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THE FACTORS OF GENDER, ETHNICITY AND ACADEMIC ACHIEVEMENT AS PREDICTORS OF EARLY CAREER INTERESTS

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As Predictors of Early Career Interest

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THE FACTORS OF GENDER, ETHNICITY AND ACADEMIC ACHIEVEMENT AS PREDICTORS OF EARLY CAREER INTERESTS

By

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ABSTRACT

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There is an increasing concern about the labor shortage in the area of Science, Technology, Engineering, and Mathematics (STEM) in the workforce in U.S. The present study examined the issue by looking at the career interest development during adolescence. The study investigated how gender, race and academic performance are related to the early STEM career interests, the nature of the changes of these career interests, and how gender, race and academic performance accounted for these career interest changes. Archival assessment data of more than three thousand students from the Memphis City Schools were used in the study. The data contained students' academic performance scores and career interest rating scores when they were 8th graders and then 10th graders. The results of the study showed that gender, race and academic performance were all related to STEM career interests. However, no interaction effects were found among the three factors on STEM career interests. Furthermore, from grade 8 to grade 10, students experienced dramatic increases in the career interest of Technical, but didn't experience significant change in the career interest of Science and Technology. On the other hand, even though students did not show a significant change in the career dimension of Science and Technology, students who improved their academic performance in Science did exhibit a significant rating score increase in the career dimension of Science and Technology. Finally, for those students who improved their academic performance in Math, only males exhibited a significant increase in the career interests of both Technical and Science/Technology; and when students improved

their academic performance in Science, only males exhibited a significant increase in career interest of Technical.

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Introduction

Current Workforce in STEM Fields

There is broad consensus that the long-term key to continued U.S. competitiveness in an increasingly global economic environment is the adequate supply of a high-quality workforce in Science, Technology, Engineering, and Mathematics (STEM). Scientific innovation has produced roughly half of all U.S. economic growth in the last 50 years (National Science Foundation, 2004). The STEM fields and those who work in them are critical engines of innovation and growth; according to one recent estimate, while only about 5% of the U.S. workforce is employed in STEM fields, the STEM workforce accounts for more than fifty percent of the nation's sustained economic growth (Babco, 2004). However, a particular concern in this report was that there exists a serious worker shortage in STEM fields and the production of American scientists and engineers was low (RAND, 2006). The Business Roundtable (2005) warns that, if current trends continue, more than 90% of all scientists and engineers in the world will live in Asia. As a result of this labor shortage, the U.S. stands to lower its standard of living, reducing tax revenues, and weakening the domestic market for goods and services. Once this cycle accelerates, it will be difficult to regain lost preeminence in technology driven innovation and its economic benefits (Public Workforce System, 2007).

There might be multiple reasons for the existing problem of workforce shortage in STEM fields. For example, many students never make it into the STEM pipeline because of inadequate preparation in math and science, many who are academically qualified for postsecondary studies in science and math fields do not pursue those programs in colleges for various reasons, and many who are working in these fields are disappointed by the demanding workload and relatively low salaries in STEM fields compared to other professions, etc. (Public Workforce System, 2007).

Because career interest is one of the factors that determine an individual's career choice, it should be a reasonable way to examine the issue of workforce shortage in STEM fields by looking at the development of career interests for students, even before their high school years. More importantly, according to some research (Wimberly &Noeth, 2004), students start to have occupational interests as early as 8th grade, and there was relatively little change in these interests through 12th grade. Based on this, measuring and understanding occupational interests of middle and high school students can serve the goal as to provide useful information for the current issue in STEM fields.

Measuring Occupational Interests of High School Students

The goal of occupational interest measurement is to help people identify careers that they would enjoy in the future (for detailed information about career interest measurement, please see the following section). For high school students in particular, the transition from high school education to college and/or the world of work involves numerous and complex career decisions. Prediger (1974) suggested that, although vocational interest development is a continuous process, it occurs through a sequence of choices. Each choice involves a preparatory stage that ideally includes a period of exploration and information gathering as a prelude to the decision.

The idea that career decision making by high school students includes a period of exploration has important implications for the research on career interest inventories. The role of an interest inventory in career decision-making is twofold. First, the results of an interest inventory provide a description of the individual's interests, information that can facilitate self-exploration. Descriptive information may be used to help students understand themselves and to organize information about themselves and the world of work. The second major role of the interest inventory in educational and career decision making is to facilitate focused exploration of the world of work (Prediger, 1974). Focused exploration does not single out the specific college major or career choices for a person; rather, it intends to point to general areas for consideration. Because high school students cannot afford to explore and to keep all available options open forever, a major task for educators is to help them identify and explore personally relevant options. Thus, the research on career interest measurement can assist them in the focusing process of exploration.

History of Career Interest Measurement

Career interest was first defined by William James (1890) as a cognitive function of selecting and organizing an individual's experience. Kitson (1925) perceived the concept in terms of the psychological constructs of "identification" and "self". Bingham (1937) defined an interest as a tendency to become absorbed in an experience and to continue in it. Strong (1943) noted that interests "point to what the individual wants to do, they are a reflection of what he considers satisfying" (P.19). According to Holland (1973), vocational interests are simply another reflection of personality. In spite of the fact that there appears to be no consensus on the meaning of the construct of career interests, one theme common among these definitions is that they represent a constellation of relatively discrete likes and dislikes that lead to consistent patterns of behaviors (Hanson, 1974). The question is whether the concept of career interests is a useful tool for understanding the vocational and educational behavior of people.

