DOCUMENT RESUME

ED 091 198 SE 017 761

AUTHOR Zambotti, Geno; Fazio, Frank
TITLE An Investigation of Some Cognitive Style Variables and Their Relationships to Science Achievement.
PUB DATE 16 Apr 74
NOTE 26p.; Paper presented at the Annual Meeting of the National Association for Research in Science Teaching (47th, Chicago, Illinois, April 1974)

EDRS PRICE MF-$0.75 HC-$1.85 PLUS POSTAGE
DESCRIPTORS *Achievement; Cognitive Development; *College Science; Educational Research; Learning Activities; *Learning Processes; Predictor Variables; Science Education; *Student Behavior; *Student Motivation
IDENTIFIERS Research Reports

ABSTRACT

This study was designed to survey the cognitive style preferences of college students. Two instruments were used in obtaining data for this inquiry. The Cognitive Preference Survey for Physical Science, developed by the authors, gave three preference scores: Memory, a preference for simple content facts; Principle, for a concept or theoretical construct; and Questioning, a preference of a higher order processing, that of challenging, questioning, or adding to the concept. The Survey of Personal Values (SPV, by Gordon) provided measures of stylistic values. The student sample consisted of 241 nonscience majors in a physical science course and 16 freshmen chemistry majors in a general chemistry course. All data were collected at the end of the academic year. Statistical analyses used were analyses of variance, t-tests, correlational analysis, and multiple step-wise regressions. The study showed that the physical science nonmajors were significantly higher on the Memory preference scores as well as on the Variety value. The chemistry majors had Memory, Achievement, and Goal Orientation as significant predictor variables for course achievement, while the others had Principle, Achievement, and Orderliness as significant predictor variables for science achievement. (Authors/EB)

An Investigation of Some Cognitive Style Variables and Their Relationships to Science Achievement

Geno Zambotti
Frank Fazio

Chemistry Department
Indiana University of Pennsylvania
Indiana, Pennsylvania 15701

This research was supported in part by a grant from the Gulf Oil Foundation, Pittsburgh, Pennsylvania

Paper presented at the 47th Annual Convention of the National Association for Research in Science Teaching

April 16, 1974

Chicago, Illinois

INTRODUCTION

Educators and psychologists in their attempts to improve the teaching-learning process have in recent years focused attention on the inter-individual differences of the learner. These differences are centered on the individual learner's ways of cognitive functioning and cognitive organization which appear to be characteristic of a kind of consistent behavior of the learner. The science educator is especially interested in the modes of cognitive functioning that are of importance in the processing of science information which will subsequently lead to successful achievement in science. There has been very little reported research in this area of relating modes of cognitive style or functionings to science achievement and even less research in the area involving undergraduate chemistry majors.

PURPOSE

The main purpose of this study was to investigate several aspects or modes of cognitive functioning or styles that may be indicative or predictive of success in undergraduate chemistry achievement. A concurrent investigation was also made of the non-science majors cognitive style preferences. More specifically, the objectives of the study were designed to focus on (1) science content preferences and (2) the individual's personal values and the relationship of those variables to science achievement.

LITERATURE REVIEW

Recent research has investigated "cognitive style" in relation to several areas. These areas include: cognitive styles and the teaching method, cognitive styles and educational-vocational preferences, cognitive styles and related variables, cognitive styles and mathematics as well as science achievement. Very little research, however, is to be found in relationship to science achievement.

Coop and Brown (1970), using college educational psychology students, found that there was no significant interaction between the single measure of style called "analytic" and the teaching method used. Davis and Klausmeir's (1970) findings revealed that cognitive style is significant in influencing concept-identification performance according to the type of training offered. They found that "high-analytic" style students had fewer errors. This study seems to support the premise that cognitive style is highly relevant in an instructional situation.

