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ABSTRACT

This research studies both students' and teachers' divergent and convergent abilities and their interaction within the normal classroom. Divergence and convergence were operationally defined and measured by paper and pencil tests. After reviewing the literature on divergence and convergence and on divergence and classroom achievement, the authors present their own research conducted with 450 high school students and 20 of their teachers. Results indicate that the divergent student is not considered less appealing than his convergent peer in the classroom; in fact, the diverger distinguishes himself by participating more often and offering more original ideas. In terms of the teachers, classroom climate appears to be highly dependent on their cognitive styles. The authors feel that educational researchers must consider the classroom within the multivariate-interactive model, since a simple univariate approach does not project a clear interaction of the underlying classroom processes. (Author/SES)

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The Interaction of Divergence and Convergence of Students and Teachers with Personality and Instructional Variables Affecting Educational Outcomes

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In any school situation all of the learning is likely to be the result of the interaction of the student's characteristics, the teacher's characteristics, the social environment and subject content (Siegel and Siegel, 1967). Hundreds of studies have been completed which attempted to isolate critical interaction variables. Most of these studies point out the importance of one or more variable, believed to be critical to student learning, and observe how they interact with a number of different treatments, that is, methods of instruction. By and large, the results indicate that few experiments have been successful in discovering salient interactions (Dubin and Traveggia, 1968). This fact, coupled with the apparent increase of interest in individualized instruction, makes it imperative for researchers to try more novel approaches. More recently researchers have given much attention to "creativity" as a relevant variable within the context of the classroom and it is the purpose of this research to explore this relevance.

In spite of the great amount of creativity research done in the last twenty years, critics of this area have not been convinced of the validity of the so-called creativity tests.

The early work of Guilford and his associates has

repeatedly been able to demonstrate the independence of the creativity factor from the IQ factor but has yielded only low correlations with any creative behavior.

Defining this critical factor as "divergent" thinking a mode of productive thinking which produces novel and original responses, Guilford developed tests which purported to discriminate between the creative and non-creative. Far from convincing, the results have been contradictory and confusing.

Basically the methods of validity research used by researchers have followed two paths of investigation. The first, can be labelled a trait-type approach which assumes a normal distribution of creative ability within the general population. This method includes testing all subjects for creativity and then obtaining an independent judgement of the subjects "creativity." Almost all of these methods involve ratings of some sort.

An analysis of the data in Drevdahl's (1956) study of arts and science students demonstrated the students rated as creative by independent judges performed at a higher level on the creativity tests, the scores correlating .33 with the ratings. When divergent production was correlated with teacher nominations for creativity the correlations were somewhat lower (.20) (Merrifield,

Gardner and Cox, 1964; Piers, 1960; Torrance, 1962). In the more difficult area of art productivity, the Guilford tests did an even poorer job of predicting those artists who produced the more "creative" works of art. (Beittel, 1964; Skager, Klen and Schultz, 1967).

The other method, that of identifying persons in our society deemed creative by their peers and then administering creativity tests to them to measure their deviation from the average performance level has also yielded inconclusive results. With respect to MacKinnon's (1961) "creative" architects, when scored for quality or quantity of responses, the Guilford tests did not correlate well with their degree of creative production.

The failure of these instruments is simply due to the following two factors. First, there is no guarantee that raters use the same criteria in deciding who is creative. Without going into the obvious criteria problems in too much detail, it is sufficient to note that creativity per se, is probably not a uni-dimensional variable with one single criteria. Although there is little argument that the creative process involves the formulation and production of some unique and novel output for a given amount of time, there is little consensus as to the dimensionality of the product. The specific criteria of creativity

in the physical sciences probably does not apply to the arts.

In addition, from a psychometric point of view, the individual raters using a Likert type scale would be subject to experimenter bias, use of extraneous criteria, response bias, and possible misinterpretations of the dimensions.

The second factor, proposed by Dellas and Gaier (1970) suggests that the creativity test might in fact be inappropriate to the group being investigated. As stated earlier that since creative output is different for each discipline it also stands to reason that the tests might not be entirely appropriate for two different groups. For instance, Elliot using semantic divergent production found high correlations with creative advertising executives but Beittel (1964) using the same instrument found little or no correlation with creative performance of college art students. Such inconsistancy points to the inappropriateness of the predictor test.