Thurstone (1931) undertook the first major attempt to identify job-related interest dimensions through factor analyzing 18 occupational scales of the early Strong Vocational Interest Bank (SVIB) (Strong, 1927). He identified four major factors: Science, People, Language, and Business. Ten years later, using a larger number of scales from the SVIB, Darley (1941) identified six factors that he called Technical, Verbal, Business Contact, Welfare, Business Detail, and Certified Public Accountant. Strong (1943) found consistency in the same four dimensions or factors identified by Thurstone. Perhaps the most comprehensive study of vocational interest factors was conducted by Guilford (1954), who developed a 10-item interest scale and found 8 interest factors: Scientific, Social Welfare, Mechanical, Outdoor, Clerical, Business, Aesthetic Expression, and Aesthetic-Appreciation.

Super and Crites (1962) summarized the results of studies attempting to identify interest factors and concluded that the studies suggest the following major interest dimensions: Scientific, Social Welfare, Literary, Material, Systematic, Contact, and Aesthetic. The consistency with which these same factors continue to appear suggests that that there are some basic dimensions of vocational interest. These previous studies directly led to the work of Holland, who made significant contributions to career interest research through his development of the Vocational Preference Inventory (VPI, 1953), an instrument that was widely accepted and applied by other psychologists (Hanson, 1974). Holland presented his Interests Dimensions Model in 1966, systematically articulating career interest theory. Specifically, he theorized that career choices are largely a function of personal factors (e.g., personality traits, self-knowledge, occupational knowledge) and environmental factors (e.g., family, school). His model stimulated a period of rapid development and research in career interests, most of which are based on Holland’s theory.

The essential idea in Holland’s theory is that people can be characterized by their congruence with one of six personality types: Realistic, Investigative, Artistic, Social, Enterprising and Conventional. According to Holland (1966), the Realistic type prefers work that requires technical, mechanical, physical or athletic skill. The Investigative type is scientific, task-oriented, likes to learn, observe and analyze, and prefers to do work that requires abstract thinking and creative problem-solving. Those with an Artistic interest gravitate toward writing, music and art, as well as other forms of individual expression. The Social type encompasses interest in working with and serving people. The Enterprising type prefers leadership roles aimed at achieving economic objectives. Those with Conventional interests prefer a well-structured environment and chain of command, and tend to be followers rather than leaders. Holland, Whitney, Cole, and Richards (1969) depict all six types in a hexagonal arrangement, with those on the opposite sides of the hexogen being the least similar (see Figure 1).

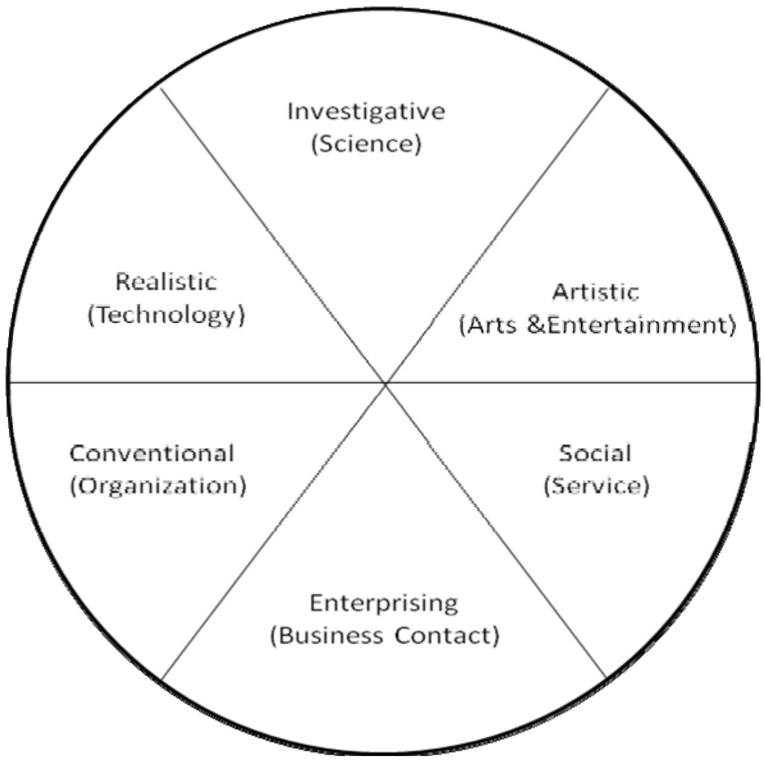

Figure 1: Circular Ordering of Holland and Roe Categories

Holland et al. (1969) addressed the possible implications of their hexagonal model for organizing occupations to facilitate counseling and exploration. Subsequently, Cole and Hanson (1971) reported findings indicating the generalizability of the hexagonal structure of the vocational interest for men. In their study, examination of several well known and widely used interest inventories (e.g., SVIB, Kuder, Minnesota Vocational Interest Inventory) revealed that the hexagonal arrangement of scales was supported in every instance. Later, Cole (1973) expanded the analysis of hexagonal interest structure to women and found the same circular configuration of interest for women.

The evidence from the accumulated research suggests that the interest dimensions proposed by Holland (Holland, 1966) provide a valid framework for describing the nature and structure of occupational interest. The universal finding that these basic interest dimensions are arranged in a circular fashion provides a definite structure for use in developing a new interest inventory.

Measuring Occupational Interest among High School Students: UNIACT Interest Inventory

Without broad occupational experiences, which few students have, how can they make informed career decisions? How do their preferences relate to the world of work? Although reasons for completing an occupational interest inventory vary, most people want to identify occupational fields or occupations in line with their everyday likes and dislikes.

