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# Relationship between Cognitive Style and the Relative Preference for Discovery Learning and Expository Learning

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Kajian ini meniasat perhubungan di antara empat gaya kognitif (field independence-field dependence, gaya konsep, gaya pembedaan konsep dan pemikiran bertumpu-bercapah) dan keutamaan relatif bagi pembelajaran penemuan bandingan dengan pembelajaran pendedahan. Keutamaan relatif ini dikaji daripada dua dimensi iaitu kesenangan/kesukaran dan keenakan/kebencian. Cara melaksanakan kaedah pembelajaran ialah melalui modul-modul pengajaran sendiri. Subjek-subjek dengan gaya pembedaan konsep tinggi dan pemikiran divergen mengamati pembelajaran penemuan lebih sukar daripada pembelajaran pendedahan. Subjek-subjek 'field independent' dan pemikiran inferensi tinggi mengamati pembelajaran penemuan lebih keenakan daripada pembelajaran pendedahan. Keputusan ini menunjukkan gaya kognitif juga boleh mempengaruhi ciri afektif berkaitan dengan pembelajaran di samping hasil kognitif yang kerap kali dilaporkan. Ini mengusulkan bahawa konsep 'sikap-bakat-interaksi' harus termasuk dalam penyelidikan gaya kognitif oleh sebab sikap pelajar terhadap sesuatu strategi pengajaran mungkin menjadi lebih penting untuk pembelajaran berlaku daripada bakatnya.

## Introduction

The primary purpose of this study was to identify a possible relationship between selected cognitive styles and students' relative preference for two different instructional modes. A considerable amount of research has been conducted during the last decade to investigate the interaction relationship between cognitive styles on learning behaviour and achievement (Annis 1979, Bolocofsky 1975, Coop and Brown 1970, Douglas and Kahle 1978, Goodenough 1976, Gray and Knief 1975, Grieve and Davis 1971, Koran et.al. 1971, Mcleod and Adam 1979, Nebelkof and Drayer 1973, Ogumyemi 1973, Ritchy and Lashier 1981, Roach 1979, Rubble and Nakamura 1972, Satterly and Telfer 1979, Shymamshy and Yore 1980). However, research investigating the relationship between students' cognitive styles and their preference for different instructional modes or learning situations are rare. Students' preference for an instructional strategy may prove to be no less important for their learning than their aptitude for a subject. Also, it can be hypothesised that such relationship could exist because cognitive styles have been found to influence in the choice of courses and selection of jobs (Witkin et.al. 1977, Keen 1974, DeRussy and Futch 1971).

Hence, this study was undertaken to find out whether any relationship exists between students' cognitive styles and their relative preference for discovery learning as opposed to expository learning. The discovery and expository learning modes were selected for study because of the great emphasis of discovery learning in the new science and mathematics curricula and the deemphasis of expository teaching as being a source of rote learning in these disciplines. Thus, discovery learning occurs when the learner identifies or infers a particular

rule from a set of exemplars implying the rule. By contrast, in expository learning, the learner is explicitly given a particular rule and this is amplified by examples illustrating the rule.

The cognitive styles selected for this study were:

- (i) Field independence - Field dependence style refers to an analytical, in contrast to a global way of perceiving. In its field independent form it entails a tendency to experience items as discrete from their background and reflects the ability to overcome the influence of an embedding context (Witkin et.al. 1974).
- (ii) Conceptualisation style refers to consistencies in the utilisation of particular conceptualizing approaches as basis for forming concepts - such as the routine use in concept formation of thematic or functional relations among stimuli as opposed to the use of descriptive attributes or the inference of class membership (Kagan et.al. 1963).
- (iii) Conceptual Differentiation style refers to individual differences in the tendencies to categorize perceived similarities and differences among stimuli in terms of many differentiated concepts or dimensions (Gardener and Schoen 1962).
- (iv) Convergency and Divergency style refers to an individual's relative reliance upon convergent thinking as contrasted to divergent thinking in terms of quality of relevant output (Hudson 1966).

Theoretically it is possible to predict the following interaction between the cognitive styles and the students' relative preference for discovery and expository learning modes.

