CHAPTER VII

COGNITIVE PREFERENCES

7.1   Introduction

Cognitive preferences constitutes a kind of
cognitive style which have distinct orientation towards
processing of information and deals with attributes of
special relevance to the learning of science and science-
related subject matter. Cognitive preferences are
believed to represent modes used by students in dealing
with scientific information and as Heath (1964) suggested,
the "interest is not in whether the student can identify
correct or incorrect information, but rather in what he
is likely to do with the information intellectually".
The modes of preferences are acquired as a result of
certain learning experiences. In turn they interact with
other individual characteristics, such as abilities,
thereby influencing further outcomes in subsequent
learning and information processing situations.

Cognitive preferences represent the modes in
which individuals can attend to the information or task
presented to them and as has been suggested by Messick
(1970), "promise to provide a more complete and

effective characterisation of the student than could
be obtained from intellectual tests alone". The potential
value of these preferences lies in two directions. First,
the knowledge of such preferences may provide a basis
for adjusting instructional strategies to the learning
characteristics of the individuals. Second, cognitive
preferences may be seen as parameters, additional to
the conventional cognitive and affective measures, to be
considered in the assessment of an individuals intellectual
performance or in the evaluation of educational processes.

Glaser (1970) argued that it is the teacher who
directs and disciplines the student's thought process
thus influencing the cognitive preferences. Several recent
studies in which student's science-based cognitive
preferences were examined (Heath, 1964; Atwood, 1968;
Marks, 1967) established distinct differences in thinking
styles to emerge from different curricular treatments and
would therefore seem to support Glaser's view, at least
with respect to 'discipline oriented' cognitive styles.
In the context of science education the interest in the
identification and measurement of cognitive preferences
centres on their potential usefulness for evaluative
purposes, not only in relation to curriculum development,
but also in order to extend the assessment of
individuals beyond the normal achievement tests.

Cognitive preferences testing had been successfully employed by Heath (1964) and others for the comparative evaluation of several science curricula. For this, it was assumed that a good science curricula should bring about appropriate changes in the students cognitive preferences. The present study is designed to find out whether the instructional strategy, based on Gagne's conditions of learning, adopted in the experiment described earlier, brings any change in the cognitive preferences of the students. In fact a positive shift towards preferences of problems should indicate the efficacy of the learning hierarchy mode of instructional strategy used in the experiment.

Heath, for the first time in 1964 postulated four different cognitive preferences or "differing modes of attending to the subject matter of a course". (Heath,1964, p.241). They were as follows :

Preference (F):(Recall, Memory)- Preference for remembering a specific fact or term related to information provided.

Preference (R): (Principles, Rules)- Preference for identifying the fundamental principle or rule underlying the information provided or for drawing conclusions based on the underlying principle.

Preference (A): (Application)- Preference for
identifying a practical application related to information
provided.

Preference (P): (Questioning, Problems)- Preference
for critical questioning challenging of information provided
or recognition of a limitation or extension of the
information or a problem to be solved.

A measure of a learner's cognitive preference gives
information on the ways in which a learner prefers to go
beyond a given piece of information. In particular it
indicates which of the four ways (F, R, A & P) the learner
prefers to adopt in relating a new piece of information to
previous information.

The construct validity of the definitions of the
four modes of preferences mentioned above was initially
established by Heath (1964) through an analysis of the
published objectives of various science curricula. The
concurrent validity of this form of testing was established
by measuring changes in cognitive preferences on the
physical science study committee curriculum (Heath,1964;
Mackay,1972; Vanden Berg, Lunetta and Tamir, 1978),
demonstrating significant shifts of cognitive preference
scores in the predicted directions. Further evidence

of concurrent validity is provided by Tamir (1981),
who correlated cognitive preferences with a wide range
of alternative measures. It is generally agreed that if
the objectives of a course require that the students
master different capabilities which can exhibit a
preference for material in one of the above forms rather
than another, then the construction of an instrument
such as Heath's (1964) is justifiable (Brown,1975).

7.2   Previous Studies

Since its inception in 1964, the construct of
cognitive preference has become the focus of, close to
100 studies conducted almost exclusively in four countries,
namely, U.S.A., U.K., Australia and Israel (Tamir,1985).
A quarter of these studies were carried out as Ph.D. or
Master's dissertations. At the beginning most studies
attempted to replicate Heath's (1964) study by comparing
the cognitive preferences of students who studied inquiry
oriented curricula to those who studied traditibnal
programme in high school. Eventually the scope has been
extended to study additional problems as well as younger
and older students. While the work in most studies
pertain to learning of science, a few deal with other
areas such as mathematics and social sciences. While the

majority of the studies relate to cognitive preferences
of students, a few attempts have been made to compare the
cognitive preferences of students to those of teachers.
Several reviews of the literature have already been
published (Brown,1975; Tamir,1975; Tamir,1977); a few of
the Ph.D. dissertations include extensive reviews as well
(Vanden Berg,1978; King,1980; McRobbie,1982).