The Unisex Edition of the ACT Interest Inventory (UNIACT) was introduced in 1977 (and revised in 1989) and is based on Holland's VPI model; it is intended to serve students in the early stages of career planning or re-planning (Discover Research Report, 2006). Its purpose is to identify personally relevant career options. UNIACT was designed to help students see the connection between the work world and the common, everyday things they like to do (Discover Research Report, 2006). UNIACT contains 15 items for each of its six scales— 90 items total—and uses a three-choice response format (dislike, indifferent, like). UNIACT is untimed and usually takes about 12–15 minutes to complete. UNIACT scale titles corresponding to Holland types are:

Science & Technology: Investigative.

Arts: Artistic.

Social Service: Social.

Administration & Sales: Enterprising.

Business Operations: Conventional.

Technical: Realistic.

UNIACT items emphasize work-relevant activities (e.g., fix a toy, conduct a meeting) that are familiar to students, either through participation or observation. Occupational titles and job duties are not used. As noted by Kuder (1977), the less accurate knowledge people have about various occupations, the more help they need with career planning. Interest inventories that use occupational titles or job duties may not help the people who need it most. UNIACT items were carefully chosen to minimize gender-related differences in responses. For example, item content avoids activities subject to gender-role stereotypes. This feature of UNIACT minimizes differences in the career options typically suggested to males and females by other interest inventories and permits the use of combined-sex norms.

Since its creation, numerous studies have employed the UNIACT for a variety of purposes. For example, Prediger (1991a) provided the most direct evidence of construct validity. The results of his study indicated that the relationships among UNIACT scales approximate Holland's hexagonal model. These relationships suggest that the scales are measuring the intended constructs, and that the dimensions measured are underlying Holland's hexagon, and the results provide a solid foundation for career exploration and planning. Some research (Discover Research Report, 2006) examined the test-retest reliability; the results indicated that, when using an average test-retest interval of 5.4 months, across the six scales, coefficients of reliability ranged from .68 to .78 (median of .75) for males, and from .69 to .82 (median of .78) for females. Also, some studies investigated the criterion-related validity, examined by finding the percentage of criterion group members who score highest on the scale appropriate to their group; that is, the “hit rate.” The most common method of determining criterion group membership is by identifying people with the same occupational choice, college major, or occupation. Thus, a biology major would be included in the Science & Technology (Holland’s I-type) criterion group and would be counted among the hits if his or her highest score were on the Science & Technology scale. The percentage of persons who are hits (the “hit rate”) is then computed for each of the Holland-type criterion groups. By chance alone, the hit rate is 17% (1/6). Hit rate results for UNIACT typically ranged from 31% to 55% and exceeded the chance rate of 17%.

To understand what facts the data reveal about the career interests for middle and high school students, Tracey, Robbins, and Hofsess (2005) investigated whether there was a relationship between students’ academic achievement and their career interests. They found that, although they certainly overlap, career interests and academic achievement appear to develop independently. That is, students may often have skills in an area in which they have little interest, or may be interested in an area in which they have few skills. To investigate whether students’ career interests are consistent with their college major and career choices, these authors found that students’ interests and choices are consistent. However, students’ career choices may not be consistent with current or future workforce demands. For example, more ACT-tested students express a desire to enter occupations in the visual, performing, and applied arts than there are jobs in these areas. In contrast, fewer students express a desire to enter occupations in areas such as law enforcement, record keeping, and nursing – career areas in which there are many available jobs.

Although the development of career interest has received increasing research attention for many years (Savickas & Spokane, 1999), it is surprising that the relation of academic skills to interests has received relatively little attention (Tracey, et al. 2005). Regarding the issue relating to what causes interest, the reigning model is the Social Cognitive Career Theory (SCCT) presented by Lent, Brown, and Hackett (1994). SCCT proposes that career choice is influenced by the beliefs the individual develops and refines through four major sources: a) personal performance accomplishments, b) vicarious learning, c) social persuasion and d) physiological states and reactions. How these aspects work together in the career development process is through a process in which an individual develops an ability for a particular endeavor and meets with success. This process reinforces one's self-efficacy or belief in future continued success in the use of this ability. In essence, the SCCT model proposes that ability affects self-efficacy, and self-efficacy affects interest.

Because the social cognitive career theory views academic progress as a developmental complement to career initiation and growth, and interest and skills formulated during school years shape career-related selection, it suggests that academic skills should be predictive of relevant career interest. Evidence from the application of some career interest measurements has been found to support this SCCT model. For example, Smith (2002) found that the mastery experience in information technology was a significant predictor of information technology interest of undergraduate students. However, little research has been conducted to investigate the degree to which academic skills are also predictive of early career interest development, e.g., the career interest of students in middle school, and junior and senior high school. As mentioned before, one study (Tracey, Robbins and Hofsess, 2005) focused on 8th graders and 12th graders and examined the relationship between these two factors. The authors reported that there was no relation between academic skills and subsequent interest for either 8th graders or 12th graders. In that study, they first hypothesized that science and math would relate to Investigative interest development, but results from their Structural Equation Model (SEM) analysis demonstrated that this relation was not present. However, there were two problems in the SEM model. First, math and science were treated as a single skill component and only one path was hypothesized to relate to Investigative (Science-Technology). Actually it is possible that only the ability in math or science will determine the career interest in Investigative dimension. Secondly, the model looked only at the effect of academic performance of students in grade 8 on the interest development of students in grade 10, and the effect of their academic performance in grade 10 on their interest development in grader 12. It might be the case that students' academic skills in grade 8 are related to their career interests in grade 8. Therefore it is necessary to examine the concurrent relationship between these two factors at the same time.

