}}}
\]

Where,

\(\bar{X}_H\) = Arithmetic mean of the given item for high group

\(\bar{X}_L\) = Arithmetic mean of the given item for low group

\(X_H\) = Score of high group

\(X_L\) = Score of low group

\(n\) = Number of subjects in the group

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>‘t’ value</th>
<th>Sl. No.</th>
<th>‘t’ value</th>
<th>Sl. No.</th>
<th>‘t’ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
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<td>21</td>
<td>4.31</td>
<td>41</td>
<td>3.68</td>
</tr>
<tr>
<td>2.</td>
<td>3.41</td>
<td>22</td>
<td>6.28</td>
<td>42</td>
<td>2.65</td>
</tr>
<tr>
<td>3.</td>
<td>5.91</td>
<td>23</td>
<td>3.81</td>
<td>43</td>
<td>5.69</td>
</tr>
<tr>
<td>4.</td>
<td>7.22</td>
<td>24</td>
<td>9.38</td>
<td>44</td>
<td>2.23</td>
</tr>
<tr>
<td>5.</td>
<td>1.22</td>
<td>25</td>
<td>1.36</td>
<td>45</td>
<td>3.62</td>
</tr>
<tr>
<td>6.</td>
<td>4.88</td>
<td>26</td>
<td>5.64</td>
<td>46</td>
<td>5.2</td>
</tr>
<tr>
<td>7.</td>
<td>5.65</td>
<td>27</td>
<td>0.68</td>
<td>47</td>
<td>1.03</td>
</tr>
<tr>
<td>8.</td>
<td>3.46</td>
<td>28</td>
<td>9.39</td>
<td>48</td>
<td>1.53</td>
</tr>
<tr>
<td>9.</td>
<td>1.24</td>
<td>29</td>
<td>2.50</td>
<td>49</td>
<td>4.52</td>
</tr>
<tr>
<td>10.</td>
<td>9.31</td>
<td>30</td>
<td>6.51</td>
<td>50</td>
<td>5.25</td>
</tr>
<tr>
<td>11.</td>
<td>8.41</td>
<td>31</td>
<td>4.85</td>
<td>51</td>
<td>1.85</td>
</tr>
<tr>
<td>12.</td>
<td>6.51</td>
<td>32</td>
<td>5.86</td>
<td>52</td>
<td>3.7</td>
</tr>
<tr>
<td>13.</td>
<td>9.80</td>
<td>33</td>
<td>1.98</td>
<td>53</td>
<td>6.2</td>
</tr>
<tr>
<td>14.</td>
<td>1.11</td>
<td>34</td>
<td>8.22</td>
<td>54</td>
<td>3.42</td>
</tr>
<tr>
<td>15.</td>
<td>10.28</td>
<td>35</td>
<td>3.79</td>
<td>55</td>
<td>1.38</td>
</tr>
</tbody>
</table>
Item having the t-value 2.5 and above were selected. Thus the final test of process skill of science contains 40 items.

(vii) Validity

According to Murphy and David Shofer “If a test determining or measuring what is supposed to measure and determine whether that test can be used in making accurate discussion, such a test said to be valid’

The present inventory was constructed is such a way that it covers the thirteen areas. Each item in the test was prepared by the components and sub-components proposed by AAAS.

The concurrent validity was established by correlating the scores of test of process skills of science obtained from 100 pupils from standard IX of Thrissur (Dt). The validity established is 0.66.

(viii) Reliability

When we measure the consistency of tests by determining how much variation exists in specific individuals score, such variability is intra individual variability. If is expressed as standard error measurement. If you measure the consistency of scores of a group by determining how much variation exists the two group’s measures, such type of variability is inter individual variability or Reliability measurement.