Investigators like Atwood (1968a,1968b), Marks
(1967) and Kempa & Dube (1973) have used the four types
of preferences postulated by Heath to study the cognitive
preferences of students undertaking chemistry courses.
Both Atwood (1968a,1968b) and Marks (1967) showed that
a strong preference for memory did not seem to be
advantageous to the student under the new curricula which
sought to have the student develop analytic problem solving
skills. Preference for critical questioning or problem
solving and for principles seemed advantageous with respect
to achievement but the advantage of the preference for
application depended on the stress laid on it in the
course content (Atwood,1968a,1968b; Marks,1967).

Atwood also demonstrated that certain combinations
of preferences are particularly useful to the student.
However, the work of Marks suggested that changes in

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cognitive preferences may not be related to academic
achievement. A study conducted by Carmel Mcnaught (1982)
has demonstrated that cognitive preferences are correlated
with achievement and, in particular, with types of tasks
in an achievement examination. So, many of these studies,
mostly conducted in the science areas indicate that
cognitive preference is a relevant variable in relation
to achievement in secondary school science courses.
Borham, Ellis and Morgan (1985) conducted a study on the
effect of sequence of instruction on student cognitive
preferences and found that there was ample indication
that sequencing instruction from application to theory
instead of from theory to application could increase
students' preferences for being taught theory as opposed
to its applications. Tamir, Pennick and Lunetta (1982)
found significant relationship between cognitive
preferences in science and selected dimensions of
creativity. The study demonstrated that a particular
cognitive preference orientation characterised as high
intellectual curiosity was positively related to creative
experiences in the life history of individual students as
well as to their capability to grow in creativity through
certain educational experiences.

Tamir (1985) conducted a meta-analysis of studies in cognitive preferences and various aspects related to learning of science. After reviewing about 54 studies, found suitable for meta-analysis, the results indicated that the cognitive preference construct demonstrated a reasonable level of validity, that cognitive preferences made significant contribution to learning and that their inclusion in further educational research as well as their consideration in educational practice was to be encouraged. Although there had been many studies as reported earlier on cognitive preferences, no effort was made, it seems, to make use of this useful construct in our country. The present study intended to make use of the cognitive preference constructs to evaluate the effect of the instructional strategy used in the experiment already reported.

7.3   Purpose

The purpose of this study is to find the changes produced in the cognitive preferences of the students due to the introduction of the new instructional strategy designed based on learning conditions as suggested by Gagne and thereby establish whether the strategy brings any desired changes in the way the students approach

or process the new information made available to them.
As the instructional strategy oriented the students
towards the problem solving capability, as the highest
terminal behaviours, one would expect the students to
develop a preference for problems as compared to
verbalized information or facts. Also cognitive preference
form an effective measurement as to how the strategy has
changed the student's thinking styles which extends the
evaluation of the strategy beyond the normal achievement
tests. More specifically the study attempts to :

(i) find whether the instructional strategy
    used in the experiment brings any change in
    the cognitive preferences of the students.

(ii) examine whether the strategy with orientation
     towards problem solving as its highest
     achievable capability can motivate the students
     to change their preference from facts to
     problems.

(iii) evaluate the effectiveness of instructional
      strategy based on the findings in the
      cognitive preference measurements.

7.4   Sample

The sample for the investigation about cognitive preferences consisted of 35 students from group A and 30 students from group B as described in the earlier chapters. After having administered the tests result sheets were scrutinized for those correctly marked ones. Thus, after rejecting wrongly marked papers, the sample got reduced to 56 students, i.e., 32 students from group A and 24 students from group B.

7.5   Instrumentation

The instrument used for studying the cognitive preferences, was based on Science Cognitive Preference Inventory (SCPI) developed at the Science Education Centre, University of Iowa (Tamir, Penick and Lunetta, 1982). The original SCPI was a 30 items inventory including 17 items representative of biological sciences and 13 items representative of the physical sciences. The researcher selected 20 items from the inventory which suited the present study. The items were selected based on the criterion that the information contained in the item falls within the knowledge level of those who have completed Std. VIII which was the previous class of the sample taken.

It should be noted that the content of the cognitive preference test extended beyond the topic dealt in physics instruction. Every item begins with an introductory statement, that is, followed by four extension statements, each of which corresponds to one of the four cognitive preference modes described earlier. An example of the item type is given in the illustration below :

Illustration No.7.1

The water that is "pushed away" when an object is placed under water is called displaced water.

(45) A good way to measure the volume of an object with an irregular shape is to measure the volume of water displaced when it is placed under water.