To summarize, the SCCT model proposes a relationship between academic skills and career interest, but different research evidence was found that both supported and challenged the theory. This situation triggers the proposed study to further investigate this issue.

Gender and ethnicity differences on career interest have been another big concern for researchers in the area of vocational behaviors. More specifically, a matter of increasing concern to educators and scientists is the relatively low number of scientists and engineers who are women or members of certain minority groups. Those two segments of the population, combined, comprised about only 6% of the nation's engineers and scientists (O'Brien, Martinez-Pons, and Kopala, 1992). Also, women and minorities will comprise 50% and 30% of the population, respectively, by the year 2010, requiring increased need to examine this group in light of the anticipated shortfall in the STEM professions (Gallagher, 1993). The reasons why only a small number of females and minorities currently work in the STEM fields are not clear. Numerous studies have been conducted to understand this issue, but those studies were primarily focused on adults. Only a few studies have examined whether or not there are gender or race differences in career interests during adolescence. The results of one study on the UNIACT career interest inventory demonstrated that females scored significantly higher than males on the Social, Artistic and lower on Realistic, and there were differences by ethnicity for each RIASEC dimension on Holland's model, except for Realistic (Tracey, et al. 2005). Using a different career interest survey, another study also found that male students rated quantitative and scientific occupations significantly higher than females (Oppler, 1993). To explain gender differences, researchers proposed that the socialization process provides a possible explanation (Oppler, 1993). In Western culture, females traditionally have been reinforced for more social, artistic and conventional behaviors. Males, on the other hand, scored significantly higher on the Realistic themes and related interests (e.g., Agriculture, Military), in accordance with differential socialization. To explain the ethnic differences, one theory proposed that ethnic identify is the central determining factor. Ethnic identity is defined as a clear understanding of one's ethnicity and valuing of one's ethnic membership (Phinney, 1992). Ethnic identify has been related significantly to general decision making processing and career goals. It is highly possible that aspects of ethnic identity may lower self-efficacy in mathematics, thus influence the career preference in science and engineering (Phinney, 1992).

Even though a few studies have used the UNIACT Interest Inventory to examine gender and ethnicity differences with respect to career preferences, no research has been done to examine whether or not other factors such as academic performance, will moderate or mediate gender and ethnicity differences on career interests. As mentioned above, research that investigated the factors that affect the career preferences considered only the relevant factors separately; therefore, they failed to reveal if there exist interaction effects among factors. As a result, the real factors that differentiate career interests may not be identified. This issue can be interpreted through the relationships among gender, ethnicity and academic performance. For instance, gender or ethnicity difference may exist when they are examined separately. However, they may disappear when considering the existence of academic performance. It is possible that the students who perform well in science or math courses are very likely to show interest in science and engineering, regardless of the gender or race.

Based on the issues mentioned above, the purposed archival study will first examine the relationships among gender, race and academic skills and the career interest preference among students in the 8th and, later, when they are in 10th grade. More specifically, the first research question is to investigate the differences of gender, race and academic skills on career interest, the interaction between gender and academic skills, and the interaction between race and academic skills. The test for an interaction effect is to examine whether or not the existence of academic performance will moderate the differences of gender and ethnicity on career interest preference among 8th through 10th graders. If gender and/or ethnicity differences exist regardless of academic performance in a certain subject, then career counselors and other educators should take into account this fact and make appropriate suggestions. If academic performance is indeed to relate the shifts in career aspirations, then gender and ethnic considerations are not important. More specifically, if academic performance relate to students' career preferences, more effort should be made to improve their performance in subject areas such as math and science in order to develop their career interest in the STEM area and encourage adolescents to explore beyond traditional, gender-typed and minority-typed occupations. The exploration of this issue will help educators, counselors and parents focus on the key intervening processes dealing with females and minority groups' low-rate of involvement in STEM careers.

In addition to the difference of gender, race, and academic skills and the interactions among these factors on career preferences, how the three factors are related to the stability and change of career interest during adolescence is another research concern in this area. Many career development theories address interest development over time. For example, researchers studying the construct of person-environment match (Assouline & Meir, 1987; Spokane, 1985) proposed that interests themselves evolve over time. Individuals, especially adolescents, are hypothesized to become more realistic with increasing age. However, most of the studies on career development focus on adults and little is known about career interest change of the early years. Thus, the second goal of the proposed study is to investigate the nature of changes in interest scores over time during adolescence and determine the degree to which gender, race and academic performance account for any changes in interest scores.

The information from the ACT test package provides a good opportunity to examine the relationships between academic performance and career preferences and development. Students are exposed to the UNIACT through two tests: the EXPLORE and PLAN. The EXPLORE and PLAN are specifically designed by American College Testing (ACT) for 8th grade and 10th grade students, respectively, for the purpose of measuring students' academic longitudinal development. The content of the two tests is similar to the ACT test. Both tests cover the subjects of English, Math, Reading, and Science. Generally, the English test measures conventions of standard written English and of rhetorical skills; the Mathematics test emphasizes solving practical quantitative problems; the Reading test measures reading comprehension as a product of referring and reasoning skills; and finally, the Science test measures scientific reasoning skills. When students take either

EXPORE in grade 8 or PLAN in grade 10, they also take the UNIACT interest inventory survey as part of the test protocol.