Mehrens and Lehman (1978) says “reliability can be defined as the degree of consistency between two measures of the same thing”
Ratability Coefficient	Interpretation
0.85 and above	High reliability
0.85 to 0.60	Moderate reliability
Below 0.60	Very low reliability

Reliability of the test of process skill in science was found using split half method. Items selected through item analysis of test of process skill in science were split in to two equal halves in such a way that the scores of odd number items forms the first half and the even number items forms second half. The two set of scorers were used to find out the reliability coefficient using Pearson Product Moment Method (Garret, 1979).

\[ r = \frac{N \sum XY - \sum X \sum Y}{\sqrt{[N \sum X^2 - (\sum X)^2] [N \sum Y^2 - (\sum Y)^2]}} \]

X= Total scores for first half items
Y= Total scores for second half items
N= Number of students

From the self correlation of the half tests, the reliability coefficient of the whole test may be estimated from spearman brown prophecy and is as follows.

\[ r_{xx} = \frac{2 r_{1/2}^{1/2} r_{1/2}^{1/2}}{1 + r_{1/2}^{1/2}} \]

Where, \( r_{xx} \) = Estimate reliability of the whole test
\( r_{1/2} \) = reliability of the half test

The obtained reliability index was 0.862

2. Scientific Attitude Inventory

In order to study the scientific attitudinal change if any, of secondary and higher secondary students due to the effect of various techniques of teaching it was
decided to measure the attitudinal changes of students. Since a suitable tool was not available it was decided to construct one to serve the purpose.

(i) Construction of the Attitude Inventory

In this regard the researcher carefully studied the suggestions made by Thurstone and Chave (Allen L.1957:11-12). In order to get enough items for the attitude scale, the investigator studied several books, magazines and journals dealing with psychological objects and attitude scales and questionnaire that have already been constructed and used by others in the field, after a thorough scrutiny, 88 statements were selected and were given to experts for comments. Some items were eliminated and others were modified as per their suggestions. Thus a final scale consisting of 60 statements was used for the pilot study. Some of the irrelevant items had been eliminated by the above procedures.

(ii) Pilot study

It was not possible to eliminate irrelevant items. So the test was administered on a small group of 30 students, but representative sample for eliciting comments and queries about ambiguities and obscurities that had not been previously detected so that the investigator could make the necessary corrections before preparing the final form of the attitude scale. After selecting the items care was taken to ensure that equal number of favorable and unfavorable items were included. When the statements are collected the next step is to decide scale values to these statements. Mainly there are two methods for assigning scale values to the statements. They are Thurstones method and Likert method. For the present investigation, it was very difficult to get enough number of experts to whom the statements were to be submitted to sort them independently according to their position. Therefore a Likert type of attitude scale was constructed and used.
(iii) **Administration of the try out**

As part of the present investigation, it was intended to measure and to state in quantitative terms the scientific attitude of students of secondary schools. In this try out consists of 370 samples from two different IX class secondary school students of Thrissur district. They were permitted to choose any one of the 5 categories for each item.

Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D) and Strongly Disagree (SD).

(iv) **Scoring**

<table>
<thead>
<tr>
<th>Statements</th>
<th>SA</th>
<th>A</th>
<th>U</th>
<th>S</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Favorable</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Unfavorable</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Table – 4.02

The scoring of Scientific Attitude was done using the procedure

The score of individual statement were summated to arrive at the total score

(v) **Selection of criterion groups**

The proportion of the total subject population to be included in each criterion group can be set at the upper and lower third , the upper and lower 25% or the upper an lower 27% or any other desired figures.

In the present study, the investigator used the upper and lower 27%. The use of upper and lower 27% offers the best compromise between the two variables which can affect the reliability of the results. (Leonard Ferguson 1952: 114) these two variables are the number of cases and the scalar distance between the two groups. These variables are inversely related. As we increases the number of cases, the scalar
distances contracts and as we increases the scalar distances, the number of cases diminishes.

(vi) Item analysis

By item analysis is meant of the processes by which one can find which items differentiate and which do not differentiate between the contrasting criterion groups (Ferguson 1952 :115) item analysis is used as a basis for the final selection of statement in the method of summed ratings. The method employed in the present investigation is given below.

After arranging the total score in the ascending order, the 27% of the subjects with the highest scores and 27% of the subjects with the lowest scores were evaluate the individual statements. Thus having selected the 27 highest scoring subjects (the top 27%) and 27 lowest scoring subjects (the bottom 27%) as criterion groups, the numerical values of their mean responses to each statement was computed.