(46) The volume of one gram of water is one cubic centimetre $(1cm^3)$.

(47) The volume of the displaced water equals the volume of the sub-merged object.

(48) I wonder if it is possible to measure the volume of objects with irregular shapes other than by the method of displaced water.

Statement 45 refers to application (A), 46 states a fact(F) 47 represents a principle or rule (R) and 48 indicates a problem solving or a questioning situation. A second example is given below :

Illustration No.7.2

The average weather of an area over a long period of time is called the climate of the area.

(33) Large bodies of water have a moderating effect on the climates of nearby areas.

(34) The year 1977 had exceptionally low temperatures in the winter and high temperatures in the summer.

(35) From tree rings one can tell whether years were dry or rainy a long time ago.

(36) Is the amount of rainfall on coastal plains greater or less than that on high mountains?

The first part is the introductory statement, viz.,

33 refers to application (A),

34 states a fact (F)

35 indicates a relation (R)

36 represents a question (P).

The instructions for the test were as follows :

Illustration No.7.3

Directions: In this inventory, we are NOT testing you on your ability. We DO want to find out about some of the things you like in science. Each item in this booklet begins with some information about science. An item is followed by four statements that all contain correct information. You are asked to indicate your preference for each of these statements. Out of the four statements any two have to be

ranked 1 or 4 as follows :

    1 - for the statement that you like best, or
       that is most interesting to you.

    4 - for the statement you like least, or that is
       least interesting to you.

For each statement, mark your ranking in one of the circles
for that response number on your answer sheet. (You will not
use circle O 5). Each response has its own number on
the answer sheet.

Example: On a Friday night many things could be done.
        (5) I could go to a movie.
        (6) I would go out and dance.
        (7) I could watch a wrestling match.
        (8) I could sit around and talk.

Sample answer sheet:

  (5) o o o o o   (6) o o o o o   (7) o o o o o   (8) o o o o o

The person who filled out this sheet preferred going to
a movie (5), and the least preferred statement was going out
and dance (6).

Important:

    1. Read the items and statements carefully, read all
four statements before recording your ranking on the answer
sheet.

    2. Preferences of people are different, there is no
best way of answering this inventory, give your personal
preference.

The scores on the four cognitive preference
scores were calculated using the method (Carmel Mcnaught,
1982) described below :

Score on each
cognitive preference = (Number of Items)
+(Number of Items on which
options for that cognitive
preference were chosen
as most appealing)
-(Number of Items on which
options for that cognitive
preference were chosen
as least appealing)

Thus, the 20 items test would yield a score for
each preference between 0 and 40.

For example, a student can mark the statement
relating to problem as most liked in all the 20 items.
This means that he will have a score as 20 for most liked
and naturally 0 as least liked for the problem statement.
The final total score then is

$$P_{max} = 20 + 20 - 0 = 40$$

If the another student has marked all the problem
statement as least liked then the minimum score for
problems

$$P_{mini} = 20 + 0 - 20 = 0$$

Thus, the maximum score which can be ontained
for any preference for a particular preference is 40 and
the minimum 0.

One of the interesting aspect of this test is
that as one's liking increases for a particular type of
preference corresponding decrease will have to be shown
for another preference. A students get a score between
0 and 40 for each of the four preferences. This means that
a student will have a total score of 80. For example, the
student who mark all the problem statements as most liked
and all the facts statements as least liked his score
will be :

$$P = 20 + 20 - 0 \quad = 40$$
$$F = 20 + 0 - 20 \quad = 0$$
$$A = 20 + 0 - 0 \quad = 20$$
$$R = 20 + 0 - 0 \quad = 20$$

Total of all four scores :   80

In the case of application and rules the individual
preference score comes to 20 as per our method as he had not
shown any preference negative or positive.

The data obtained on each of these cognitive preference modes were then analysed by finding the difference between the pre-test mean and the post-test mean value on scores. This was followed by the determination of the 't' value to see the significance.

7.6   Procedure

As mentioned earlier, a 20 item science cognitive preference inventory (SCPI) was prepared. This was given to the both the experimental group (Group A) and control group (Group B) before the teaching based on the instructional strategy was introduced. The students were asked   to tick mark the most liked statement and the least interesting item on the additional sheet provided, as shown in the example on the inventory sheet. The same test was given to both the class on completion of the experiment. The data obtained from the pre-test and post-test were then analysed.

7.7   Analysis of Results

The data collected, as described earlier gave a score ranging from 0 to 40 for each preference. All students score on a particular preference was then

computed for determining its mean value for the group.
Thus we got a mean value of score for facts, principles,
applications and problems for each group. This was
determined for the pre-test as well as the post-test.
The standard deviation, standard error of means, difference
between means and the 't' ratio was then calculated for
each group.

