AN INVESTIGATION INTO FACTORS AFFECTING COGNITIVE PREFERENCE STYLES IN BIOLOGY

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A step-wise regression analysis was performed in relation to a range of factors (Age, Nature of Schooling, Educational Practices, Gender, Achievement in Biology and Parental Education) affecting cognitive preference styles in biology of 12th graders aged 17+ years. A cluster sampling technique was employed. A reduced version of Biological Cognitive Preference Inventory originally developed by Pinchas was used. It was found that educational practices and achievement levels were strongly associated with cognitive preference styles. Gender is important for recall and critical questioning. The types of schooling exhibited its relation to recall and application where as parental education had shown relationship only with principles. There was no relationship between age and cognitive preference styles.

In the process of curriculum transaction depending upon individual idiosyncrasy a characteristic pattern of information processing is discernible. As noticed by Harris:

> most of the achievement testing in schools focuses on the can do class of behaviours...these are the knowledge, skill, ability types of objectives. But there may be other objectives, the achievement of which is evidenced by what the student typically does do. These are the attitude, interest cognitive style types of objectives perhaps more affective than cognitive (Harris, 1974: p. 86).

This 'does do' class of behaviour is a personal or population attribute that helps an individual to selectively attend information. Heath (1964) suggested four modes of attending scientific information, later reformulated by Van den Berg, Leneta & Tamir (1978).

These modes are:

Factual Information or Recall (R)

Acceptance of Scientific information for its own sake, without consideration of its implications or applications. A preference for recall indicates learning names, numbers, definitions, formulae and reported observations.

Principles (P)

Representation of scientific explanation of fundamental scientific principles of relationships. A preference for principles indicates identifying relationships between variables, or rules that can be applied to classes of objects, organisms, phenomena or variables, or explaining phenomena.

Questioning (R)

Critical questioning of information for completeness, general validity or limitations. A preference for questioning indicates analysing and commenting on the validity of scientific information and/or generating suggestions and hypotheses for further research.

Application (A)

Application of scientific information in problem solving in general, social and scientific contexts of real life in particular. A preference for application indicates using scientific information to solve problems in commerce, industry, farming and daily life.

Since the classical study by Heath (1964), studies have been increasingly in vogue world wide. Tamir (1985) using the technique of meta-analysis has succinctly provided the status of research on cognitive preferences. Concerted efforts were made in India to study cognitive preferences. Saxena (1986) compared the cognitive preference styles of students studying physics under two different educational practices. The results have shown that irrespective of the types of the educational practices, students have strongest preference for recall and least preference for critical questioning. While Rathore and Singh (1987) studied cognitive preferences and academic achievement of tenth grade biology students. Based on their findings, Rathore, and Singh opined that the most preferred mode, in general, is recall, though with the increase of academic achievement, preference for recall decreases. Bagchi and Uddin (1990), based on their study on cognitive

preferences of secondary science teachers in India, found that the overall pattern of cognitive preferences that emerged is Recall-Principles-Application-Questioning.

The National Policy on Education (1986) clearly states science education programmes should be designed to enable the learner to acquire problem-solving and decision-making skills, and to discover the relationship of science to health, agriculture, industry and other aspects of daily life. In the revised Programme of Action (Government of India, 1992, p. 203) while describing the evaluation policy it is reiterated that the emphasis will be on testing of expected levels of achievement of a variety of learning objectives in order to ensure due importance to higher abilities of understanding, application, analysis, synthesis, judgment and parallel parameters and not only to committing to memory.

It is understood that knowing cognitive preference styles of students in relation to important institutional and pedagogical variables will provide a basis for improved instructional practices that would ultimately facilitate the attainment of national goal which is nothing less than the creation of scientific ethos (Government of India, 1968).

