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ABSTRACT

The relationships between vocational interests and cognitive skills were explored through a study of the measured interests and thinking skills of 63 eighth-grade students. Verified scores on the ACT Interest Inventory were correlated with logic, insight, divergent-thinking, and creative-thinking test scores as well as with scores on measures of IQ and achievement. Two patterns of relationship were found. On the one hand, interest in science correlated with logic, insight, IQ, and achievement. On the other, interest in the arts correlated with logic, divergent thinking, and creative thinking, but not with IQ or achievement. When IQ was controlled, first-order partial correlations between scientific interests and logic and artistic interests, logic, divergent thinking, and creative thinking remained significant. Although the size of correlations did not exceed previous findings, these contrasting intellectual profiles differed enough to warrant exploration of educational implications. (Five data tables are appended.) (Author/YLB)

Cognitive Skills and Vocational Interests of Intermediate Adolescents

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Running head: COGNITIVE SKILLS AND VOCATIONAL INTERESTS

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Abstract

The relationships between vocational interests and cognitive skills were explored through a study of the measured interests and thinking skills of 63 eighth-graders. Verified scores on the ACT Interest Inventory were correlated with logic, insight, divergent- and creative-thinking test scores as well as with scores on measures of IQ and achievement. Two patterns of relationship were found. On the one hand, interest in science correlated with logic, insight, IQ and achievement. On the other, interest in the arts correlated with logic, divergent thinking and creative thinking, but not with IQ or achievement. When IQ was controlled, first-order partial correlations between 1) scientific interests and logic, and 2) artistic interests and logic, divergent- and creative-thinking remained significant ($p < .05$). Although the size of correlations did not exceed previous findings, these contrasting intellectual profiles differed enough to warrant exploration of educational implications.

Cognitive Skills and Vocational Interests of Intermediate Adolescents

As long as vocational interests have been measured, relationships between occupational interests and cognitive abilities have been hypothesized. Correlations between interests and intelligence have typically been moderate, ranging from -.40 to .40, with positive correlations obtained between measures of scientific or linguistic interest on the one hand and general intelligence on the other (e.g., Strong, 1943, pp. 332-33). Investigations of specific aptitudes have been less common, with some findings supporting hypothesized relationships, while others not (e.g., Kelso, Holland & Gottfresdon, 1977; Super & Crites, 1962, pp. 401-403). What may be useful at this point is a study of the relationships between vocational interests and specific cognitive skills which is controlled for subjects' general intelligence and any response biases due to insincerity.

Holland's (1985) theory of vocational personalities was chosen as a point of departure for several reasons. First, the theory is well-known and can be related to several vocational interest measures. It can be easily understood and operationalized in terms of existing instruments. Second, it represents personality types in a two-dimensional image known as "Holland's hexagon" that appears to have some validity. Opposed vertices on the hexagon represent less strongly correlated traits and interests than do adjacent vertices. Third, the theory appears to be related to other constructs, such as the orthogonal arrangement of interests based on the distinctions of ideas/data and things/people suggested by Prediger (1981).

A cognitive skills theory developed by the author (Wakefield, in press) was used to help generate hypotheses systematically. This theory assumes that four cognitive skills can be arranged on the basis of distinctions related to problem finding and problem solving. Problem finding situations can range from problem recognition to problem invention (Dillon, 1982). Problem solving situations can range from factual to expressive. When these two distinctions are used as the basis for an orthogonal arrangement of cognitive skills, it is apparent that logic is a meaningful response to the problem recognition/factual solution situation; insight a response to the problem invention/factual solution situation; creative thinking a response to the problem invention/expressive solution situation; and divergent thinking a response to the problem recognition/expressive solution situation.

To generate hypotheses, the cognitive skills theory was superimposed over the hexagon so that the conventional type became associated with logic, the scientific type associated with insight, the artistic type associated with creative thinking, and the enterprising type associated with divergent thinking. Neither the hexagonal arrangement of vocational types nor the orthogonal arrangement of cognitive skills appeared to be distorted by the juxtaposition of the two theories. The correlations between four vocational interests and their associated cognitive skills thus became the principal hypotheses of the study.

Method

Subjects

Students at the end of junior high school were chosen as subjects for three reasons. First, a recent study has revealed that almost all adolescents think about what kind of work they will do in the future, with younger adolescents (12-13) thinking about their future careers about as often as older ones do (Offer, Ostrov & Howard, 1981, p. 150). At least two vocational interests (scientific and artistic) are known to have crystallized as early as the eighth grade

(Tyler, 1964). Second, a study of intermediate adolescents (14-15 year olds) might yield implications for high school curriculum in general, not just for the top grade levels, as might be the case had older adolescents (16-17) been tested. Third, a study of the thinking skills and vocational interests of older adolescents was planned and is currently in progress.