Based on the above discussion, nine hypotheses were generated for the proposed study:

H1: For both grades 8 and 10, there will be gender difference in STEM career interests, such that, male students will score higher in the dimensions of Realistic (Technical) and Investigative (Science/Technology) in UNIACT career interest measurement than female students.

H2: For both grades 8 and 10, there will be race difference in the two STEM career interests, such that, white students will score higher in the dimensions of Realistic (Technical) and Investigative (Science/Technology) than black students.

H3: For both grades 8 and 10, students in the top quartile in Math, Science, and Reading will score significantly higher in the dimensions of Realistic (Technical) and Investigative (Science/Technology) than those in the bottom three quartiles.

H4: For both grades 8 and 10, there will be an interaction effect between gender and academic performance, such that the gender difference on STEM career preferences will be mediated when students' scores in Math, Science, and Reading are taken into account.

H5: For both grades 8 and 10, there will be an interaction effect between race and academic performance, such that the race difference on STEM career preferences will become non-significant when students' scores in Math, Science, and Reading are taken into account.

H6: For both grades 8 and 10, there will be an interaction effect between gender and race, such that the gender difference on STEM career preferences will be mediated when students' race is taken into account.

H7: For students whose Math/Science/Reading test performance from 8^{th} to 10^{th} grade increases enough to move them into the fourth (upper) quartile, they will also exhibit a significant increase in the STEM career interests.

H8: For students whose Math/Science/Reading test performance from 8th to 10th grade increases enough to move them into the fourth quartile, only males, but not females, will exhibit a significant increase for the STEM career interests.

H9: For students whose Math/Science/Reading test performance from 8^{th} to 10^{th} grade increases enough to move them into the fourth quartile, only white students, but not black students, will exhibit a significant increase in STEM career interests.

Method

Participants

Archival student assessment data from the Memphis City Schools were used in the study. The data came from 3,092 students who took the Explore test in the 2006-07 school year when they were 8^{th} graders, and then took the PLAN test in the 2008-09 school year when they were 10^{th} graders. Of these students, there were 1,810 females and 1,282 males. The sample included: 2,557 African Americans (1,537 female), 252 Caucasian Americans (128 female), 55 Mexican Americans/Chicanos (25 female), 52 Asian Americans (33 female), and 176 others.

Measurements

The archival data included two parts, the first part contained students' academic performance scores in EXPLORE and PLAN for each of three subjects (Reading, Math, and Science) for the 8th and 10th grade administrations. The second part contained the information from the UNIACT Interest Inventory collected from the EXPLORE and PLAN tests during those two administrations. The score difference on career interest in each dimension between the EXPLORE and PLAN tests was used to conceptualize changes in career interests. There were six sets of scores from the six career dimensions representing the development of career interests from 8th grade to 10th grade. The range of possible scores of each subject on EXPLORE test was from 0 to 25, and the range of possible scores of each subject on PLAN test was from 0 to 32, respectively. Because the original scale scores for each academic subject were different for the two years, the percentage rank among students (based on the whole Memphis City School District) for each raw score was used throughout the study.

To test for academic performance differences in career interest, the students' scores were coded into two levels, with scores equal to or greater than the 75th percentile (upper quartile) being considered as belonging to the high performance group and percentiles less than 75 (lower three quartiles) as belonging to the low performance group. To test for the degree of relationship between increases in academic performance and movement toward a STEM career interest, the analysis included only students who experienced score changes from below 75th percentile to above 75th percentile from 8th to 10th grade on the subject of Reading, Math, and Science.

Results

Results for Hypothesis 1:

Hypothesis 1 stated that for both grades 8 and 10, there would be a gender difference in STEM career interests, such that male students would score higher in the dimensions of Technical (Realistic) and Science/Technology (Investigative) in UNIACT career interest measurement than female students. The results of the Univariate analysis about the main effect of gender were presented in Table 1 below. Note that the interaction effect was tested first and, because the interaction effect was not significant, the significance of the main effect then was reported.

Table 1

Results of Hypothesis 1: Gender Difference on STEM Career Interests

Career Interest	Grade	Gender	*N*	*M*	*SD*	*F*
Technical	8th	Male	1282	55.00	29.97	64.7*
		Female	1810	45.76	28.53	
	10th	Male	1282	62.45	26.74	130.4*
		Female	1810	50.25	27.05	
Science & Technology	8th	Male	1282	59.18	28.65	3.39*
		Female	1810	57.52	28.71	
	10th	Male	1282	60.23	25.21	7.86*
		Female	1810	57.58	26.12	

Note: “*” means that the *F* ratio was significant ($p < .05$).

As can be seen from Table 1, for both grade 8 and grade 10, there was a significant gender difference on STEM career of Technical and

Science/Technology. The rating scores of males were significantly higher than those of females. Thus, Hypothesis 1 was confirmed.

Results for Hypothesis 2:

Hypothesis 2 stated that, for both grades 8 and 10, there would be a race difference in the two STEM career interests, such that white students would score higher in the dimensions of Technical (Realistic) and Science/Technology (Investigative) than black students. The results of the Univariate analysis to examine this hypothesis were presented in Table 2. The interaction effect was tested first and, because the interaction effect was not significant, the significance of the main effect of race then was reported.

Table 2

Results for Hypothesis 2: Race Difference in STEM Career Interests

Career Interest	Grade	Gender	*N*	*M*	*SD*	*F*
Technical	8th	White	252	55.76	28.93	5.17*
		Black	2557	48.77	29.54	
	10th	White	252	55.93	27.27	4.42*
		Black	2557	53.57	27.77	
Science & Technology	8th	White	252	58.53	28.56	3.58*
		Black	2557	56.29	28.63	
	10th	White	252	58.03	25.66	6.81*
		Black	2557	56.92	26.43	

Note: "*" means that the *F* ratio was significant ($p < .05$).