STRUCTURE OF INDIAN SCHOOL EDUCATION

India has two distinct streams of school education: non-formal and formal. It was in 1979 non-formal system of schooling first introduced. The Open School was set up under the aegis of Central Board of Secondary Education (CBSE). The Open School system evolved to democratise education. It provides an alternative channel especially to those group of learners who had dropped out or failed on account of the rigidity of the formal stream or could not continue in formal stream because of socio economic constraint. In 1989 National Open School (NOS) in its present form came into existence (NOS, 1995). Formal system of education has three types of Boards of Secondary Education. The State Board of Secondary Education is operational only in its constituent state where as other two boards: The Central Board of Secondary Education (commonly known as CBSE) and Indian School Certificate (commonly known as ISC) have all India jurisdiction. The prevailing educational practices of NOS, CBSE, and ISC are inquiry approached where as state board emphasizes on content or factual part of the discipline.

For the last seven years two distinct streams of school education are functional: face to face and distance mode. Therefore there is a growing need to find out the cognitive preference styles of students of both the streams in relation to important pedagogical variables.

PURPOSE OF STUDY

This study sets out to assess the cumulative effects of groups of variables such as age, gender, types of schooling, educational practices, achievement levels, and parental education) on each of the four modes of cognitive preference styles i.e., recall, principles, questioning and application. Further the purpose is finally to provide best model using all independent variables. All the six independent variables are dichotomously branched. A brief description of the variables is given below:

A.	Age:	Students belonging to two age groups are considered. Students aged 17 to 19 years or 20 years and above.
B.	Gender:	Both male and female students are considered.
C.	Types of schooling:	Types of schooling is either formal (i.e., face to face system of instruction) or non-formal (i.e., distance mode of instruction).
D.	Educational Practices:	Educational Practices can be traditional (i.e., emphasis is on content mastery) or enquiry oriented (i.e., thrust is on problem solving and critical thinking).
E.	Achievement Levels:	Biology Students scoring or equal to 75th percentile at the twelfth grade public examination in biology are designated as high achievers and those scoring below or equal to 25th percentile are designated as low achievers.
F.	Parental Education:	This is divided into two categories: students whose parents received university education and those only had school education.

METHOD OF RANDOM SAMPLING

The population for the study consisted of urban male and female students of twelfth grade aged 17+ years studying biology in the formal and non-formal institutions. Cluster sampling technique (see Best 1983; p. 12) was employed. In formal system 500 students from each of the two types of educational practices traditional and enquiry oriented were sampled. 500 students enrolled in the Board of High School and Intermediate Education here after referred as BIE following traditional educational practices were sampled. Similarly 500 students enrolled in the Central Board of Secondary Education here after referred as CBSE following enquiry oriented educational practices were sampled. In non-formal system, 120 students enrolled in National Open School (NOS) were sampled. Because of the non-availability of the complete set of data some of the cases were rejected. The finally obtained sample is given in Table 1.

COGNITIVE PREFERENCE TEST

A reduced form of the Biological Cognitive Preference Inventory originally compiled by Tamir (n.d.) consisting 40 items was used. The reduced form of the inventory included 20 items. Of these, 10 pertains of Zoology and 10 to Botany. The same inventory had been used and found appropriate in earlier study (see Bagchi & Uddin, 1990). However, extensive pilot testing was made to ensure it's suitability for the present population. A sample item is already given at the beginning. All the 20 items in the inventory similar to the sample item under reference have an introductory statement followed by four extension statements, each corresponding to one of the four modes of cognitive preference. For scoring purpose, the graded rating procedure suggested by Kempa and Dube (1973) was employed in which the most preferred or best liked response receives a weightage of 4 points; the second preferred response receives a weightage of 3 points; the third one receives a weightage of 2 points; and the fourth the least preferred receives a weightage of 1 point. There are altogether 20 items and each item contains all the four modes of cognitive preferences. The score for each cognitive preference mode is calculated by summing the score for each individual mode in all the 20 items. Thus each cognitive preference mode has highest possible score of 80 and lowest of 20, with a midpoint of 50. In the present study the Biological Cognitive Preference Inventory yielded

test-retest reliability coefficients of 0.71 for Recall, 0.66 for Principles, 0.83 for Questioning, and 0.57 for Application. The Cronbach alpha coefficient which is a measure of internal consistency as well as factor concentration yielded coefficients of 0.74 for Recall, 0.68 for Principles, 0.78 for Questioning and 0.65 for Application preference.