- (a) The field independent person because of his ability to discern information from unstructured situations should find discovery learning relatively easy and more enjoyable than the field dependent person who finds it difficult to discern information embedded in context.
- (b) Most discovery learning situations involve students in the recognition and formulation of concepts. Inferential conceptualisation which appears to contain an analytical as well as a synthesis component should have a direct bearing on students' success in discovery learning. Hence, high inferential thinkers might be expected to express a preference for discovery learning. The high descriptive thinkers also, to a lesser extent, can be expected to express a preference to discovery learning. On the other hand the relational thinkers because of their preference for a conceptualisation style which involves more direct type of linkages may be expected to prefer the more direct type of learning to discovery learning.
- (c) Like the inferential conceptualisation style, low conceptual differentiation seems to contain both an analytic and a synthetic component. Hence, it may be hypothesised that a low level of differentiation may induce positive preference for discovery learning.
- (d) With respect to convergency and divergency, it may be hypothesised that convergent thinkers should have a greater preference for discovery learning than divergent thinkers because, in general, discovery learning is a 'closed' situation involving the examination of given sets of information and abstraction of patterns or generalisations that fit all information. Divergent thinkers should find such a situation restrictive as generation of alternative solution to a problem is their mode of cognitive functioning.

These theoretical analyses of the possible effects or interactions of students' cognitive styles on their preference for learning from the discovery and the expository modes were examined in the study reported here.

### Sample and Design of Study

The study was conducted at four Comprehensive schools in North Midlands, United Kingdom. The sample consisted of 275 third formers. All 275 students were tested for their cognitive styles using the Concealed Shapes Test, (Satterley and Telfer, 1979); Conceptual Preference Test (Kempa, 1979), Object Sorting Test (Clayton and Jackson 1961) and The Use of Objects Test (Hudson, 1966). All 275 subjects were exposed to both discovery learning and expository learning through two sets of self-instructional modules. The discovery learning module consisted of learning situations in which the learner was provided with a set of exemplars implying a particular rule. The learner was required to 'decode' the examples, i.e. identify or infer the rule implicit in them. By contrast, in the expository learning module, a particular rule was explicitly pointed out to the learner and amplified by examples illustrating the rule. The content of both modules were different. After students had worked through both modules they were asked to complete the Preference for Learning Type Inventory based on their experience of these two modes of self-instructions.

### Instrumentation

Standardized instruments as well as instruments developed by the researcher for this study were used for testing cognitive styles and learning preference.

1. **The Concealed Shapes Test (CST)**, was selected as a measure of field dependence - field independence (Satterley and Telfer 1979).

The CST consists of 24 rows of shapes. Each row presents a simple shape followed by four complex shapes. The student was required to judge whether or not the simple figure is embedded or hidden in the complex figures following it. In 51 of these, the sample figures were embedded in the complex figures whilst they were absent in the remaining 45 complex figures. In the analysis only the scores for the 'present items' were used. The Cronbach alpha reliability of the 'present' subtest was 0.820.

2. **Conceptual Preference Test (CPT)**. The version designed by Kempa, University of Keele, following the pattern described by Sigel (1963) was selected as a measure of conceptualisation styles. The test consists of 24 triads of line-drawing pictures of common objects. Each picture also carried the name of the object depicted in it so as to avoid any ambiguity. For each triad, three statements are given expressing a relational linkage, a descriptive linkage and an inferential (categorical) linkage between two of the objects. Students were asked to select from the three responses given for each picture triad the one they most preferred and the one they least preferred. Three points were assigned to the most preferred statement, one point to the least preferred statement and two points to the remaining one. On this basis three scores were derived for each student expressing respectively (i) his preference for inferential concepts (ii) his preference for descriptive concepts and (iii) his preference for relational concepts with the scores ranging from 24 to 72. The Cronbach alpha reliability of the three scales were 0.799, 0.741 and 0.799 respectively.

3. **Object Sorting Test (OST)** was selected to measure the difference between individuals in terms of their conceptual differentiation. This test was adopted from the work of Clayton and Jackson (1961). The OST consists of 50 line-drawings of common everyday objects set out in rows of fives. Subjects were required (i) to collect and list all objects that seemed to belong together in some way, and (ii) indicate a reason for putting them together. The number of groups formed by an individual that contained two or more items constituted the individual's conceptual differentiation score.
4. **The Use of Objects Test (UOT)**. This test was selected to measure the convergency - divergency trait of the subjects. The test for the present study employed six items (newspaper, brick, paper-clip, tin-can, cork, blanket). Subjects were required to think and list as many different uses as they can for each item in the test. The flexibility score, which indicated the sum of the different classes of uses suggested for each of the six items was used for the analysis. The Cronbach alpha reliability of the scale was 0.736.
5. **Preference for Learning Type Inventory:** It was decided to base this enquiry on two constructs. The ease/difficulty of the two instructional approaches (discovery - expository) and the enjoyment of/dislike for the two approaches in terms of the extent to which they were thought to be engaging and interesting or dull and boring. Each construct was measured by a set of six rating items developed as 'semantic differential items'. The inventory was examined for scale reliability, in the normal manner. Five of the six items in the ease/difficulty scale produced item - total score correlation of above 0.60 for both discovery learning and expository learning. The one item not producing a satisfactory correlation was removed from the ease/difficulty scale. The resulting reduced scale showed a reliability of 0.874 and 0.923 for the discovery and expository modes respectively. The scale consistency of the six items in the enjoyment/dislike scale was found to be satisfactory. Likewise, the alpha reliability coefficient of the whole scale were found to be 0.844 and 0.818 respectively for the discovery learning and expository learning.