Fragale (1969) determined a "collective cognitive style" for industrial technology teachers in a community college and a "collective cognitive style" for technology students. He found that the data indicated that the matching of individual faculty and student cognitive style does exert an effect on the educative process. Blanzy's (1970) research involved cognitive styles of students and teachers in a mathematics curriculum in a community college in Michigan. He found a distinctive collective style of students in the top 27% of the class in achievement of performance goals and of those students with the most positive and those with the least positive attitudes toward mathematics. He also found that students whose cognitive styles were highly similar to the teacher's cognitive style had a higher achievement. Success in using

programmed instructional materials was also identified with a distinctive cognitive style. Shuert (1970) determined a set of six elements of cognitive style that were unique to a group of students who were successful in math courses. His findings were consistent with the literature about factors and abilities associated with success in mathematics.

Hervey's study (1966) involved 80 male upperclassmen representing a variety of academic fields of study. She attempted to relate a single cognitive style dimension to a specific school task. Her predicted relationships were not significant. Post-hoc analysis, however, suggested that cognitive style is undoubtedly related to school behavior but its influence in actual classroom tasks may be affected by some stronger factors such as motivation, major field of study, and past experiences.

Williams (1970) research presented a strong argument for regarding cognitive styles as preferences rather than as abilities. He constructed a preference test in three content areas: science, mathematics, and social studies. His subjects were freshman students at the university. The findings showed that persons were pervasive in their cognitive preferences in different subjects. There were differences in cognitive preferences between persons majoring in different subject fields. The preference scores were unrelated to scores on tests of academic aptitude. The scores were also found to be unrelated to scores on traditional psychological tests of cognitive styles. This study strongly suggests that specific cognitive preference tests can be used as effective measures of a dimension of cognitive style.

Several researchers attempted to relate "cognitive style" to vocational preferences and interests. Pierson (1965) using the styles, field independence and preference for structure, found that the field-independent

style was related to interest in the physical science and technical areas. French (1963) showed that personality measures along with aptitudes and interest data could be used to contribute to the college major-field grades. Won-Shik (1966) using four cognitive style measures, the Kuder Preference Record, and biographical data was able to find that cognitive style measures were able to discriminate significantly among eight major college groups. Students in the humanities, music, and social science exhibited similar styles, but the other areas, including the natural sciences and engineering, deviated in some ways from the cluster. Osipow (1969) made a study of college women's cognitive styles and vocational preference selections. The women were in the professions of nursing, home economics, dental hygiene, special education, and general areas. His findings also showed that educational groups preparing for a vocation or a profession have or exhibit distinctive cognitive styles.

Cropley and Field (1969), investigating the four cognitive style variables of: stage of mental operations, category width, originality, and flexibility, with science achievement of high school students, found only a limited degree of relationship. Significant relationships were found for stage of mental operations for boys and girls and originality only for the female group. The authors strongly recommended that a multi-dimension approach be used in determining the "cognitive styles" of science students. These writers feel that personal values are important individual attributes and are a vital part of an individual's basic motivational patterns. Very little research has included personal values as elements of style.

TEST INSTRUMENTS

Two instruments were used in obtaining the data described in the objectives. The instrument Cognitive Preference Survey for Physical Science (CPS) was developed by the two writers. The format for this instrument was modeled upon the research of Heath (1964) and Atwood (1967) and their cognitive preference tests. This CPS test consisted of chemistry content material that was usually covered in the physical science course and the general chemistry course. A content statement is made and this is followed by three multiple choice cognitive preference items. They include: (1) Memory or recall of rather specific facts (2) identification of a fundamental Principle or concept and (3) critical Questioning or challenging of the stated information.

The validity of the instrument was established based upon the defined construct of cognitive style. The content validity was based upon the judgement of three college professors of chemistry as well as the two writers who are involved in the teaching of the physical science courses. The reliability measures were done using the Kuder-Richardson procedure as programmed on the University's IBM-360 TESTAT II program. The pilot study data (1972) with 301 students involved, showed values of $r = 0.795$ for Memory, $r = 0.551$ for Principle, and $r = 0.726$ for the Questioning preference score. The present study (1973) with 257 total subjects found comparable reliability measures of 0.772, 0.528, and 0.781 for the three preference scores.

The second instrument Survey of Personal Values (SPV) by Leonard V. Gordon was used to obtain measures of the individual's stylistic values. The writers feel that values are related to an individual's basic

motivational patterns and as a result may determine to some degree what he does or how well he performs.