Divergence and Convergence

With such discouraging results, the question of the tests' value as a measure of psychological importance must be answered. Fortunately a number of researchers have succeeded in finding important uses for these measures.

In order to remove the emotive and misleading connotation of the term "creativity", Hudson (1966) and Cronbach (1968) both suggest the original Guilford-derived term of "divergence" to describe the multiple responses to a single stimuli. Consequently, they also replace the term "intelligence" with "convergent" ability to denote the ability to produce a single response to a stimulus situation.

The relationship between convergence and divergence has often been explored, with the rather consistent findings that both these abilities function relatively independently from one another. The effect is more orthogonal when high convergent subject's scores have been used (Ripple and May, 1962). What actually makes this finding important for educational psychologists, is that in spite of large convergent differences between high and low divergers, both achieve as well in an environment which has traditionally been considered highly convergent (Getzels and Jackson, 1962; Torrance, 1962). Equally important are the findings that suggest that teachers in general, prefer those students exhibiting strongly convergent biases (Getzels and Jackson, 1962; Torrance, 1962). In spite of the frequent criticism of this research (Burt, 1962; Demille and

Merrifield, 1962; Thorndike, 1962) only a few studies have attempted to replicate the findings. Yamamoto (1964) found similar results, Torrance (1962) reported inconsistent findings dependent upon the type of school, while Hasan and Butcher (1968) using Scottish children and correcting some of the methodological errors led to conclusions contrary to the Getzels and Jackson work.

When results such as those presented above are considered in light to the work done by Hudson, for example, who has demonstrated that students with convergent biases choose scientific training and the divergers prefer the arts, it becomes all the more apparent that the convergent and divergent biases are crucial variables in describing a student's development and behavior. The emphasis however has shifted from arguments of validity to the study of cognitive bias and how it interacts with the environment.

Divergence and Classroom Achievement

If divergence is independent of convergent ability then what effect does this variable have on classroom achievement? Evidence provided by Hudson (1966) clearly indicated that IQ alone did not identify the intellectually superior children. In addition, Torrance (1967) showed that using IQ as the sole selector of giftedness overlooks

a large number of deserving students. In fact, his data showed that the top 20% of the school population according to IQ tests tends to include only about 30% of those individuals who are in the top 20% on divergent thinking. This indicates that the gifted group overlooked 70% of the highly divergent student group.

Despite IQ differences of more than 20 IQ points both Getzels and Jackson (1962) and Torrance (1962) found that the Hi "creatives" achieved as well as the Hi "IQs". Yamamoto (1964) also compared the academic performance of secondary school children selected the same way as Getzels and Jackson's subjects. Again despite the 20 point IQ difference, the divergent thinking group did as well on the Iowa Test of Educational Development as did the high IQ group. These results were found for boys and girls and both groups combined. In a second study, Yamamoto partialled out the initial IQ differences, and found that the Hi divergers performed better than low divergers from which he concluded that achievement differences were not entirely due to differences in IQ.

Cropley (1967) also investigated the extent to which "creativity" scores affect achievement. After sampling a group of 320 children, he divided the sample into four groups. The first group (Hi-Hi) were above the median in "IQ" and "creativity", the second (Hi-Lo) group consisted of above median IQ but below on "creativity", while the third and forth were (Lo-Hi) low on IQ but not

on "creativity and low on both IQ and creativity." He expected that if creativity was an important enough variable then the Hi-Hi group should out perform the Hi-Lo and the Lo-Hi should surpass the Lo-Lo. Both of these hypotheses were supported. Thus, although the Hi IQ group surpassed the two low IQ groups as expected, the Hi-Hi "all rounders" exceeded both the Hi IQ and the Hi creative groups.