In evaluating the responses of the high and low groups to the individual statement ‘t’ values were calculated using the formulae

\[ t = \frac{\overline{X}_H - \overline{X}_L}{\sqrt{\frac{\Sigma (X_H - \overline{X}_H)^2 + \Sigma (X_L - \overline{X}_L)^2}{n(n-1)}}} \]

\( \overline{X}_H \) = the mean score of the high group for a given statement

\( \overline{X}_L \) = the mean score of the lower group for a given statement

\( X_H \) = the score of a given individual for the statement in the high group

\( X_L \) = the score of a given individual for the statement in the low group

\( N \) = number of subjects in the criterion group

The value of t is a measure of the extent to which a given statement differentiates the high group and low group t – value of about 1.75 indicates that, the average responses of the high and low group to a statement differs significantly.
(vii) Preparation of final attitude scale

As a crude and appropriate rule of thump, we may regard any \( t \) – value equal to or greater than 1.75 as indicating that average responses of the high and low groups to a statement differ significantly provided we have 25 or more subjects in the high group and also in the group (Edwards 1957: 153)

In the present study, out of the 60 items, 38 items having the highest \( t \) values were selected. They were arranged in a random order in the final scale. Then with necessary instruction 100 copies of the attitudinal scale were made ready for administration.

(viii) Validity

This scientific attitude inventory, the face validity inferred by the five expert, and they reported the item have high face validity

(ix) Reliability

The reliability means the consistency with which a set of test scores measures whatever they do measure (Robert L.Ebel, 1960:310)

In the present study the reliability coefficient of the attitude scale was calculated using the split half method. A random sample of 100 response sheet was selected. The scores obtained for each of the 100 pupils for the odd and even item were grouped separately. Thus for every individual a pair of scores was obtained. The reliability co-efficient for the whole test was calculated using the Spearmen –Brown Prophency formula.

\[
R = \frac{2r}{1+r}
\]

where \( r \) is the reliability coefficient of the half test.

The value of \( R \) obtained 0.902, which shows that the test has high reliability.
3. Criterion Referenced Test

(i) Planning

For the selection planning is the key to effective testing. Careful planning will remove all the deficiencies of a test.

(ii) Preparation

The investigator prepared a pool of 75 items which include objective type, short answer type, and essay type in Malayalam representing the test of achievement in biology. After scrutiny by experts 25 items deleted and some are modified.

(iii) Pilot Study

The prepared items tried on very small sample of 30 students and to find out the gross deficiencies. Based on the pilot study result items are modified to avoid ambiguity, to balance difficulty level.

(iv) Try out

The draft was tried out on a stratified representative sample of 370 pupils of standard IX.

(v) Item discrimination

Item discrimination refers to the degree to which an item differentiates correctly among test takers in the behavior that test is designed to measure. It is desirable for each item to have as high on index of discrimination as possible.

\[ \text{Discriminating power} = PH + PL \]

\[ \text{Difficulty Level} = \frac{PH + PL}{2} \]

items having discriminating power coming under .4 to .3 level and Difficulty level comes under .4 to .6 were selected for final test. The questions include 64% average, 16% easy, 20% difficult.
(vi) Validity

This criterion referenced test the content validity inferred by the five subject expert.

(vii) Reliability

Reliability of the test of Criterion referenced test in biology was found using test-retest method. The test-retest was conducted at time period (two week). The two state of scorers were used to find out the reliability coefficient using Pearson Product Moment Method and got reliability as 0.812.

(viii) Preparation of the final Criterion Referenced Test

TABLE – 4.03
Planning of the Achievement Test

<table>
<thead>
<tr>
<th>Name of the School</th>
<th>St Antony’s HSS Puthenpeedika</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of the scholar</td>
<td>Freejo K J</td>
</tr>
<tr>
<td>Standard</td>
<td>IX</td>
</tr>
<tr>
<td>subject</td>
<td>Biology</td>
</tr>
<tr>
<td>Time</td>
<td>1Hr</td>
</tr>
<tr>
<td>Maximum Mark</td>
<td>25</td>
</tr>
<tr>
<td>Unit</td>
<td>I, II, III</td>
</tr>
</tbody>
</table>