In this instrument, (SPV) the subject was given some examples of everyday activities and was asked to assign relative importance to these everyday activities. Forced-choice format included 30 sets of 3-statements each and the individual indicates one statement that is most important to him and one statement that is least important. The six values measured by the SPV are:

P - Practical Mindedness: To always get one's money's worth, to take good care of one's property, to get full use out of one's possessions, to do things that will pay off, to be very careful with one's money.

A - Achievement: To work on difficult problems, to have a challenging job to tackle, to strive to accomplish something significant, to set the highest standards of accomplishment for oneself, to do an outstanding job in anything one tries.

V - Variety: To do things that are new and different, to have a variety of experiences, to be able to travel a great deal, to go to strange or unusual places, to experience an element of danger.

D - Decisiveness: To have strong and firm convictions, to make decisions quickly, to always come directly to the point, to make one's position on matters very clear, to come to a decision and stick to it.

O - Orderliness: To have well-organized work habits, to keep things in their proper place, to be a very orderly person, to follow a systematic approach in doing things, to do things according to a schedule.

G - Goal Orientation: To have a definite goal toward which to work, to stick to a problem until it is solved, to direct one's efforts toward clear-cut objectives, to know precisely where one is headed, to keep one's goals clearly in mind.

The validity of the SPV instrument was based upon its development through the use of factor analysis as well as its concurrent validity in being able to confirm findings of other studies. The reliabilities of the six scales are all consistently high (See Table 2).

PROCEDURE

The student sample used in this study consisted of 241 non-science majors enrolled in a physical science course and sixteen freshman chemistry majors enrolled in the general chemistry course. All the data were collected at the end of the semester (May 1973). Both tests were administered on the same day with each test taking approximately 20 minutes to complete.

FINDINGS

From the summaries tabulated in Table 4, simple t-test comparisons were made of the preference scores of the chemistry majors with those of the non-science majors. The physical science students who were the non-science majors had significantly higher Memory preference scores than the chemistry majors (significant at .001). The chemistry majors had significantly higher Questioning preference scores than the non-science majors (significant at .01). Of the six SPV measures only the Variety score was significantly different at about 0.07. The non-science majors were significantly greater in their Variety value score than the chemistry majors.

The non-science majors (N=241) were sorted out into various academic majors. This was done in order to explore possible differences in preference values that may be attributed to one's academic area. The

sub-groups were the arts and sciences majors, the criminology majors, the elementary education majors, the business majors, and secondary teaching majors. Several students were unclassified due to, the unlisting of the majors, transfer students, and the changing of majors.

A one-way analysis of variance was conducted with the five sub-groups of non-science majors versus each of the preference scores.

There were no significant differences among the five major sub-groups in the three content preference scores (M, Pr, Q). With the SPV measures, however there was no significant difference in the Achievement (A) value score and the Goal-Orientation (G) value score but differences were indicated in the Practical-Mindedness (PM), Variety (V), Decisiveness (D), and Orderliness (O) value scores. A post-hoc comparison was conducted to determine these differences. Table 6 summarizes the post-hoc comparisons. The business majors PM score was significantly greater (0.01) than the arts and science majors PM score. The arts and science majors scored significantly higher (0.05) on the Variety score than the criminology majors and the secondary teaching majors. The arts and science majors scored significantly higher (.01) on the Decisiveness value than the business majors and the arts and science majors scores were also significantly greater (0.08) than the secondary teaching majors Decisiveness score. The secondary teaching majors Orderliness score was significantly greater (0.05) than the arts and science majors score. The criminology majors Orderliness score was slightly significant (0.10) over the arts and science majors score.

In Table 5, the summary of mean preference scores of the non-science males and females clearly indicates no significant difference between the sexes in their preferences as well as the course letter grade. With

respect to the sexes, the non-science major group was quite homogeneous. The chemistry major group (N=16) consisted of only 3 females and therefore statistical comparison was not reliable.