ANALYSIS OF DATA

The unit of analysis was individual student. The stepwise regression analysis was performed where the best variable was added in sequence until the addition of a variable produce a non-significant F statistic. The alpha value was set at 0.05. Finally, a set of variables were formed constituting the best model. The sequence of the predictor variables in the best model are in the order of its percentage of accounted variance with the criterion.

RESULTS AND DISCUSSIONS

Table 1

The Distribution of Formal and Non-formal Education

Formal	Non-Formal	
BIE	CBSE	NOS
468	491	118

BIE: Board of High School and Intermediate Education
CBSE: Central Board of Secondary Education
NOS: National Open School

The results of step-wise regression analyses and the created best model appear in Tables 2, 3, 4 and 5.

Table 2
Results of Regression Analyses for Recall

Variable		Rank	Cumulative Percentage Accounted Variance
Age			
a)	17 years to 19 years old	1	2.6
b)	20 years and above	2	3.1
Gender			
a)	Female	1	5.4
b)	Male	2	6.0
Types of Schooling			
a)	Formal	1	8.4
b)	Non-formal	2	10.1
Educational Practices			
a)	Traditional	1	8.7
b)	Enquiry oriented	2	10.4
Achievement Levels			
a)	Low achievers	1	5.2
b)	High achievers	2	8.5
Parental Education			
a)	Parents with school education	1	1.7
b)	Parents with university education	2	2.2
Best Model			
a)	Traditional educational practices	1	8.7
b)	Formal schools	2	16.2
c)	Female	3	20.3

Table 3
Results of Regression Analyses for Principles

Variable	Rank	Cumulative Percentage Accounted Variance
<u>Age</u>		
a) 17 years to 19 years old	1	3.4
b) 20 years and above	2	4.2
<u>Gender</u>		
a) Female	1	3.3
b) Male	2	5.1
<u>Types of Schooling</u>		
a) Non-formal	1	5.8
b) Formal	2	7.4
<u>Educational Practices</u>		
a) Enquiry oriented	1	13.4
b) Traditional	2	15.3
<u>Achievement Levels</u>		
a) High achievers	1	11.6
b) Low achievers	2	13.3
<u>Parental Education</u>		
a) Parents with university education	1	10.2
b) Parents with school education	2	12.5
<u>Best Model</u>		
a) Enquiry-oriented educational practices	1	13.4
b) High achievers	2	23.2
c) Parents with university education	3	28.8

Table 4
Results of Regression Analyses for Questioning

Variable		Rank	Cumulative Percentage Accounted Variance
Age			
a)	17 years to 19 years old	1	2.2
b)	20 years and above	2	2.5
Gender			
a)	Male	1	10.6
b)	Female	2	13.1
Types of Schooling			
a)	Non-formal	1	4.3
b)	Formal	2	5.6
Educational Practices			
a)	Enquiry-oriented	1	15.2
b)	Traditional	2	17.6
Achievement Levels			
a)	High achievers	1	20.4
b)	Low achievers	2	23.7
Parental Education			
a)	Parents with school education	1	5.5
b)	Parents with university education	2	6.4
Best Model			
a)	High achievers	1	20.4
b)	Enquiry-oriented educational practices	2	29.8
c)	Male	3	35.3

Table 5
Results of Regression Analyses for Application

Variable		Rank	Cumulative Percentage Accounted Variance
Age			
a)	20 years and above	1	2.6
b)	17 years to 19 years old	2	3.1
Gender			
a)	Male	1	2.2
b)	Female	2	2.8
Types of Schooling			
a)	Non-formal	1	6.3
b)	Formal	2	7.7
Educational Practices			
a)	Enquiry oriented	1	8.1
b)	Traditional	2	14.2
Achievement Levels			
a)	High achievers	1	4.4
b)	Low achievers	2	6.8
Parental Education			
a)	Parents with university education	1	2.9
b)	Parents with school education	2	3.3
Best Model			
a)	Enquiry-oriented educational practices	1	8.1
b)	Non-formal	2	13.2