A total of 94 participants took the vocational interest inventory on the first day of testing, but only 63 completed all of the testing in good form and became subjects of the study (see Table 1). The attrition of

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Insert Table 1 about here

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participants was not regarded as excessive given the control for insincere responses, the need for three testing sessions, and the nature of the tasks. The 63 subjects were on the average 14.25 years old and were almost evenly divided between males (30) and females (33). Their eighth-grade Otis-Lennon SAI scores (an indication of general intelligence) ranged from 84 to 143, indicating that the subjects were generally average and above in intelligence.

Instruments and Measures

Permission was obtained from the American College Testing Program (ACT) to reproduce copies of the unisex edition of the ACT Interest Inventory for use in the study. The ACT Interest Inventory is a 90-item survey of interests in six areas corresponding to Holland's personality types (Lamb & Prediger, 1981). Interest areas (and their corresponding vocational types) are creative arts (artistic), social service (social), business contact (enterprising), business organization (conventional), technical (realistic), and scientific (investigative). This instrument was selected for its theoretical base, its appropriateness for eighth graders, its ease of administration and scoring, and its control for an insincere response set.

Scores are normally converted into percentiles appropriate for a grade level (in this case, grades 8-10), and these percentiles can be converted into stanines. When scores indicate an extreme bias in one of three response categories ("dislike," "indifferent," "like"), conversion into standard scores is not made, and the examinee is told that interests are unclear at this time. In this manner, response bias due to insincerity can be controlled.

According to information provided by the ACT, the criterion scores for designating unclear interests exclude 5% of a normal sample. These criteria were slightly redefined so that the top 2% of scorers in each response category (a total of 6 out of 94) were given an indication that their interests were unclear, and their scores were excluded from the study.

Four measures of cognitive skills were specifically designed for the study. The first (in order of presentation to the subjects) was a divergent-thinking test, which called for divergent associations in response to each of four ambiguous shapes or lines (an infinity sign, a spiral, and another shape and line). Subjects had four minutes to write down as many things as they could think of that each shape or line might be, for a total of 16 minutes of divergent-thinking response time. Since originality and other derived scores on divergent thinking tests appear to be strongly influenced by sheer number of responses (e.g., Clark & Mirels, 1970), only the fluency score was calculated. And since a significant sex difference was detected in fluency scores, scores of male subjects were corrected by multiple of 1.3 to establish sex equality. The alpha coefficient of the corrected scores was .84.

The second exercise was a creative thinking test, which called for subjects to design and respond to four of their own divergent-thinking items. More specifically, following the presentation of the first two divergent-thinking items, subjects were asked to draw an ambiguous shape of their own, and to write down as many things as they could that their whole drawing could be. In the next exercise, they were asked to join this shape with a different one, and write down as many new things as they could that the combined shapes could be. This procedure was repeated after the second two divergent-thinking items were presented, except that subjects were asked to draw ambiguous lines rather than shapes. Subjects were given four minutes on each of four creative-thinking items for a total of 16 minutes on task. A significant sex difference was detected in the creative-thinking fluency score, so male scores were multiplied by a factor of 1.5 to eliminate bias. The alpha coefficient of the corrected scores (.83) was essentially the same as the coefficient for divergent-thinking fluency.

The third exercise was an insight test, which was developed from puzzle items similar to those available in a number of recent sources (Gardner, 1978; Sternberg, 1986). The test consisted of 20 multiple-choice items which called for problem reformulation. Item #2, for example, read:

> A gumball machine has purple and green gumballs. Each gumball costs one cent. There are more green than purple gumballs. You want to be sure that you get two of the same color. How much money do you need?

Solutions were presented in multiple choice format (e.g., one cent, two cents, three cents, four cents), and subjects were given 16 minutes working time. The score was the number correct. Generally low scores and a low standard deviation limited the alpha coefficient (.35), so to determine if the scale might be reliable, it was administered to 26 teachers. Raw scores of the teachers ranged from 1 to 18, with a mean of 7.58 (SD 3.49). The somewhat higher and more variable scores of the teachers resulted in a stronger demonstration of scale reliability (alpha = .70).