(ix) Preparation of a design for the test

1. Weightage to objectives

TABLE – 4.04
Weightage to objectives

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Objectives</th>
<th>Mark</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Knowledge</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>2</td>
<td>Understanding</td>
<td>11</td>
<td>44</td>
</tr>
<tr>
<td>3</td>
<td>Application</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>4</td>
<td>Skill</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
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2. Weightage to Content

Table – 4.05
Weightage to Content

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Content</th>
<th>Mark</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Unit- 1 : The sign of life</td>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td>2</td>
<td>Unit-2 : The chemical changes of food</td>
<td>9</td>
<td>36</td>
</tr>
<tr>
<td>3</td>
<td>Unit-3: Circulating Pathways</td>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>25</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

3. Weightage to Form of Questions

Table – 4.06
Weightage to Form of Questions

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Form of Questions</th>
<th>No. of Question</th>
<th>Mark</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Objective Type</td>
<td>12</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>2</td>
<td>Short answer type</td>
<td>6</td>
<td>12</td>
<td>48</td>
</tr>
<tr>
<td>3</td>
<td>Unit-3: Circulating Pathways</td>
<td>8</td>
<td>32</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>25</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
</tr>
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</table>

4. Weightage to difficulty Level

Table – 4.07
Weightage to difficulty Level

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<thead>
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<th>Difficulty</th>
<th>Mark</th>
<th>%</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Easy</td>
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</tr>
<tr>
<td>2</td>
<td>Average</td>
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<td>Difficult</td>
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<td>20</td>
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<tr>
<td></td>
<td><strong>Total</strong></td>
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<td><strong>100</strong></td>
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5. Blue Print of Achievement Test

Table – 4.08
Blue Print of Achievement Test

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Knowledge</th>
<th>Understanding</th>
<th>Application</th>
<th>skill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form of Questions</td>
<td>O</td>
<td>SA</td>
<td>E</td>
<td>O</td>
</tr>
<tr>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit-1</td>
<td>½(1)</td>
<td>2(1)</td>
<td>½(3)</td>
<td>2(1)</td>
</tr>
<tr>
<td>Unit-2</td>
<td>½(1)</td>
<td>2(2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit-3</td>
<td>½(2)</td>
<td>½(2)</td>
<td>2(1)</td>
<td>½(2)</td>
</tr>
<tr>
<td>No. of Questions</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Mark</td>
<td>21/2</td>
<td>2</td>
<td>21/2</td>
<td>8</td>
</tr>
<tr>
<td>Grand Total</td>
<td>4</td>
<td>11</td>
<td>6</td>
<td>5</td>
</tr>
</tbody>
</table>

Foot Note: number outside the bracket denote number of questions and number with in the bracket denote mark for each
6. Preparation of scoring key and marking scheme

Table – 4.09

Preparation of scoring key

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Answer</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>B</td>
<td>B</td>
</tr>
</tbody>
</table>

6. Osmosis

7. Enamel

8. 0.8 Seconds

9. Capillaries     ----  Transport of materials

10. Semi lunar valves ----  Arteries

11. Stethoscope    ----  Heart Beat

12. Skin           ----  Excretory Organ
7. Preparation of marking scheme

Table – 4.10

Preparation of marking scheme

<table>
<thead>
<tr>
<th>Question No.</th>
<th>Value Points</th>
<th>Marks</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 i)</td>
<td>Reflection of green light falling on the surface of the leaf</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>14 ii)</td>
<td>ii) chlorophyll can not absorb green colour</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>15. i)</td>
<td>The worm expands the pharynx. the enlargement of the pharyngeal cavity</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>draws the food in to the buccal cavity</td>
<td>1/2</td>
<td>2</td>
</tr>
<tr>
<td>16. ii)</td>
<td>Gizzard grinds and makes food soft and in the stomach enzymes digest</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>17.</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>i) availability of Co2 and H2O</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. ii)</td>
<td>intensity of light</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>iii) atmosphere temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. i)</td>
<td>The wave like contraction is and relaxation of muscular walls which</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
20. help food to pass through is called peristalsis
   ii) Oesophagus

i) The endocrine part of the pancreas is made of islets of langerhans, which are formed of A and B cells. B cells produces insulin which converts extra glucose in to glycogen and store in the liver cells.