### Analysis of Data

Following completion of the tests, computer analysis of CST, CPT, UOT, OST and the Preference for Learning Type Inventory was performed to determine the reliability of these measures. For the purpose of the general analysis of the influence of cognitive styles on students' preference for the learning modes, the subjects were divided into high and low groups on each of the traits and a t-test analysis was performed using their relative preference scores on the two constructs ease/difficulty and enjoyment/dislike as the variables. All tests of significance were one-tailed at the 0.05 level of probability.

As regards the students' perception of the ease/difficulty and enjoyment/dislike of discovery or expository instructional mode, the *relative* ratings attached to the modes and not their absolute ratings were used.

The relative ratings were obtained as follows:-

#### *For the difficulty scale*

Perceived difference in the difficulty rating =  $\frac{\text{difficulty value (discovery mode)} - \text{difficulty value (expository mode)}}{\text{difficulty value (discovery mode)} + \text{difficulty value (expository mode)}}$

### *For the enjoyableness scale*

Perceived difference in = enjoyment value – enjoyment value  
 the enjoyment rating (discovery mode) (expository mode)

On the above measure, the higher the score difference calculated in relation to the ease/difficulty scale, the greater is the difficulty associated with discovery learning compared with learning from expository instruction. In relation to enjoyment/dislike scale, the larger the score difference, the greater is the dislike for discovery learning compared with learning from expository situation.

Initially an analysis of students perception of the ease/difficulty and enjoyment of the two instructional approaches without examining the association of cognitive styles with these perceptions was carried out using the absolute scores. Thereafter, the differential effect of the cognitive styles was examined in detail.

## **Results and Discussion**

### **General View on Discovery and Expository Learning**

Students perceived learning from discovery to be significantly more difficult than learning from expository situation ( $t = 8.66$ ;  $p < 0.001$ ) (Table 1). This is not surprising as involvement in discovery requires students to abstract, from information provided, patterns or rules implied in the information on their own. This is a task which is intrinsically more demanding and hence difficult than the more passive form of reception learning which is the essence of expository approach.

<b>Instructional Mode</b>	<b>Mean Rating</b>	<b>Std. Dev.</b>	<b>t-value</b>	<b>One-tailed Prob.</b>
Discovery	17.97	6.95	8.66	0.001
Expository	12.62	7.43		

Score Range Max = 30, Min = 5

**TABLE 1: Mean Ratings, Standard Deviations on Ease/Difficulty Scale and Result of t-Test Analysis (N = 275)**

With respect to the enjoyment/dislike construct, learning by discovery appears to be preferred to learning from expository situations. ( $t = 2.55$ ,  $p > 0.01$ ) (See Table 2). Though this finding is statistically significant at the 1% level it is worth noting that the difference is really quite small and certainly smaller than might have been expected in view of the claim often made that discovery learning has a major motivating effect.

Instructional Mode	Mean Rating	Std. Dev.	t-value	One-tailed Prob.
Discovery	23.22	8.08	2.55	0.001
Expository	24.57	8.02		

Score Range Max = 36, Min = 6

TABLE 2: Mean Ratings, Standard Deviations on Enjoyment/Dislike Scale and Result of T-Test Analysis (N = 275)

### Field Independence/Field Dependence and Students' Preference for Instructional Modes

Table 3 presents the mean ratings and standard deviations achieved by the field independent and field dependent subjects on the comparative difficulty and enjoyment scales together with the results of the t-test analyses. There is no significant differential effect on the perception of the ease/difficulty of two instructional modes.