The fourth exercise was a logic test, which called for recognition of two practice syllogisms and 40 test syllogisms as valid or invalid. Syllogisms were taken from measures for grades 7-12 published by the Instructional Objectives Exchange of the UCLA Center for the Study of Evaluation (1971). Twenty-four of the test items called for an understanding of conditional reasoning, two items for each of twelve principles of conditional logic. Sixteen of the items called for an understanding of class reasoning using eight principles of class logic. After _valid_ and _invalid_ were explained to subjects by way of two practice items, subjects were given 16 minutes working time. Once again, generally low scores seemed to limit the alpha coefficient (.45), so to determine if the scale might be reliable, it was administered to 28 teachers. Raw scores of the teachers ranged from 20 to 36, with a mean of 27.07 (SD 4.42). The somewhat higher and more variable scores of the teachers resulted in a stronger demonstration of scale reliability (alpha = .83).

In addition to these measures, scores on the Otis-Lennon School Ability Index (_N_ = 58) and the Stanford Achievement Tests (_N_ = 63) were available from a routine assessment of progress just two weeks before. The Otis-Lennon School Ability Index (SAI) has been commonly regarded as a measure of Spearman's _g_ factor of intelligence. The SAI has the statistical properties of a deviation IQ. Normal Curve Equivalent scores from the Mathematics, Science, Language and Reading subtests of the Stanford Achievement Tests were used as measures of achievement. The measures of SAI and achievement were used to validate the cognitive skills scores and to test exploratory hypotheses.

Procedures

Testing was timed to follow a general assessment of educational progress at the end of the eighth-grade year. Five eighth-grade English classes (including two accelerated classes) were oriented to the study and individuals were given the option not to participate. All chose to participate and receive vocational interest scores as a benefit of participation. The classes were then tested on three consecutive days. The first day, the subjects were given the ACT Interest Inventory. The second day, they were given the divergent-thinking and creative-thinking tests (each 20 minutes). The third day, they were given the insight and logic tests (each 20 minutes), and after testing was completed, they were given their interest inventory stanines, Holland codes, examples of appropriate careers, and a reference for further information.

Interest stanines, cognitive skill scores and other variables relevant to the study were then intercorrelated. Correlation coefficients for hypothesized relationships were tested for significance using one-tailed tests at the .05 level. All other correlation coefficients were tested for significance using two-tailed tests at the .05 level.

Results

Results bearing on the subject sample and the cognitive skills tests will be reported before the main findings, which confirmed two of the four central hypotheses. Means and standard deviations for the study variables are reported in Table 2. While interests of the

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Insert Table 2 about here

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subjects seemed to be skewed towards arts and science, all interest means were within half a standard deviation of the norm. Given the above-average intelligence and achievements of the group, their interests were about as expected.

Cognitive skills tests were correlated with each other and with SAI and measures of achievement to test their construct and concurrent validities. The results of intercorrelating the cognitive skills tests tended to confirm their construct validity (see Table 2). All of the tests intercorrelated about as expected from theory, with

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Insert Table 3 about here

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two exceptions. Divergent thinking and creative thinking were highly (.67) instead of marginally correlated, and somewhat surprisingly, divergent thinking was moderately correlated with insight (.37). To determine the effect of these correlations on the relationship between creative thinking and insight, divergent thinking was partialed out. The first-order partial correlation between creative thinking and insight remained significant (.26).

Further evidence of the validity of the cognitive skills tests was obtained by correlating these skills with performance on the IQ and achievement measures (see Table 4). Logic, which is a strong component of most IQ tests,

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Insert Table 4 about here

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correlated highly (.56) with the SAI and mathematics achievement, and moderately with all other measures of achievement. Insight, which may also be a component of intelligence, correlated moderately with SAI and mathematics achievement, and marginally with all other achievement areas. Divergent thinking correlated moderately with SAI and marginally with two areas of achievement (mathematics and language). Finally, despite its reliability, creative thinking correlated neither with intelligence nor with any area of tested achievement.

The results of correlating cognitive skills with vocational interests confirmed only two of the four central hypotheses (see Table 5), but some unexpected results

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Insert Table 5 about here

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combined with hypothesized results in two patterns. Interest in science correlated not only with insight as expected, but also with logic. Interest in the creative arts correlated not only with creative thinking, but also with divergent thinking and logic. What emerged from the statistical tests of relationships between cognitive skills and vocational interests were intellectual profiles of two vocational personality types, the scientifically- and the artistically-inclined student.