<table>
<thead>
<tr>
<th>i) superior vena cava</th>
<th>Right Atrium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inferior vena cava</td>
<td>Pulmonary vein</td>
</tr>
<tr>
<td>Pulmonary artery</td>
<td>Left Atrium</td>
</tr>
<tr>
<td>Aorta</td>
<td></td>
</tr>
</tbody>
</table>

i) Xylem
   Vessels, Tracheids, Xylem
   Parenchyma
   Transportation of Water and minerals
   Structure of tooth
8. Question Wise Analysis

Table – 4.11

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Content</th>
<th>Objectives</th>
<th>Specification</th>
<th>Form of questions</th>
<th>Difficulty Level</th>
<th>Marks</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Unit – 1</td>
<td>Understanding</td>
<td>Compares</td>
<td>Objective</td>
<td>Easy</td>
<td>½</td>
<td>½</td>
</tr>
<tr>
<td>2</td>
<td>Unit – 1</td>
<td>Knowledge</td>
<td>Recalls</td>
<td>Objectives</td>
<td>Easy</td>
<td>½</td>
<td>½</td>
</tr>
<tr>
<td>3</td>
<td>Unit – 2</td>
<td>Knowledge</td>
<td>Recalls</td>
<td>Objectives</td>
<td>Easy</td>
<td>½</td>
<td>½</td>
</tr>
<tr>
<td>4</td>
<td>Unit – 3</td>
<td>Understanding</td>
<td>Differentiate</td>
<td>Objective</td>
<td>Average</td>
<td>½</td>
<td>½</td>
</tr>
<tr>
<td>5</td>
<td>Unit – 3</td>
<td>Knowledge</td>
<td>Recalls</td>
<td>Objectives</td>
<td>Average</td>
<td>½</td>
<td>½</td>
</tr>
<tr>
<td>6</td>
<td>Unit – 1</td>
<td>Knowledge</td>
<td>Recognize</td>
<td>Objectives</td>
<td>Average</td>
<td>½</td>
<td>½</td>
</tr>
<tr>
<td>7</td>
<td>Unit – 2</td>
<td>Knowledge</td>
<td>Recalls</td>
<td>Objective</td>
<td>Easy</td>
<td>½</td>
<td>½</td>
</tr>
<tr>
<td>8</td>
<td>Unit – 3</td>
<td>Application</td>
<td>Applies</td>
<td>Objectives</td>
<td>Average</td>
<td>½</td>
<td>½</td>
</tr>
<tr>
<td>9</td>
<td>Unit – 3</td>
<td>Knowledge</td>
<td>Recalls</td>
<td>Objectives</td>
<td>Easy</td>
<td>½</td>
<td>½</td>
</tr>
<tr>
<td>10</td>
<td>Unit – 3</td>
<td>Understanding</td>
<td>Identifies</td>
<td>Objective</td>
<td>Easy</td>
<td>½</td>
<td>½</td>
</tr>
<tr>
<td>11</td>
<td>Unit – 3</td>
<td>Application</td>
<td>Applies</td>
<td>Objectives</td>
<td>Easy</td>
<td>½</td>
<td>½</td>
</tr>
<tr>
<td>12</td>
<td>Unit – 3</td>
<td>Understanding</td>
<td>Compares</td>
<td>Objective</td>
<td>Easy</td>
<td>½</td>
<td>½</td>
</tr>
<tr>
<td>13</td>
<td>Unit – 2</td>
<td>Application</td>
<td>Applies</td>
<td>Short Answer</td>
<td>Difficult</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
4.10 EXPERIMENT

Pre-test –post test non equivalent groups design was adopted for the study. Two divisions of class IX, St.Antony’s HSS Thrissur, were taught through two different teaching strategies. One division of class IX D was exposed to the concentration based learning activities acted as experimental group while the other IX E which was exposed to the conventional lecture method teaching acted as a control group.