Variable (Score Range)	Subgroup	Mean Rating (Std. Dev.)	t-value	One-tailed Prob.
Ease/Difficulty (Max = +30, Min = -30)	Field Dependent	5.61 (10.71)	0.33	N.S
	Field Independent	5.19 (9.97)		
Enjoyment/Dislike (Max = +36, Min = -36)	Field Dependent	-0.18 (8.29)	-2.35	0.01
	Field Independent	-2.69 (9.27)		

TABLE 3: Mean Ratings, Standard Deviations on Comparative Scales, and results of t-Test Analysis (Field Independence/Dependence Style)

The initial hypothesis that field dependent persons should perceive discovery learning relatively more difficult than field independent persons because discovery learning involved abstraction of structure from a seemingly random array of information is not borne out.

One reason for this might be that the learning units were presented in a self-instructional format. Field dependent persons who are generally more socially oriented than field independent persons would have thus perceived the self-instructional format as relatively more difficult than teacher based instruction because of an absence of 'personal touch'. This might

have counteracted any greater ease which they might have associated with the actual learning from expository situation. It must be said, however that this is a largely speculative argument.

In relation to the comparative enjoyment scale the field independent students find discovery learning more enjoyable than expository learning compared to the field dependent students. The differentiation is statistically significant at the 1% level. This finding is not inconsistent with the assumption that each group would be preferentially attracted to the instructional mode which closest matches its cognitive behaviour and style. Thus, field dependent students who have low inclination toward situations demanding information to be abstracted, structured and synthesised find discovery learning less satisfying and less enjoyable than their counterparts, and vice versa.

### Conceptualisation Styles and Students' Preference for Instructional Modes

Tables 4 presents the results concerning the three conceptualisation styles i.e. inferential, descriptive and relational respectively. It can be seen from Table 4, that there is very little difference between the comparative mean ratings of the low and high groups of the three conceptualisation styles on the ease/difficulty scale. Thus no differentiation appears between students in term of their conceptualisation style on the perception of ease/difficulty of the two modes of instruction. In relation to the enjoyment scale there appears to be significant differences between the groups. High inferential thinkers express a greater enjoyment of the discovery learning with its demand for abstraction and structuring of information than do the low inferential thinkers. The difference is significant at the 1% level. This finding is in line with the initial hypothesis.

Variable (Score Range)	Subgroup	Mean Rating (Std. Dev.)	t-value	One-tailed Prob.
Ease/Difficulty (Max = +30, Min = -30)	Low Inferential	4.78 (9.34)	0.05	N.S
	High Inferential	4.04 (10.22)		
Enjoyment/Dislike (Max = +36, Min = -36)	Low Inferential	0.02 (8.08)	2.39	0.01
	High Inferential	-3.02 (8.73)		
Ease/Difficulty (Max = +30, Min = -30)	Low Descriptive	4.57 (10.15)	0.21	N.S
	High Descriptive	4.26 (9.43)		

Continues table 4

Variable (Score Range)	Subgroup	Mean Rating (Std. Dev.)	t-value	One-tailed Prob.
Enjoyment/Dislike (Max = +36, Min = -36)	Low Descriptive	-2.55 (8.72)	-1.64	0.051
	High Descriptive	-0.43 (8.23)		
Ease/Difficulty (Max = +30, Min = -30)	Low Relational	3.62 (10.96)	-1.17	N.S
	High Relational	5.35 (8.12)		
Enjoyment/Dislike (Max = +36, Min = -36)	Low Relational	-2.53 (9.15)	-1.74	0.05
	High Relational	-0.29 (7.61)		

**TABLE 4: Mean Ratings, Standard Deviations on Comparative Scales, and Results of t-Test Analysis (Conceptualisation Styles)**

The low descriptive thinkers have also express a slightly greater satisfaction with discovery learning than high descriptive thinkers. The differential is only reaching the 5% level of significant and thus a relatively 'weak' finding. Interestingly the observed differential is not in line with the initial prediction according to which a high descriptive style person should perceive discovery learning as more enjoyable then low discriptive style individuals. A likely explanation for this is that the previous finding about the association of the comparative enjoyable rating with inferential thinking style masks any association between that rating and the descriptive style due to the ipsative nature of the scores on the conceptualisation styles test. Negative correlations exist between the various styles measures. For the inferential and descriptive styles the calculated correlation is  $r = -0.39$ .

With respect to the relational style, the low relational thinkers perceive discovery learning as somewhat more enjoyable or more satisfying than learning from exposition. In absolute term, the difference is rather small, despite the fact that it reaches the 5% significance level. Bearing in mind the ipsative nature of the conceptualisation style scores, it would be unwise to attach deep meaning to the present result.

**Conceptual Differentiation and Students' Preference for Instructional Modes**

Table 5 presents the basic data and the results of the t-test analyses. The data indicates that high conceptual differentiators perceive discovery learning to be comparatively more difficult than learning from expository teaching. The differential is significant at the 5% level.