As can be seen from Table 2, for both grade 8 and grade 10, there was race difference on STEM career of Technical and Science/Technology. The rating scores of white students were significantly higher than those of black students, confirming Hypothesis 2.

Results for Hypothesis 3

Hypothesis 3 stated that, for both grades 8 and 10, students in the top quartile in Reading, Math and Science would score significantly higher in the dimensions of Technical (Realistic) and Science/Technology (Investigative) than those in the bottom three quartiles. The results of the Univariate analysis examining this hypothesis were presented in Table 3 and Table 4. As mentioned before, the interaction effect was tested first and, because the interaction effect was not significant, the significance of the main effect of academic performance then was reported.

Table 3

Results of Hypothesis 3: Academic Performance Difference on STEM Career Interest of Technical

Career Interest	Grade	Academic	*N*	*M*	*SD*	*F*
Technical	8th	Reading High	1046	51.00	29.40	16.07*
		Reading Low	2046	45.52	29.48	
	10th	Reading High	1015	57.44	27.33	42.04*
		Reading Low	2077	50.63	27.55	
Technical	8th	Math High	1310	51.29	29.47	4.15*
		Math Low	1782	48.39	29.51	
	10th	Math High	1379	56.80	27.28	12.84*

Table 3 (Continued)

Results of Hypothesis 3: Academic Performance Difference on STEM Career Interest of Technical

Career Interest	Grade	Academic	*N*	*M*	*SD*	*F*
		Math Low	1713	53.20	27.84	
Technical	8th	Science High	1309	50.34	29.71	4.53*
		Science Low	1783	48.32	29.17	
Technical	10th	Science High	1009	56.25	27.49	9.11*
		Science Low	2083	53.06	27.66	

Note: "*" means that the *F* ratio was significant ($p < .05$).

Table 4

Results of Hypothesis 3: Academic Performance Difference on STEM Career Interest of Science &Technology

Career Interest	Grade	Academic	*N*	*M*	*SD*	*F*
Science & Technology	8th	Reading High	1046	60.63	29.59	7.15*
		Reading Low	2046	57.71	28.24	
	10th	Reading High	1015	59.39	27.20	4.29*
		Reading Low	2077	57.26	25.05	
Science & Technology	8th	Math High	1310	61.26	29.06	18.08*
		Math Low	1782	56.82	28.35	
	10th	Math High	1379	59.76	26.44	4.78*
		Math Low	1713	57.72	25.19	

Table 4 (Continued)

Results of Hypothesis 3: Academic Performance Difference on STEM Career Interest of Science &Technology

Career Interest	Grade	Academic	*N*	*M*	*SD*	*F*
Science & Technology	8th	Science High	1309	61.89	28.45	28.22*
		Science Low	1783	56.36	28.73	
	10th	Science High	1009	60.35	27.25	6.67*
		Science Low	2083	57.80	24.99	

Note: "*" means that the *F* ratio was significant ($p < .05$).

As can be seen from Table 3 and Table 4 above, there were academic performance differences associated with STEM career interests. Students with high performance in Reading, Math and Science had significantly higher rating scores in the career dimensions of Technical and Science/Technology than students with low performance in these subject areas. Therefore, Hypothesis 3 was confirmed.

Results for Hypothesis 4

Hypothesis 4 stated that, for both grades 8 and 10, there would be an interaction effect between gender and academic performance, such that the gender difference on STEM career preferences would diminish when students' scores in Reading, Math, and Science were taken into account. The results of the Univariate analysis examining this hypothesis are presented in Table 5. Each independent variable exhibited a main effect when the full model was tested.

Table 5

Results for Hypothesis 4: Interaction Effects Between Gender and Academic Performance on STEM Career Interests

Career Interest	Interaction	Grade 8 *F*	Grade 10 *F*
Technical	Gender x Reading	.16	.49
	Gender x Math	.60	.12
	Gender x Science	1.79	.36
Science & Technology	Gender x Reading	2.11	1.51
	Race x Math	1.99	.94
	Gender x Science	3.69	1.45

As Table 5 indicates, no interaction was found between gender and academic performance for either STEM career interest. Thus, Hypothesis 4 was rejected.

Results for Hypothesis 5

Hypothesis 5 stated that for both grades 8 and 10, there would be an interaction effect between race and academic performance, such that the race difference on STEM career preferences would diminish when students' scores in Reading, Math and Science were taken into account. The results of the Univariate analysis examining this hypothesis were presented in Table 6. Each independent variable exhibited a main effect when the full model was tested.

Table 6

Results for Hypothesis 5: Interaction Effects Between Race and Academic Performance on STEM Career Interests

Career Interest	Interaction	Grade 8 *F*	Grade 10 *F*
Technical	Race x Reading	.85	.80
	Race x Math	1.55	2.77
	Race x Science	1.09	1.81
Science & Technology	Race x Reading	2.7	1.37
	Race x Math	1.39	1.94
	Race x Science	2.85	1.89

As Table 6 reveals, there was no interaction effect between race and academic performance; therefore, Hypothesis 5 was rejected.

Result for Hypothesis 6

Hypothesis 6 stated that, for both grades 8 and 10, there would be an interaction effect between gender and race, such that the gender difference on STEM career preferences would diminish when students' race was taken into account. The results of Univariate analysis examining this hypothesis are presented in Table 7. Each independent variable exhibited a main effect when the full model was tested.