In order to investigate and to explore the preference values that might be predictive of achievement in chemistry and in physical science a step-wise multi-regression analysis was used. The nine preference measures were used as predictor variables with the course letter grade as the dependent variable. The three CPS scores were run first as predictor variables to determine which of these scores could be used alone as a predictor of course achievement. The six SPV measures were also run separately to determine the best predictors. The CPS best predictors were (-) Memory (- means negative slope) for the chemistry majors and Principle for the non-science majors enrolled in the physical science course. The Survey of Personal Values (SPV) scores that were the best predictors were -Goal and Achievement Orientation for the chemistry majors while Achievement and Orderliness values were the best predictors for the non-science majors. When all nine variables were loaded together and run, the order of loading of the predictor variables were in the same order as when run separately. Table 7 summarizes the analyses and lists the two regression equations that can be used to predict course letter grade.

The predictor variables for males and females differed somewhat. Table 8 summarizes the analyses. The males loaded (-) Questioning, Achievement and Orderliness while the females loaded Principle, Achievement, and Variety as the best predictor variables. Regression equations using these three variables are listed.

The predictor variables for the five majors sub-groups are listed in Table 9. It is interesting to note that all three predictor variables for the arts and science majors had negative slopes; (-) Variety, (-) Orderliness and (-) Principle. The preference for Principle is the best predictor for the two largest groups, business majors and elementary education majors. The criminology and the secondary teaching majors' regression equations were not significant for the first three predictor variables.

Discussion of Results

The validity confirmation as described earlier in this paper as well as the statistical reliability data substantiate the potential usefulness of the two test instruments in providing some measures of cognitive style variables. Both test instruments were found easy to use and administer. The average time taken by a student is about 15-20 minutes per each test. The scoring and tabulation of the test results can be easily computerized.

Since this was an exploratory study, the findings have suggested several conclusions. The chemistry majors, who can be assumed to be generally quite thorough and deeper in comprehension of subject matter content were found to be significantly higher in the Questioning or challenging preference. The Questioning preference is a higher order of preference style. The non-science majors were significantly higher in the lower order Memory preference than the chemistry majors. The Variety value score was also found to be significantly higher for the non-science majors. This may be interpreted as implying that the chemistry majors

are more conservative or that the non-science majors like to do or to have a variety of experiences, or to experience an element of danger.

The regression equations for predicting course letter grade for chemistry majors lists Goal Orientation and negative Memory and negative Achievement as significant predictors. The first two predictors seem intuitively linked to successful achievement but the negative Achievement value is difficult to interpret. The non-science majors loaded Principle first followed by Achievement and Orderliness. Instructors that teach science courses will probably agree that the stylistic preference for understanding of principles or concepts is a desired outcome in course objectives. Having a strong personal value for Achievement and Orderliness should also help in achieving success in a science course. These three variables are all intuitively acceptable and useful in providing a regression equation for predicting course letter grade in the physical science course.

The males and females regression equations differed somewhat. The males loaded Orderliness first, while the females loaded Principle first. The Achievement value was common for both sex groups. The loading of negative Questioning for the males and Variety for the females seemed anomalous with respect to the proper interpretation. Both of these regression equations were statistically significant.

The comparisons of the data of the five majors sub-groups of physical science students might serve some value to the advisors in these academic areas. Although from Table 6 we might conclude that there is in general an overall similiarity in the mean style preferences. However, some slight differences in the post-hoc comparisons as well as the differences in the regression loadings might be of specific value to instructors of

the physical science course and to the student's academic advisor. The business majors and the elementary education majors are the two largest groups and their data seem most reliable when compared to the other three smaller groups.

The findings suggest possible use by the course instructors to put more stress on understanding of principles or concepts and to let the students know what the best style predictors of course success are. An awareness of these findings to the course instructors and to the students themselves, may lead to possible changes of style preferences of the student toward those style preferences that are most likely to lead to course success.

Suggestions for Further Research

The results of this exploratory study suggest that further research is needed. The number of chemistry majors was small and therefore a replication study with larger numbers is needed.

There are many other style variables that could be studied and incorporated with those mentioned in this investigation.

Another area of possible investigation would be to match curriculum instructional approaches such as the lecture method, individualization, project method, etc. with students grouped according to their cognitive style preferences. Another research question posed is "Does cognitive style change as a result of an instructional approach?"

Table 1

Sample Items from Test Instruments

Cognitive Preference Survey

Equal volumes of gases, measured at the same temperature and pressure, contain equal numbers of molecules.