Table No. 7.1 shows the difference between means
and the t-ratio for group A. We see that the mean score
with respect facts have decreased on the administration of
the instructional strategy. This decrease is also seen in
application. But slight increases are noticed with respect
to problems and principles. Mean scores as a whole shows
almost evenly distributed between facts principles
applications and problems. This may be because the strategy
was employed for a short time of 4 months. A longer
duration, hopefully, would have brought out distinctive
differences between them. The slight increase of mean scores
in the case of principles and problems was causing small
decrease in the scores for facts and application. Gagne's
emphasis on principles and problems as the higher
capabilities and the orientation in the learning materials
developed should have played an important role in bringing
about the changes in the attitude i.e., in the preferences

Table No. 7.1:   Difference Between Means and 't' Ratio - Group A

	No. of Students	Mean Score Initial	Final	S.D. Initial	Final	Standard Error Initial	Final	Difference Between Means	't' Value
Facts	32	18.37	16.03	3.97	3.05	0.70	0.54	-2.34	-3.49**
Principles (Relations)	32	20.72	22.13	2.97	2.90	0.53	0.51	1.41	2.20*
Applications	32	20.31	18.69	2.81	4.60	0.50	0.81	-1.63	-1.60
Problems	32	20.56	23.25	5.02	4.53	0.89	0.80	2.69	3.68**

** shows significance for $P < .01$

* shows significance for $P < .05$

Table Value :   t .05 = 2.04

t .01 = 2.75

of group A, the experimental group. Also from the
standard deviation values we see that variation in the
case of problems, applications and facts have reduced.
The 't' values show that preference on information or
facts shows significance at P $<$ .05 in the negative
direction. That is, the preference for facts is
significantly reduced. Preference for principles with a
't' value 2.20 shows significance for P $<$ .05   change
in the preferences for applications is not significant
at .05 level. Of all the values the most significant change
is in the case of problems. The 't' value of 3.68 is
significant at .01 level. Thus, 't' value shows that there
is significant change towards principle and problem
preferences.

Group B mean difference results are shown in
table 7.2. The initial mean score varies between 19 and
22 whereas the final between 18 and 22. The only increase
we have noticed is the case of applications. No special
affinity towards problems were exhibited. In fact, the
mean score has marginally decreased in the case of facts
principles and problems. In general, we may say that
there has not been any change in the scoring after the
instruction and before the instruction. The 't' values
in the case of group B shows no significance at all.

Table No. 7.2 : Difference Between Means and 't' Ratio – Group B

	No. of Students	Mean Score		S.D.		Standard Error of Means		Difference Between Means	't' Value
		Initial	Final	Initial	Final	Initial	Final		
Facts	24	19.92	18.50	3.51	4.41	0.72	0.90	-1.42	-1.38
Principles (Relations)	24	21.35	22.45	2.44	3.55	0.50	0.68	1.1	1.608
Applications	24	19.54	20.17	3.86	3.29	0.79	0.67	0.63	0.63
Problems	24	19.33	18.75	3.53	4.05	0.72	0.83	0.58	-0.44

Table Value   t .05 = 2.06

t .01 = 2.80

Well, we must remember that there was no special input
as far as group B was concerned and they remain where
they were.

7.8   Discussion and Conclusions

The findings of a significant effect of the
instructional strategy on group A cognitive preferences
was as expected. Problem solving was given highest
priority in Gagne's learning hierarchy. It is only natural
that the students oriented towards problem solving activity
exhibits preference for the same. The 't' value shown by
group A for problems and principles with significant
positive change speaks of the success of the instructional
strategy used with the experimental group. Significantly
the positive change towards problem preference was
accompanied by corresponding negative preference towards
facts. The significant changes in principles and problems,
in fact, goes very well with their achievement also which
was discussed in the earlier chapter. The changes noticed,
I confess, may not be very high; for any big change to occur,
especially when one deals with the process aspect of
learning and thinking, longer durations are necessary. The
group B shows no significant change in any preference.

Well, they were not given any special input also. As
a whole the result shows the success of the instructional
strategy. The study leads to the following main conclusions :

    (i) The instructional strategy designed based on
        Gagne's conditions of learning had helped to
        ·bring changes in the cognitive preference of
        the students.

    (ii) The experimental group showed significant
        change of preference from facts and applications
        to problems and principles.

    (iii) The control group has not exhibited any
        significant change in any of the cognitive
        preferences.

    (iv) Based on the findings mentioned above, we can
        infer that the instructional strategy employed
        in the experiment was effective in terms of
        their cognitive preferences measurement.

The analysis also validates the usefulness of using
cognitive preference tests for determining the effectiveness
of the curriculum materials. The results provide enough
encouragement for further work in this field as an effective
study technique to evaluate learning materials and
instructional methods.