Table 7

Result for Hypothesis 6: Interaction Effects Between Gender and Race on STEM Career Interests

Career Interest	Interaction	Grade 8	Grade 10
		F	*F*
Technical	Gender*Race	.69	.98
Science & Technology	Gender*Race	1.33	1.57

AS Table 7 indicates, there was no interaction effect between gender and race on STEM career interests; therefore, Hypothesis 6 was disconfirmed.

Results for Hypothesis 7

Hypothesis 7 stated that, for students whose Reading /Math/Science test performance from 8^{th} to 10^{th} grade increased enough to move them into the fourth (upper) quartile, they would also exhibit a significant increase in the STEM career interests. The results of Paired Samples t Tests are presented in Tables 8 through 11.

Table 8

Results of Paired Samples t Tests for all students.

Interest	Grade	*N*	*M*	*SD*	*t*
Technical	8th	3092	49.48	29.49	10.45*
	10th	3092	55.21	27.58	
Science & Technology	8th	3092	58.7	28.7	.13
	10th	3092	59.6	25.7	

Note: “*” means that the *t* value was significant (p<.05).

Table 9

Results of Paired Samples t Tests for Those Whose Reading Scores Changed from Below to Above the 75th Percentile

Interest	Grade	*N*	*M*	*SD*	*t*
Technical	8th	262	49.81	28.83	2.30*
	10th	262	50	27.07	
Science &	8th	262	61.03	28.45	.72
Technology	10th	262	56.41	26.95	

Note: "*" means that *t* value was significant ($p < .05$).

Table 10

Results of Paired Samples t Tests for Those Whose Math Scores Changed from Below to Above the 75th Percentile

Interest	Grade	*N*	*M*	*SD*	*t*
Technical	8th	370	50.54	29.29	2.91*
	10th	370	54.95	28.05	
Science &	8th	370	58.98	27.59	.56
Technology	10th	370	59.06	25.92	

Note: "*" means that *t* value was significant ($p < .05$).

Table 11

Results of Paired Samples t Tests for Those Whose Science Scores Changed from Below to Above the 75th Percentile

Interest	Grade	*N*	*M*	*SD*	*t*
Technical	8th	264	51.50	29.70	2.29*
	10th	264	58.34	29.66	
Science &	8th	264	57.12	29.66	2.60*
Technology	10th	264	58.34	27.33	

Note: "*" means that *t* value was significant ($p< .05$).

Tables 8-11 indicate that, from grade 8 to grade 10, when the student data are taken as a whole, they demonstrated a significant rating score increase in the career dimension of Technical, $t = 10.45$, $p < .01$. No significant score increase was found in the career dimension of Science and Technology. However, for those students whose Science scores changed from below the 75th percentile to above the 75th percentile, there was a significant increase in the career interest of Science and Technology, $t = 2.60$, $p < .01$. The results partially confirmed Hypothesis 7.

Results for Hypothesis 8

Hypothesis 8 stated that, for students whose Reading/Math/Science test performance from 8th to 10th grade increased enough to move them into the fourth quartile, only males would exhibit an increase in the STEM career interests. The results of Paired Samples t Test for this hypothesis are presented in Table 12.

Table 12

Results of Paired Samples t Tests for Those Whose English Scores Changed from Below to Above the 75th Percentile, Grouped by Gender

Interest	Gender	*N*	Grade	*M*	*SD*	*t*
Technical	Male	100	8th	55.14	28.41	.59
			10th	56.72	26.33	
	Female	162	8th	45.56	28.46	.45
			10th	46.04	26.75	.21
Science & Technology	Male	100	8th	55.42	28.01	1.76
			10th	60.50	26.91	
	Female	162	8th	56.69	28.77	1.89
			10th	60.99	27.00	

Table 13

Results of Paired Samples t Tests for Those Whose Math Scores Changed from Below to Above the 75th Percentile, Grouped by Gender

Interest	Gender	*N*	Grade	*M*	*SD*	*t*
Technical	Males	162	8th	56.19	29.10	4.09*
			10th	64.65	25.93	
	Females	208	8th	46.38	28.98	.45
			10th	47.36	27.54	
Science & Technology	Males	162	8th	55.41	26.66	2.35*
			10th	60.96	24.68	
	Females	208	8th	57.54	28.29	1.78
			10th	60.66	26.96	

Note: "*" means that *t* value was significant ($p < .05$)

Table 14

Results of Paired Samples t Tests for Those Whose Science Scores Changed from Below to Above the 75th Percentile, Grouped by Gender

Interest	Gender	*N*	Grade	*M*	*SD*	*t*
Technical	Males	102	8th	56.88	29.78	2.04*
			10th	62.80	28.28	
	Females	162	8th	48.17	29.44	1.24
			10th	50.94	27.04	
Science & Technology	Males	102	8th	55.95	31.29	.33
			10th	56.86	28.73	
	Females	162	8th	57.40	28.78	1.13
			10th	*58.98*	*26.63*	

Note: "*" means that *t* value was significant ($p < .05$).

As the above tables indicate, there was a gender difference with respect to the movement toward both Technical and Science & Technology dimensions. When Math scores increased to above the 75th percentile, only the males exhibited a significant increase in the career interest of Technical (*N* = 162, *t* = 4.09, *p* < .01) and Science & Technology (*N* = 100, *t* = 2.35, *p* < .05). There was gender difference on the change of Technical dimension when Science score changed, which was, from grade 8 to grade 10, when students' Science score changed from below 75 percentile to above 75 percentile, only male students (*N* = 102) exhibited significant increase in the career interest of Technical, *t* = 2.04, *p* < .05. Therefore, these results partially confirmed Hypothesis 8.