To control for the effect of intelligence, SAI was partialed out of the correlations between cognitive skills and scientific and artistic interests for a subsample of 58 subjects. Because of the significant correlation of intelligence with interest in science (.26), this procedure affected the profile of the scientifically-inclined student more than that of the artistically-inclined one. Still, when intelligence was controlled, the first-order partial correlation between scientific interest and logic remained significant (.30), as did the three partial correlations between artistic interest and the skills of logic (.27), divergent thinking (.34) and creative thinking (.36).

The only other relevant findings were marginal correlations between interest in science and achievements in mathematics (.24), science (.29) and language (.26). These correlations might have been predicted from earlier studies.

Discussion

The present study did not find correlations of greater magnitude than previous studies, and it did not find the pattern of correlations which was predicted, but it did find correlational patterns between cognitive skills and two vocational interests.[1] The scientifically-inclined student, whose thinking skills have been implied by previous studies, tends to do better on measures of IQ and school achievement than many peers. His or her most prominent intellectual skill of the four tested appears to be logic, but insight is a significant second. The artistically-inclined student on the other hand is more skillful at divergent thinking, creative thinking and logic than many peers, but does not stand out on tests of intelligence or achievement.

These two profiles are similar to ones found by Hudson (1966, 1968) in Great Britain, who explored the vocational implications of Guilford's (1967) distinction between convergent and divergent thinking. Hudson was able to distinguish two types of clever student. The "converger" excelled on intelligence tests, specialized in science or the classics, held conventional attitudes, had interests connected with mechanical things, and was emotionally inhibited. The "diverger" excelled at open-ended tests, specialized in the arts or in biology, held unconventional attitudes, had interests connected with people, and was emotionally uninhibited. He concluded that "such differences have implications for both the study of career choice and of originality" (1968, p. 1). These types are reflected in the profiles found in the present study, but the present study differs from Hudson's in its approach to the problem. Using vocational interests to distinguish types allows one to see the problem from a new angle.

The results of the present study differ from Hudson's in two respects. First, the results include logic in both patterns, not just in the intellectual profile of the scientifically-inclined student. A distinction must be made between intelligence and deductive logic. Because it is a thinking skill, logic can be taught, and there is no reason why it should not be taught in the arts as well as the sciences. Second, the results suggest that problem finding skills enter the picture, perhaps more clearly for the artistically-inclined student than for the scientifically-inclined one. Superficially, the insight and creative thinking tests were quite different, yet their scores were correlated even when the effect of divergent thinking (which was unexpectedly correlated with both) was controlled. Controlling for other variables would have had even less effect. There is some evidence in the data to support the problem-finding construct and its relation to vocational interests in both the arts and sciences.

Other results are noteworthy for their relationship to research on originality. Of particular significance is the intriguing correlation of artistic interest with both logic and creative thinking, yet the absence of a significant correlation between logic and creative thinking. This odd relationship has been discovered by several prominent researchers who have studied older adolescents and adults in artistic and scientific careers. Insightful and creative types are able to combine "the imaginative, personal, intuitive phase of subconscious thought and the controlled, consensual, analytic phase of conscious thought" (Getzels & Csikszentmihalyi, 1967). This combination appears to occur through the scientific or artistic personality, and not through some third cognitive construct, such as general intelligence (MacKinnon, 1960; Forisha, 1978).

There were several shortcomings in the present study, but most could be explained either through the nature of the tests (which in hindsight appear to have been oriented to ideas rather than data) or the need to continue to develop new measures of insight and creative thinking. Such shortcomings should not discourage continuing investigations of the complex relationships between cognitive skills and vocational interests, however, because only through an understanding of the complexities can recommendations be made about practice in the schools. Four recommendations are now tentatively advanced with the caveat that they require continuing educational research.

First, deductive logic needs to be taught throughout the arts and sciences. Currently, instruction in logic is entering the secondary curriculum through critical thinking skills, which include deduction as only one thinking skill in various theories of reasoning (Baron & Sternberg, 1987).

The results of the present study suggest that deductive logic in particular is a skill which exists in relation to IQ but which is not limited to IQ, so within limits, it may be teachable. As programs to teach logic develop, however, they also need to be assessed for their effectiveness, both apart from and in relation to particular content areas.

Second, insight can and perhaps should be taught (Davidson & Sternberg, 1984), especially through the mathematics curriculum. The present study found insight and mathematics achievement to be moderately related, and instructional strategies exist to develop "problem posing" skills in mathematics (Brown & Walter, 1983; in press). These strategies need to be integrated into the secondary mathematics curriculum. Insight exercises should eventually find their way into high school science curricula, but specific exercises will require continued monitoring for their relation to achievement in science.