(Q) (A) Whether this information strictly applies to all gases might well be asked at this point.

(P) (B) Measured under the conditions stated, the ratio of the weights of the molecules for two different gases must be the same as the ratio of the weights of the two gas samples.

(M) (C) This is a statement of Avogadro's Hypothesis.

Survey of Personal Values

Mark one statement as representing what is most important to you and one statement as representing what is least important.

	Most	Least
To take proper care of my things.	____	____
To settle a problem quickly.	____	____
To be systematic in the things I do.	____	____

	Most	Least
To have a challenging job to tackle.	____	____
To visit new and different places.	____	____
To have a definite goal toward which to work.	____	____

Table 2

Reliability of Test Instruments

Cognitive Preference Survey (CPS)
(Kuder-Richardson)

	Pilot Study (N = 304)	Current Study (N = 257)
Memory	0.795	0.772
Principle	0.551	0.528
Questioning	0.726	0.781

Survey of Personal Values (SPV)

	P	A	V	D	O	G
N = 97 Test-Retest	.80	0.87	.92	.74	.83	.84
N = 167 Kuder-Richardson	.72	0.76	.92	.81	.83	.83

Table 3

Intercorrelation of the Preference Measures

Non-Science Majors

N=241

		CPS Measures			SPV Measures				
	M	Pr	Q	Pt	A	V	D	O	G
1. M		-.360	-.729	.094	-.135	-.056	-.090	.083	.107
2. Pr			-.376	-.077	.110	-.099	.039	.045	.006
3. Q				-.038	.053	.126	.061	-.114	-.109
4. Pt					-.211	-.063	-.567	.170	-.272
5. A						-.334	.175	-.180	-.186
6. V							.224	-.587	-.541
7. D								-.671	-.178
8. O									.296
9. G									

(r > .160) Significant at 1%

Table 3 (continued)

Chemistry Majors

N=16

	CPS Measures				SPV Measures				
	M	Pr	Q	Pt	A	V	D	O	G
1. M		265	-.807	.141	-.274	.213	-.145	-.189	.047
2. Pr			-.784	-.133	.062	.104	-.019	.171	-.281
3. Q				-.010	.139	-.201	.105	.017	.142
4. Pt					-.131	-.308	-.543	-.008	.075
5. A						-.101	-.018	-.053	-.348
6. V							.367	-.713	-.698
7. D								-.513	-.205
8. O									.396
9. G									

(r > 0.426) Significant at 5%*

*Walker, H. M. Lev Joseph. Statistical Inference.

Table 4

Summary of Mean Preference Scores for Chemistry Majors and Non-Science Majors

		M*	Pr	Q**	PM	A	V#	D	O	G	Course Grade
Chemistry Majors N = 16	Mean	4.94	11.56	11.50	11.50	16.94	10.88	16.06	14.81	19.81	2.81
	S.D.	4.81	4.57	7.47	5.44	4.15	9.56	4.30	6.98	5.82	0.83

		M*	Pr	Q**	PM	A	V#	D	O	G	Course Grade
Non-Science Majors N = 241	Mean	9.85	10.55	7.61	13.73	15.26	14.73	14.28	13.88	18.03	2.48
	S.D.	4.51	3.32	4.53	5.36	4.93	7.73	6.01	6.88	5.59	0.88

*Memory Scores Significant at 0.001

**Questioning Scores Significant at 0.01

#Variety Scores Significant at about 0.07

Table 5

Summary of Mean Preference Scores for Male and Female Non-Science Majors

		M	Pr	Q	PM	A	V	D	O	G	Course Grade
Males	Mean	8.90	10.83	8.27	14.29	15.82	14.03	13.98	14.12	17.68	2.46
N = 115	S.D.	4.49	3.68	4.59	5.57	5.14	8.19	6.04	7.05	5.65	0.88

		M	Pr	Q	PM	A	V	D	O	G	Course Grade
Females	Mean	10.71	10.29	7.02	13.21	14.75	15.37	14.56	13.67	18.35	2.50
N = 126	S.D.	4.36	2.94	4.41	5.13	4.69	7.25	6.00	6.75	5.54	0.88