An examination of Table 2 reveals for recall, age and parental education have produced relatively small percentages of accounted variance where as gender and achievement levels have shown moderate percentages of accounted variance. The educational practices and types of schooling exhibits slightly higher percentages of accounted variance. The best model has retained traditional educational practices, formal schools and females showing stronger relationship with the criterion i.e., recall. The traditional

educational practices being first in the rank, the formal schools being second and females being third in the rank with cumulative percentages of accounted variance 8.7, 16.2 and 20.3 respectively. The obtained result in the present analysis signifies that students in formal institution where educational practices being traditional are more prone to develop greater inclination for recall. The effect is compound in case of female students.

Table 3 shows the result of regression analysis for principles. Age, gender and types of schooling have low percentage of accounted variance as compared to educational practices, achievement levels and parental education. The best model retains three variables. They are enquiry oriented educational practices, high achievers and parents with university education with percentages of accounted criterion variance 13.4, 23.2 and 28.8 respectively. The high achievers exposed to enquiry oriented educational practices and whose parents have university education such conditions, prompted greater preference for principles.

Table 4 reveals the result of regression analysis and appears to be the best model for questioning. The percentage of accounted variance in relation to age is quite low. The variables like types of schooling and parental education have a moderate effect. The percentages of accounted variance in respect of gender, educational practices and achievement levels have shown progressively an upward swing. The best model includes three variables namely high achievers, enquiry oriented educational practices and males with percentages of accounted variance 20.4, 29.8 and 35.3 respectively. The obtained result provides an evidence that high achievers, the students in enquiry oriented educational practices and males have a greater likelihood of cognitive preference for questioning.

The results displayed for the application mode in Table 5 show, the percentages of accounted variance for age, gender and parental education is low where as for types of schooling, educational practices and achievement levels are relatively high. The best model retains only two variables. The first being enquiry oriented educational practices and the second being non-formal type of schooling with percentages of accounted variance 8.1 and 13.2 respectively. An exposure of enquiry oriented educational practices and distance mode of communication foster cognitive preference for application.

To summarise present findings:

1.   A perusal of Table 2 provides evidence for the voiced belief that traditional educational practices and formal schooling both augments the tendency for recall. The traditional educational practice is characterized by the pre dominance of content or factual part of the discipline where as formal system of schooling is for face to face interaction between teacher and taught in a classroom situation for a specified period in an academic institution. Both these conditions specify that students have hardly any opportunity to think critically or apply knowledge as they remained preoccupied during school hour in copying down from the blackboard or taking down the lecture delivered. Since the thrust of the examination system is on the minute details of the text, students at home also adheres to rote learning. This reinforces a cognitive preference for recall. The obtained result is in congruence with Heaths classical study and lend partial support to Tamir (1985).

2.   Enquiry-oriented educational practices have strong impact on cognitive preferences. Students learning science through enquiry approach are inclined more towards principles and application mode of cognitive preferences. In addition to this students following enquiry approach are also be likely to develop questioning mode of cognitive preference.

3.   Achievement level of the students is a powerful determinant of the cognitive preference pattern. The questioning is the most preferred mode for high achievers. They also have an affinity for principles. The present result and the results obtained by Tamir (1985, 1988) are in full agreement. In the Indian context Rathore and Singh (1987) on comparing cognitive preferences and academic achievement of tenth grade biology students obtained similar results.

4.   Gender difference is displayed for two extreme modes of cognitive preferences i.e., recall and questioning. The gender is ranked third most important determinants for either of the two extreme modes of cognitive preferences. The propensity of males for the preference for questioning are observed where as females have the predisposition for recall. The differences in cognitive preferences between males

and females are consistently reported in several studies (e.g., Tamir, 1975 and Bagchi and Uddin, 1990).