Three common units were taught to the two groups Viz. Sixty periods of forty minutes duration each were taken for teaching the topics. The experiment group had 48 children while the control group had 48 children.

a) Test of Process Skills in Biology
b) Scientific Attitude Inventory
c) Criterion Referenced Test

Tools were administered to the pupil to test their process competencies before the experiment commenced in both sections. After teaching the content of
science mentioned above, through the two different teaching strategies in the two sections, in the two sections, a post test was administered to the pupil.

4.11 SCORING

The investigator adopted specific method for scoring the responses from the students, finally 48 samples from experimental group and 48 samples from control group obtained. The complete answer sheets of 96 pupils were consolidated for further analysis and all entries were coded by using digits facilitating computer feeding.

4.12 STATISTICAL TECHNIQUES USED:

Suitable descriptive and inferential techniques were used in the interpretation of the data to draw out meaningful pictures of results from the collected data. In the present study, the following statistical measures were used:

1. **Mean**

   \[
   \bar{X} = \frac{A}{N} + \frac{\sum Fd}{N} \times I
   \]

   Where,
   
   \(A\) = Assured Mean
   
   \(F\) = Frequency
   
   \(D\) = Deviation from the assured Mean
   
   \(N\) = Number of observations
   
   \(I\) = Class interval

2. **Standard Deviation**

   \[
   SD = \sigma = I \sqrt{\frac{\sum Fd^2}{N} - \left( \frac{\sum Fd}{N} \right)^2}
   \]

   Where,
   
   \(F\) = Frequency
D = Deviation from arithmetic Mean
I = Class interval
σ = Standard Deviation

3. Quartile Deviation

\[ Q_1 = L_1 + \frac{\left\lfloor \frac{N}{4} - C_1 \right\rfloor}{f_1} \times i \]

\[ Q.D = \frac{Q_3 - Q_1}{2} \]

Q.D = Quartile Deviation
Q_1 = First Q.D
Q_3 = Third Q.D
L_1 L_3 = Lower Limit of medium class
N = Total Frequency
C_1 C_3 = Cumulative frequency
F_1 F_2 = Frequency of the medium class

4. Standard Error

\[ SE = \sqrt{\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}} \]

σ_1, σ_2 = Standard Deviation
N_1, N_2 = Total number of classes

5. Critical Ratio (CR) = \[ \frac{M_1 - M_2}{SE} \]

M_1, M_2 = Means of two groups
6. Analysis of Variance (ANOVA)

\[ F \text{ ratio} = \frac{\text{Variance between group}}{\text{Variance within group}} \]

Correlation term \( c = \frac{(\sum X_1 + \sum X_2 + 2 \times 3)^2}{N} \)

\[ \text{TSS} = X_2 - c \]

\[ \text{BSS} = \left[ \frac{\sum X_1}{W_1} \right]^2 + \left[ \frac{\sum X_3}{W_3} \right]^2 - C \]

\[ \text{WSS} = \text{TSS} - \text{BSS} \]

Where, \( X_1, X_2, X_3 \) are scores in different groups

\( C = \) Correlation term

\( \text{TSS} = \) Total Sum of squares

\( \text{BSS} = \) Sum of SQRS between groups

\( \text{WSS} = \) With in groups.

7. Single Factor ANCOVA

By the use of the single factor ANCOVA the influence of the uncontrolled variable, some times called the co-variable or concomitant variable was removed.

In the present study, initial status of the student in terms of Process Competencies is the covariate. By the use of ANCOVA, the effect of this co-variable can be removed (Ferguson, 1971).

An application of sample of co-variance requires paired observations on ‘k’ groups of experimental subjects. The number of pairs of observation in the ‘k’ groups of experimental subjects. The number of pairs of observation in the ‘k’ groups is denoted by \( N_1, N_2, \ldots, N_k \). The paired observations are assumed to the paired samples.
**120A MODEL ANACOVA TABLE IS PRESENTED IN TABLE NOTATION FOR THE ANALYSIS OF CO-VARIANCE**