Table 6

Summary of Mean Preference Scores for
Sub-Groups of Non-Science Majors

		M	Pr	Q	PM	A	V	D	O	G	Course Grade
Arts & Science	Mean	8.64	11.09	8.27	11.58	15.82	17.61	16.61	11.42	16.79	2.61
Majors N = 33	S.D.	4.36	3.25	4.22	4.60	4.48	8.67	5.98	7.57	6.96	0.79
Criminology	Mean	9.79	10.74	7.47	13.68	14.68	12.95	15.16	15.47	18.05	2.74
Majors N = 19	S.D.	4.63	3.72	3.67	5.98	4.47	8.44	6.74	7.44	5.13	0.81
Elementary Ed.	Mean	9.94	10.27	7.79	13.27	15.71	14.64	14.13	13.64	18.46	2.36
Majors N = 70	S.D.	4.86	3.42	5.38	4.97	5.18	7.12	6.22	6.27	5.45	1.01

Table 6 (continued)

		M	Pr	Q	PM	A	V	D	O	G	Course Grade
Business	Mean	9.50	10.71	7.79	15.50	14.92	14.62	12.88	14.52	17.47	2.48
Majors N = 66	S.D.	4.45	3.40	4.34	5.65	5.46	8.15	5.51	6.94	5.26	0.81
Sec Teaching	Mean	10.83	11.22	5.94	13.06	15.56	11.72	12.94	16.94	19.78	2.22
Majors N = 18	S.D.	4.90	3.96	3.32	5.93	4.96	6.87	6.76	6.52	4.60	0.88

Summary of Post-Hoc Comparisons

Variety	Arts and Science Majors > Secondary Teaching Majors at	.05
Variety	Arts and Science Majors > Criminology Majors at	.05
Practical Mindedness	Business Majors > Arts and Science at	.01
Decisiveness	Arts and Science > Business Majors at	.01
Decisiveness	Arts and Science > Secondary Teaching Majors at	~.08
Orderliness	Criminology Majors > Arts and Science Majors at	.10
Orderliness	Secondary Teaching Majors > Arts and Science at	.05

Table 7

Summary of Multi-Regression Analyses of All Nine Variables Versus Course Letter Grade for Chemistry and Non-Science Majors

Group	Predictor Variables (in order of loading)	Multiple r	*F-Value (Goodness of Fit)
Chemistry Majors (N = 16)	+ Goal Orientation, -Memory, -Achievement	0.781	6.25
Non-Science Major (N = 241)	Principle, Achievement, Orderliness	0.235	4.618

Regression Equations for Predicting Course Grade

Course Grade
Chemistry Majors = +0.0537 G -0.1034 M -0.0807 A +3.6260

Course Grade
Physical Science = 0.0463 Principle + 0.0201 A + 0.0131 O + 1.5048

*Significant at 0.05

Table 8

Summary of Multi-Regression Analyses of All Nine Variables Versus Course Letter Grade for Males and Females

Group	Predictor Variables (in order of loading)	Multiple r	*F-Value (Goodness of Fit)
Males = (N = 114)	Orderliness, -Questions, +Achievement	0.284	3.213
Females = (N - 127)	Principle, Achievement, Variety	0.325	4.853

Regression Equations for Predicting Physical Science Course Grade

Course grade (Boys) = +0.0282 O -0.0244 Q +0.0159 A +2.0150

Course grade (Girls) = 0.0751 P +0.0418 A +0.0129 V +0.9117

*Significant at 0.05

Table 9

Summary of Multi-Regression Analyses of All Nine Variables Versus Course Letter Grade for Males and Females

Group	Predictor Variables (in order of loading)	Multiple r	*F-Value (Goodness of Fit)
Arts & Science (N = 33)	-Variety, -Orderliness, -Principle	0.585	5.024
Criminology (N = 19)	-Decisiveness, Principle, Achievement	0.583	*2.575
Business (N = 66)	Principle, -Decisiveness, Memory	0.345	2.801
Elementary Ed. (N = 70)	Principle, Achievement, Variety	0.355	3.181
Secondary Teach. (N = 18)	-Decisiveness, -Achievement, Goal Orientation	0.391	*0.843

Regression Equations for Predicting Course Letter Grade

Course Grade = -0.0702 V -0.0305 O -0.0430 P +4.667
(A & S)

Course Grade = -0.0492 D +0.0755 Pr +0.0617 A +1.767
Criminology

Course Grade = 0.0771 P -0.0292 D +0.0233 M +1.8127
Business

Course Grade = 0.0834 P +0.0458 A +0.0201 V +0.4864
Elementary Ed.