5.   An analyses of all the four Tables 2, 3, 4 and 5 show no clear cut trends related to age. Similar result is obtained by Tamir (1985).

CONCLUSIONS

Reviewing the findings of this study following conclusions are drawn.

1.   Clearly the most striking conclusion consistently high relationships of educational practices to cognitive preference styles.

2.   The achievement levels of the students are powerfully related to cognitive preference styles especially for principles and questioning.

3.   There is an evidence of meaningful relationships between gender and two extreme modes of cognitive preference styles (Recall - Questioning).

4.   Types of schooling have demonstrated relationship with recall and application.

5.   Parental education has shown relationship at least with one cognitive preference styles principles.

6.   No meaningful relationship is observable between age and cognitive preference styles.

EDUCATIONAL IMPLICATIONS

Since the classical study of Heath (1964) an overview of literature manifests a plethora of findings divulging the relationships of cognitive preference styles with different variables. The purpose of this study is to explore the plausible determinants of cognitive preference styles in order to nurture them so that they facilitate a cognitive preference pattern characterized by high preference for critical questioning, principles and application at the expense of a low preference for recall. It is imperative to uphold the desired cognitive preferences. Therefore there is an ardent need to revamp the existing educational programmes and suitably modify conditions which are known to alter or influence cognitive preferences.

REFERENCES

Bagchi, J. P. & Uddin, H. (1990). Cognitive Preferences of Indian Secondary Science Teachers. *International Review of Education, 36*(4), 453-467.

Best, J. W. (1983). *Research in Education, 4th Edition.* New Delhi: Prentice Hall of India.

Government of India (1968). *National Policy on Education.* New Delhi: Ministry of Education and Social Welfare.

Government of India (1986). *National Policy on Education.* New Delhi: Ministry of Human Resource Development, Department of Education.

Government of India (1992). *Programme of Action.* New Delhi: Ministry of Human Resource Development. Department of Education.

Harris, C. W. (1974). Problems of Objective Based Measurement. In: Harris, C. W., Alkin, M. C. and Popham, W. J. (eds.). *Problems in Criterion Referenced Measurement.* Los Angeles: Center for the Study of Evaluation, University of California.

Heath, R. W. (1964). Curriculum, Cognition and Education Measurement. *Educational and Psychological Measurement, 24*(2), 239-253.

Kempa, R. F. & Dube, G. E. (1973). Cognitive Preference-orientation in Students of Chemistry. *British Journal of Educational Psychology, 43,* 279-288.

National Open School (NOS), (1995). Secondary Curriculum New Delhi.

Rathore, H. C. S. and Singh A. P. (1987). Cognitive Preferences and Academic Achievement of Tenth Grade Biology Students. *Indian Educational Review, 22*(4), 29-37.

Saxena, A. K. (1986). Attitude towards Physics and Cognitive Preferences Styles among Different Groups of Science Students. *Indian Dissertation Abstracts.* July-September, 307-320.

Tamir, P. (n.d.). *The Biological Cognitive Preference Inventory.* Hebrew University of Jerusalem, Israel.

Tamir, P. (1975). The Relationships Among Cognitive Preferences, School Environment, Teachers' Curricular Bias, Curriculum and Subject Matter. *American Educational Research Journal, 12,* 235-264.

Tamir, P. (1985). Meta-Analysis of Cognitive Preferences and Learning. *Journal of Research in Science Teaching, 22*(1), 1-17.

Tamir, P. (1988). The Relationship Between Cognitive Preferences Students Background and Achievement in Science. *Journal of Research in Science Teaching, 25*(3), 201-216.

Van den Berg, E. Lunetta, V. N. & Tamir, P. (1978). *Cognitive Preferences: A Validation Study.* Paper Delivered at the Annual Meeting of the National Association for Research in Science Teaching, Toronto, Ontario.

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