A tentative explanation for this observation may be that the high differentiators have a low tendency to develop broad classification patterns in which they bring together large number of stimuli. This type of pattern formation and recognition would be a major ingredient of successful learning from discovery situation. Thus, it is plausible that high differentiators should perceive discovery learning more difficult than learning from exposition. With respect to the enjoyment scale there is no significant difference in the mean comparative ratings of the two groups.

Variable (Score Range)	Subgroup	Mean Rating (Std. Dev.)	t-value	One-tailed Prob.
Ease/Difficulty (Max = +30, Min = -30)	Low Differentiation	3.11 (10.47)	-1.82	0.05
	High Differentiation	5.58 (8.50)		
Enjoyment/Dislike (Max = +36, Min = -36)	Low Differentiation	-1.30 (7.55)	0.17	N.S.
	High Differentiation	-1.51 (9.06)		

TABLE 5: Mean Ratings, Standard Deviations on Comparative Scales, and Results of t-Test Analysis (Conceptualisation Differentiation Style)

#### Convergency - Divergency and Students' Preference for Instructional Modes

Table 6 presents the basic data and the results of t-test analyses. It can be seen from that data in the table that there is a small, but significant difference in the comparative mean ratings of the convergent and divergent thinkers on the ease/difficulty scale. The divergent thinkers have perceived learning by discovery to be relatively more difficult than learning from exposition. This result is as predicted. Divergent thinkers who tend to look for alternative solutions to a problem find discovery learning difficult as it requires critical analysis of information and selection of a specific hypothesis that fit all situation. On the enjoyment scale no discernable difference exists. Therefore, it seems that the leaning towards convergency/divergency style has no bearing on the perception of the relative enjoyableness of the two modes of instruction.

Variable (Score Range)	Subgroup	Mean Rating (Std. Dev.)	t-value	One-tailed Prob.
Ease/Difficulty (Max = +30, Min = -30)	Convergent	4.33 (11.01)	-1.69	0.05
	Divergent	6.72 (10.35)		

Variable (Score Range)	Subgroup	Mean Rating (Std. Dev.)	t-value	One-tailed Prob.
Enjoyment/Dislike (Max = +36, Min = -36)	Convergent	-1.50 (9.40)	0.18	N.S.
	Divergent	-1.72 (9.33)		

TABLE 6: Mean Ratings, Standard Deviations on Comparative Scales, and Results of t-Test Analysis (Convergency- Divergency Style)

**Conclusion**

The results of this study is both interesting and of great significant to educational practices because the success of any instructional approach cannot simply be assessed in terms of the learning that results from it but must also address itself to the question of how students react to it.

In general, it is found that students find an expository teaching approach easier to cope with than an instructional approach based on discovery learning. This differentiation between the two modes of teaching in really very marked. For the second measure, the enjoyableness of the two approaches, the finding is that students prefer the discovery technique over the expository teaching, but the differentiation here is far less pronounced than for the ease/difficulty measure.

The examination of the effect of cognitive styles upon students' perception of the ease/difficulty and the enjoyability of the two self-instructional modes resulted in the following major findings.

- (i) Differences on the relative ease/difficulty scale were found in relation to the conceptual differentiation style and the convergency/divergency measure. High conceptual differentiators and divergent thinkers perceived learning by discovery to be more difficult than learning from exposition.
- (ii) For the enjoyability scale, significant differences in the relative assesement of the two learning modes were found for the following cognitive styles: field independence/field dependence and the inferential conceptualisation style. Field independent students and high inferential thinkers perceived learning by discovery to be more enjoyable than learning from exposition.

However, as discussed earlier, self instruction as a mode of learning in itself may have some effects. In the overall sense, the results show that the influence of cognitive styles is not confined to the cognitive outcomes from learning generally reported in literature but extend also to affective characteristics associated with learning as this study shows. The findings to a certain extent support some kind of 'matching theory', whereby students' ratings of the relative ease/difficulty and enjoyableness of different modes of instruction reflect the extent to which the learning requirements and conditions match the students' cognitive styles characteristics.

This suggests that the concept of attitude-aptitude-interaction should be included in cognitive style research because students attitude towards an instructional strategy may prove to be no less important for their learning than their aptitude. This is particularly important in relation to discovery learning because of the great emphasis given to discovery learning in modern science and mathematics curricula, irrespective of the learners' aptitude, cognitive characteristics and attitude towards this mode of learning.

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