Course Grade = 0.0357 D -0.0449 A -0.0277 G +2.8365
Secondary Teaching

*Not Significant

Bibliography

1. Atwood, Robert K. "Chem Study Achievement Among Groups Classified by Cognitive Preference Scores." Journal Research Science Teaching. Vol 5, 1967-68. p. 154-159.

2. Atwood, Robert K. "A Cognitive Preference Examination Using Chemistry Content". Journal Research Science Teaching. Vol 5 No. 1, 1968. page 34-35.

3. Blanzy, James J. "Cognitive Style as an Input to A Mathematics Curriculum System: An Exploratory Study in the Educational Sciences". Wayne State Univ. Dissertation Abstracts. Vol 32 (3404 A) 1971.

4. Coop, Richard H., Brown, Lawrence D. "Effects of Cognitive Style and Teaching Method on Categories of Achievement". Journal of Educational Psychology, Vol 61, 1970, No. 5, p. 400-405.

5. Cropley, A. J. and T. W. Field. "Cognitive Style and Science Achievement". Journal of Research in Science Teaching, Volume 6, 1969, page 2-10.

6. Davis, J. K., Klausmeir, H. J. "Cognitive Style and Concept Identification as a Function of Complexity and Training Procedures." Journal of Educational Psychology, Vol 61, Dec 1970, p. 423-430.

7. Fragale, Marvin Joseph. "A Pilot Study of Cognitive Styles of Selected Faculty Members and Students in a Community College Setting". Wayne State Univ. Dissertation Abstracts. Vol 31 (1595 A), 1970.

8. French, John W. "Comparative Prediction of College Major-Field Grades by Pure-Factor Aptitude, Interest, and Personality Measures". Educational and Psychological Measurement. Vol 23, No. 4, 1963, p. 767-774.

9. Gallagher, J. J. and Jenne, W. C. "Relationship of Cognitive Style to Classroom Expressiveness and Associated Variables", Journal Educational Research, Vol 60, Feb. 1967, p. 273-279.

10. Heath, Robert M. "Curriculum, Cognition and Educational Measurement." Educational and Psychological Measurement, 24 (Summer, 1964) 239-253.

11. Hervey, Sarah D. "Cognitive Style and Preferences in School Tasks". Michigan State Univ. Dissertation Abstracts. Vol 27, 1966.

12. IBM/360 Computer Multiple Regression Program, Computer Library, Indiana University of Pennsylvania, 1973.

13. Osipow, Samuel H. "Cognitive Styles and Educational - Vocational Preferences and Selection". Journal of Counseling Psychology, Vol 16, 1969, p. 534-546.

14. Pierson, Jerome S. "Cognitive Styles and Measured Vocational Interests of College Men". Dissertation Abstracts. Vol 26 (875) 1965.

15. Shuert, Keith L. "A Study to Determine Whether a Selected Type of Cognitive Style Predisposes One to Do Well in Mathematics". Wayne State Univ. Dissertation Abstract. 1971, Vol 32 (3352).

16. Wachtel, Paul L. "Style and Capacity in Analytic Functioning". Journal of Personality, Vol 36, June 1968, p. 202-212.

17. Walker, Helen M, and Lev, Joseph. "Statistical Inference". Henry Holt and Co., New York, 1953.

18. Williams, Clive. "The Pervasiveness of Cognitive Preferences". Univ. of Iowa. Dissertation Abstracts. Vol 32 (4565-A) 1971.

19. Won-Shik Chung. "Relationships Among Measures of Cognitive Style, Vocational Preferences, and Vocational Identification." George Peabody College for Teachers. Dissertation Abstracts. Vol 28, 1967.