<table>
<thead>
<tr>
<th>Treatment 1</th>
<th>......</th>
<th>Treatment j</th>
<th>......</th>
<th>Treatment k</th>
</tr>
</thead>
<tbody>
<tr>
<td>( Y_{11} ) ( X_{11} )</td>
<td>......</td>
<td>( Y_{1j} ) ( X_{ij} )</td>
<td>......</td>
<td>( Y_{1k} ) ( X_{1k} )</td>
</tr>
<tr>
<td>( Y_{21} ) ( X_{21} )</td>
<td>......</td>
<td>( Y_{2j} ) ( X_{2j} )</td>
<td>......</td>
<td>( Y_{2k} ) ( X_{2k} )</td>
</tr>
<tr>
<td>( Y_{a1} ) ( X_{a1} )</td>
<td>......</td>
<td>( Y_{aj} ) ( X_{aj} )</td>
<td>......</td>
<td>( Y_{ak} ) ( X_{ak} )</td>
</tr>
<tr>
<td>Sum ( T_{y1} ) ( T_{x1} )</td>
<td>......</td>
<td>Tyj ( T_{xj} )</td>
<td>......</td>
<td>Tyk ( T_{xk} )</td>
</tr>
<tr>
<td>Mean ( \frac{1}{a1} ) ( X_{1} )</td>
<td>......</td>
<td>Yj ( X_{1j} )</td>
<td>......</td>
<td>Yk ( X_{k} )</td>
</tr>
<tr>
<td>( T_{xx} = n \Sigma (xj - x)^2 )</td>
<td>( T_{xy} = n \Sigma (xj - x)(yj - y) )</td>
<td>( T_{yy} = n \Sigma (yj - y)^2 )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( E_{xx} = \Sigma (xij - xj)^2 )</td>
<td>( E_{xy} = \Sigma (xij - xj)(yij - yj) )</td>
<td>( E_{yy} = \Sigma (yij - yj)^2 )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( E_{x} = \Sigma E_{xxj} )</td>
<td>( E_{y} = \Sigma E_{xyj} )</td>
<td>( E_{y} = \Sigma E_{yyj} )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( S_{xx} = T_{xx} + E_{xx} - \Sigma \Sigma (xij - x)^2 )</td>
<td>( S_{xy} = T_{xy} + E_{xy} = \Sigma \Sigma (xij - x)(Yij - y) )</td>
<td>( S_{yy} = T_{yy} + E_{yy} - \Sigma(yij - y)^2 )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \sum T_{yj} = G_{y} \sum T_{xj} = G_{x} \]
**Single Factor Experiment**

\[ Tx_j = \text{Sum of measurement on covariate under treatment } j \]

\[ Ty_j = \text{Sum of measurements on variate under treatment } j \]

\[ X_j = \text{Mean of measurements on covariate under treatment } j \]

\[ Y_j = \text{Mean of measurement on co-variates under treatment } j \]

\[ Exx_j = \text{Variation on criteria under treatment } j \]

\[ Exy_j = \text{Variation on variate under treatment } j \]

\[ Exx = \text{Co-variation between variate and co-variates under treatment } j \]

\[ Exx = \sum Exx_j, Eyy = \sum Eyy = \sum Exy_j \]

\[ Sxy = \text{Overall Co-variation} = Txy + Exy \]

\[ Txx = \text{Between treatment variation on co-variation} \]

\[ Tyy = \text{Between treatment variation on variate} \]

\[ Txy = \text{Between treatment co-variation} \]

\[ Sxx = \text{Overall variation on co-variates} = Txx + Exx \]

\[ Syy = \text{Overall variation on variate} = Tyy + Eyy \]

To assist in the interpretation of the result, the adjusted means were calculated. There computations requires the pooled within cells regression coefficients.

\[ Bw = \frac{Exy}{Exx} \]

The adjusted means for the experimental group is

\[ Y_1 \text{ (adj)} = X - bw (X_1 - X) \]

The adjusted means for the control group is

\[ Y_2 \text{ (adj)} = Y_2 - bw (X_2 - X) \]
4.13 CONCLUSION

This chapter outlines the design of the present study, the procedure followed and the nature of the sample. It describes the hypotheses to be tested, the tools used and the methods of administration and scoring. Adopting the methods and procedures discussed earlier in this chapter, tests were administered and scored. The obtained scores were analyzed; using appropriate statistical techniques described in this study for the concentration based learning activity and process competencies of secondary school students.