Other studies offer further evidence of the importance of divergent thinking in the classroom. Correlations of 0.16 and 0.42 were found in the Cropley study between the six divergent test scores and academic achievement scores. Torrance (1959) reported correlations ranging from 0.37 to 0.53 with his sample of grade 4 to grade 6 children. Even with the IQ effect partialled out substantial correlations of 0.23 to 0.48 resulted. Finally, Cline, Richards and Needham (1963) demonstrated that divergent test scores correlated well with high school science marks.

Two general findings have been suggested by these studies: divergent test scores are useful predictors of academic achievement while the intercorrelations between convergent and divergent measures are low and it appears that the higher the convergent ability of the subject, the lower the interrelation between the convergent and divergent measures.

While restudying this issue, Yamamoto (1964) pointed out there was another critical variable aside from divergence and convergence which affect academic achievement. His contention was that convergent-divergent abilities of the teachers might interact with the corresponding student styles. In his study, he examined grade 5 teachers with low and high scores on a "creativity" test. Results showed that on arithmetic skills, there was a significant interaction between teacher "creativity" and "pupil creativity". When teachers were highly divergent the low divergent students did worst of all. Although Yamamoto was cautious about making generalizations he did conclude that there was sufficient evidence to demonstrate that classroom achievement was partly dependent on the cognitive styles of the teacher. In particular, low creative students achieved better than the highly "creative" when the teachers themselves were low creatives.

Using a more mature sample, Joyce and Hudson (1968) investigated the interaction of the personalities and intellectual styles of students with those of their teachers based on observations made in a statistics class of medical students. One of the hypotheses tested was the effect of teacher divergent-convergent bias on student-teacher interaction. Although only four teachers took part in

this experiment which lasted three successive classes, interesting and worthwhile results did emerge. An analysis of the final examinations suggested that certain types of students obtained better marks if taught by particular teachers. For example, students who had low convergent or high divergent scores tended to do well when taught by the most divergent teacher.

Although the overall hypotheses were confirmed, some of the findings did suggest that although learning is affected by the similarities between cognitive styles of teacher and student these interactions are not always advantageous. Sometimes convergers learned better from divergent teachers and similarily for the divergers.

The Present Project

Though a number of studies attempted in recent years to investigate the relationship of divergent thinking to educational activities, only the Joyce-Hudson study investicated divergent-convergent bias within a multivariate-interactive model. This research project set out to study both student's and teacher's divergent and convergent abilities, and their interaction within the normal classroom. In this study divergence and convergence were operationally defined and measured by pencil and paper tests.

Hypotheses

1. There is a difference between the convergent-divergent biased teacher's attitudes toward their students. It is expected that teachers prefer students whose cognitive bias is similar to theirs. The affective components of the student-teacher interaction are of particular interest. Each student's behavior was measured by Likert-type questionnaires completed by all his teachers. Among the dimensions studied were: amount of student participation in class, desire to teach a particular student again, student originality, and predicted achievement level of the student.

2. Convergent and divergent students will perceive teacher behavior differentially. It is expected that the convergent or divergent student will show a differences in attitudes towards teachers, though behavior patterns will be the same for both groups. Student attitudes were measured along fourteen dimensions including teacher flexibility, the student's opportunity to contribute ideas to class discussion, and the teacher's adherence to established school norms.

Instruments

The Cropley version of the Wallach-Kogan (1965) divergent test was chosen. The main advantage of the

p.y test (1967) is that they are group-administered and validated using a sample of students only slightly older than the present sample. The results indicated that the Wallach-Kogan tests were highly reliable, strongly inter-correlated, and had low correlation with traditional IQ measures. The tes.s were scored using two methods. A fluency count was obtained for each subtest and an originality score was derived by taking the inverse of the relative uniqueness of each response. As for fluency, originality scores were obtained for the subtests and total scores were formed by the simple summation of the four subtests.

The Raven Progressive Matrices were chosen as the convergent measure because they correlate well with traditional convergent types of tests and require a convergent response mode. They are also non-verbal, easy to administer and need not be timed, since they rarely take more than forty minutes to complete (Raven, 1958).

Classroom climate was measured by the Learning environment Inventory developed by Anderson (1968) to study a number of critical classroom interaction variables. Fourteen dimensions reflect the "relationship of the pupils to one another, to the organizational properties of the class, to class activities and to the physical environment."