Third, it is clear from the partial correlations that cognitive skills besides logic are associated with artistic interests. Expressive problem solving and problem finding both can be taught and are being taught through the English curriculum in many high schools. "Brainstorming," for example, is entering high school language arts textbooks by recommendation of the NCTE as a method to help students generate material for their assignments. Such exercises increase expressiveness in problem solving, but they do not teach students to find good problems. Good problems are always personally significant, and are found through intuition and imagination as much as through any rational skill. Use of such skills can be modeled (Getzels, 1985), and intellectual curiosity can be generally encouraged (Jones, 1981) in the arts as well as the sciences.

Fourth and finally, cognitive performance needs to provide feedback into career decisions. As adolescents move through the preparatory and exploratory stages of career development, they need to be challenged by courses which train vocationally-relevant cognitive skills as well as which develop knowledge bases. All too often grades only represent general ability to acquire facts. What is needed, especially in the arts and sciences, is increased emphasis on cognitive skills, especially among capable students, to provide increased guidance for career decisions. Only when grades reflect more than general ability to acquire facts do they become useful to the student faced with a decision about which course to take--and which to leave as the road not taken.[2]

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Footnotes

[1] A significant correlation was hypothesized between interest in business contact and divergent thinking, but the obtained correlation (.2095) was not statistically significant at the tested level when calculations were carried to four decimal places.

[2] cf. "The Road Not Taken" by Robert Frost.

Table 1

Participant Attrition

Group	Original Sample	Invalid Surveys	Incomplete Tests	Invalid Tests	Subject Sample
Male	47	(4)	(9)	(4)	30
Female	47	(2)	(7)	(5)	33
Total	94	(6)	(16)	(9)	63
Total%	100%	(6%)	(17%)	(10%)	67%

Numbers in parentheses represent losses of participants.

Table 2

Means and Standard Deviations for Study Sample (N = 63)

Score	Mean	SD
UNIACT Stanines		
Science	5.37	2.10
Creative Arts	5.59	1.92
Social Service	5.35	1.94
Business Contact	4.94	1.88
Business Organization	4.32	1.76
Technical	4.13	2.12
Cognitive Skills		
Logic	24.27	3.19
Insight	5.78	2.32
Creative Thinking	39.11	17.03
Divergent Thinking	36.71	12.56
Academic Achievement (NCEs)		
Mathematics	59.81	17.52
Science	57.51	15.19
Language	62.31	18.01
Reading	59.78	17.83
School Ability Index (IQ)[a]	113.38	14.99

[a] N = 58

Table 3

Intercorrelations of Cognitive Skills (N = 63)

	Logical	Insightful	Creative[a]	Divergent[a]
Logical	--	.40	.17	.24
Insightful		--	.42	.37[b]
Creative[a]			--	.67

Note: Underlined correlations are significant at the .05 level or above.

[a] Scores corrected for sex equality.

[b] Two-tailed test of significance.

Table 4

Correlations Between Cognitive Skills, School Ability and Achievement ($\underline{N}$ = 63)

Cognitive Skills	SAI[b]	Academic Achievement: Mathematics	Science	Language	Reading
Logical	<u>.56</u>	<u>.53</u>	<u>.45</u>	<u>.48</u>	<u>.49</u>
Insightful	<u>.47</u>	<u>.42</u>	<u>.27</u>	<u>.26</u>	<u>.26</u>
Creative[a]	.21	.19	.02	.10	.02
Divergent[a]	<u>.41</u>	<u>.35</u>	.23	<u>.28</u>	.24

Note: Underlined correlations are significant at the .05 level or above.

[a]Scores corrected for sex equality.

[b]Otis-Lennon School Ability Index ($\underline{N}$ = 58)

Table 5

Correlations Between Cognitive Skills and Vocational Interests (N = 63)

Cognitive Skills	Vocational Interests: Science	Arts	Service	B. Contact	B. Operation	Technical
Logical	.35	.29	-.15	-.05	-.06	.20
Insightful	.22[b]	.21	-.13	.04	.08	.06
Creative[a]	.15	.39[b]	.09	.23	.17	.13
Divergent[a]	.18	.40	.08	.21	.15	.18

Note: Underlined correlations are significant at the .05 level or above.

[a] Scores corrected for sex equality.

[b] One-tailed test of significance.