The Omnibus Personality inventory was used to measure the personality variables of the teachers. Although originally designed for college populations, this inventory has been administered to all age groups with satisfactory results.

Students were rated by their teachers on a seven-point scale of nine dimensions adapted from a questionnaire developed by Sutherland and Goldschmid (1971). Teachers were asked to rate only those students with whom they were familiar. A test-retest reliability study, with a one month intercal, has yielded a substantial overall correlation of about 0.88.

Procedures

A large English-speaking high school in Montreal was chosen for this project. All the students (N = 450) in the tenth and eleventh grade participated. Students sampled ranged from general students with vocational interests to advanced science students anxious for early acceptance to university. Each student's divergent and convergent ability was sampled early in the school year. Once classes had been underway for some time, students were asked to complete a learning environment inventory (LEI) in each of their classes. In more than 1100 LEIs were eventually collected from the 48 classes in our sample.

Finally, achievement scores on all academic subjects were obtained from the results of year-end province wide testing.

Toward the end of the school year, the twenty teachers who taught these students were also tested for convergent and divergent abilities. In their case a more advanced version of the convergent test was chosen to avoid any ceiling effect. At the same time, teachers completed a rating form of each of their student. More than 900 forms were collected. Various supplementary measures of student behavior were also used to provide a fuller understanding of student activities.

This design makes possible the multiple evaluation of each student and a measurement of all the learning environments to which a student is exposed.

Results & Conclusions

The results confirmed a number of previous findings and suggest interesting new questions for classroom interaction. The correlations between the various divergent subtests and the convergent measures never exceeded 0.27 with a mean correlation of 0.19. These results are in line with previous findings although the subtest intercorrelations are somewhat lower than those reported by Ycas (1972) with a college sample using the same materials.

- Place Table 1 about here -

The inter-correlations for the divergent tests were again within the expected limit signifying once again the distinct nature of divergent ability. A fatigue factor was noticed as the number and originality of responses tended to diminish on the latter items. Since the items were not randomized in order to preserve the same test structure used by Cropley, it is only a hypothesis that fatigue and not the interaction of uninteresting stimuli with fatigue produced fewer responses. Thus the tests behaved as predicted with the divergent tests correlating well with each other and only minimally with the convergent scores. The relationship between the fluency and originality types of scoring yielded surprisingly high correlations which suggested to us that the fluency scores would serve as a sufficient predictor in the subsequent analysis.

To further investigate the usefulness of these measures, a multiple regression was applied to measure the predictive abilities of divergent ability. Although it has generally been recognized that IQ and hence convergent abilities were good predictors of academic achievement. It was interesting to see how this rather loose and unstructured method would predict achievement. In each

instance the convergent scores were significantly correlated with the achievement scores at the 0.10 chance level. By including the divergent measures, the correlations in all but one case significantly contributed a better prediction at the 0.01 level. In the one maverick case the addition of the divergent score did increase the predictability if not significantly.

Results indicate that the combined divergent-convergent scores best predicted,success in biology, chemistry, physics and surprisingly english composition and english literature. The prediction of three science subjects was expected but one can only speculate about the strong relationship between convergent ability and the combined convergent-divergent with success in english courses.

- Place Table 2 about here -

A simplified interpretation is that contrary to popular opinion these subject areas do demand an unusual amount of convergent thinking ability. Students may in fact have little opportunity to practice diverse and unique ways of expressing themselves on English exams.

It is also interesting to note that the convergent and combined scores predicted french speaking skills worst of all. This finding is again consistent with other

studies which have attempted to find good predictors of second language acquisition ability.

The teacher-student interaction results provide the most provovative findings. Generally, the divergent-convergent bias does provide a useful distinction for understanding classroom behavior. It seems that there are some behaviors that are characteristic of divergent or convergent students regardless of the cognitive bias of the teacher, while in some cases an affinity exists between students and teachers of like cognitive styles.

- Place Table 3 about here -

Specifically, the teachers regardless of the cognitive bias of the student felt that divergers participated more often in class and were more original while there were no behaviors that teachers of both types felt that convergers were better. In terms of interaction, teachers felt that students with their own cognitive bias needed more attention and had a greater need for and level of achievement.

From the students point of view, the divergent teachers presented material more rapidly,maintained a more tense atmosphere by exhibiting stronger likes and dislikes for students, were less organized and less concerned,

The convergent teachers were more goal directed, encouraged competitiveness and left the class with a feeling of accomplishment and satisfaction. Along the interaction dimension, students rated teachers of like cognitive bias as having a greater diversity of interest and taught more democratically.

Conclusions

Although the final analysis has not as yet been completed a number of tentative conclusions are possible. From the existing literature as well as this study it is evident that the divergent student is actually not considered less appealing than his convergent confrère in the classroom. In fact, this study suggests it is the diverger who distinguishes himself by participating more often and offering the more original ideas. Contrary to the earlier claims of Getzels and Jackson (1962), the diverger makes his presence felt long before the final exam results are known. As far as being an "overachiever" it is more likely the diverger achieves as well as the converger because these two styles although independent are both important predictors of achievement.

In terms of the teacher, classroom climate appears to be highly dependent on their cognitive style. The strong dichotomy between the convergent-divergent classroom

points to the obvious effect of cognitive bias on classroom interaction. These results are further substantiated by significant interactions which support the earlier hypothesis of teachers showing a preference for students of similar cognitive styles. Although teachers did not indicate a preference for teaching students similar to them again, we attribute this result to the teachers' desire not to show any clear preference for one student over another. The interactions suggest that a new method of teacher, student, or classroom evaluation is necessary since a simple univariate approach does not project a clear indication of the "underlying" classroom processes. Towards this end, these interactions must be assessed in terms of their effects on a variety of educational outcomes other than teacher-student ratings and grades. For example, we are presently collecting writing samples which will be analyzed for originality and fluency. Thus, educational researchers must consider the classroom within the multivariate-interactive model. By no means are we trying to convince you that our type of cognitive bias is the only relevant one; instead we are suggesting that these results are provocative and probably important in terms of teacher-student interaction and student achievement.

TABLE 1

Correlation of Subtests and Total Score of Divergent Ability With Convergent Ability *

		Fluency					Originality					
		1	2	3	4	Tot	1	2	3	4	Tot	CON
	1		34	42	24	75	93	36	42	24	70	21
	2			29	19	70	34	79	30	18	56	23
Fluency	3				43	72	43	31	95	41	76	18
	4					62	24	26	40	94	62	09
	TOT						71	64	70	60	94	27
	1							36	44	25	74	16
	2								31	25	67	21
Originality	3									42	79	19
	4										65	10
	TOT											23

Subtest 1 - Unusual Uses

" 2 - Similarities

" 3 - Line Meanings

" 4 - Pattern Meanings

* Decimal points omitted

TABLE 2

Multiple Correlations of Criterion Scores with Convergent Ability and the Combined Convergent-Divergent Scores *

	Convergent	Convergent & Divergent
English Composition	.47	.59
Physics	.45	.53
Literature	.43	.55
Algebra	.41	.44
Geometry	.41	.44
French (written)	.40	.47
Mathematics	.39	.47
Biology	.35	.52
Chemistry	.35	.51
History	.33	.45
French (oral)	.21	.30

* All correlations significant at the 0.01

TABLE 3

Preferences of Cognitively Biased Teachers and Students on the LEI and TRF *

1. Teachers perception of Convergent versus Divergent biased students

Divergent	Convergent
Participation** Originality	

2. Students perception of Convergent versus Divergent biased teachers

Divergent	Convergent
Speed Friction Favoritism Apathy Disorganization	Goal Direction Satisfaction Competition

3. Cognitive Bias Interaction

Teacher judging student of same cognitive bias	Attention Achievement
Student rating teacher of same cognitive bias	Diverse Interests Democratic

* LEI - Learning Environment Inventory
TRF - Teacher Rating Form

** Main effects and interactions significant at the 0.05 level

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