Results for Hypothesis 9

Hypothesis 9 stated that for students whose Reading/Math/Science test performance from 8th to 10th grade increased enough to move them into the fourth quartile, only white students would exhibit significant increase for the STEM career interests. The results of Paired Samples t Test for this hypothesis were presented in Table 15 to Table 16.

Table 15

Results of Paired Samples t Tests for Those Whose English Scores Changed from Below to Above the 75th Percentile, Grouped by Race

Interest	Race	*N*	Grade	*M*	*SD*	*t*
Technical	White	34	8th	51.56	30.86	2.01
			10th	62.00	29.93	
	Black	211	8th	46.98	28.98	.45
			10th	47.36	27.54	
Science & Technology	White	34	8th	57.28	23.21	.25
			10th	59.17	26.27	
	Black	211	8th	55.61	29.29	1.17
			10th	57.01	27.15	

Table16

Results of Paired Samples t Tests for Those Whose Math Scores Changed from Below to Above the 75th Percentile, Grouped by Race

Interest		*N*	Grade	*M*	*SD*	*t*
Technical	White	29	8th	41.00	33.27	1.72
			10th	57.86	23.90	
	Black	325	8th	50.66	29.24	1.44
			10th	52.69	28.59	
Science & Technology	Whit	29	8th	49.50	30.52	.83
			10th	55.86	25.77	
	Black	325	8th	58.30	27.37	.48
			10th	59.12	25.75	

Table17

Results of Paired Samples t Tests for Those Whose Science Scores Changed from Below to Above the 75th Percentile, Grouped by Race

Interest		*N*	Grade	*M*	*SD*	*t*
Technical	White	25	8th	61.64	24.06	.44
			10th	64.64	23.65	
	Black	229	8th	50.52	29.87	1.75
			10th	53.29	28.14	
Science & Technology	White	25	8th	56.64	18.79	.15
			10th	57.82	25.74	
	Black	229	8th	55.38	27.14	.96
			10th	57.18	27.59	

The results presented in the above tables show that, when students' academic performance in Reading/Math/science improved from low to high, neither white students nor black students showed significant changes in rating scores in STEM career interests. Therefore, Hypothesis 9 was rejected.

Discussion

The first research focus (including Hypotheses 1-6) was to investigate the gender difference, race difference and the academic performance difference on early STEM career interests, and the interaction effects of the three factors on these career interests. The results supported the first three hypotheses, which stated that, for both grade 8 and grade 10, there existed a gender difference, race difference and academic performance difference on early STEM career interests. Generally speaking, male students scored significantly higher than female students in career dimensions of Technical and Science/Technology, white students scored significantly higher than black students in these two dimensions, and students with high performance (above 75th percentile) in the subjects of Reading, Math, and Science scored significantly higher in these two dimensions than students with lower performance (below 75th percentile) in these three subjects. The results of the gender and race differences in the present study are consistent with those reported in many other previous studies. The differences in academic performance on early STEM career interests supported the Social Cognitive Career Theory proposed by Lent, et al. (1994), who suggested that academic performance should be predictive of career interest. As mentioned earlier, among limited studies that examined the relationship between academic performance and career interests during adolescence, some research evidence was found to confirm the relationship between these two factors, such that, the higher performance in a certain academic subject, the greater interest in the relevant career area. However, some researchers did not find evidence for this relationship. Because there was prior research evidence that both supported and challenges the SCCT theory (Lent, et al. 1994), the results of current study provided more evidence to support SCCT model.

It was also hypothesized that interaction effects exist between gender and academic performance, between race and academic performance, and between gender and race. For example, gender and race differences would be moderated or mediated by academic performance, which meant, when students scored high in English, Math, and Science, they would be equally interested in the STEM career interests of Technical and Science/Technology, regardless of their gender and race identity. However, no evidence was found in the present study to confirm these expectations. Rather, gender and race differences still existed when academic performance was taken into account.

The second research focus of the present project (including Hypotheses7-9) was to investigate the nature of the career interest changes from grade 8 to grade 10 and how gender, race and academic performance accounted for these changes. Overall, the evidence with regard to changes in STEM career interests was mixed; when students were taken as a whole, they demonstrated a significant change toward the Technical career interest. However, they did not show a significant change in the Science and Technology career interest. Given that most developmental theories of career interest development proposed that career interest changes over time, the mixed results on career interest change in the present study were unexpected. Rather, they suggested that more theoretical models should be created to deal specifically with career interest development during adolescence.

With respect to changes from grade 8 to grade 10, the results of this study indicated that students did not show a significant change in Science and Technology career dimension. However, when they improved the academic performance in Science from low to high, they did show significant score increases in the Science and Technology career dimension. This result partially confirmed the 7th Hypothesis, which stated that, for those students whose academic performance in Science/Math/Reading increased enough to move them into the fourth quartile, they would also exhibit a significant increase in STEM career interests.

To some extent, a gender difference was found to account for the change of STEM career interests. When students' performance in Math improved from low to high, only male students exhibited a significant movement toward Technical and Science & Technology career interests. When students' performance in Science improved from low to high, only male students demonstrated significant movement toward the Technical career interest. These results partially confirmed the 8th hypothesis, which stated that, for students whose academic performance in Science/Math/Reading improved enough to move them into the upper quartile, only males would exhibit a significant rating increase in STEM career interests. However, it should be mentioned that from grade 8 to grade 10, for the group of female students who improved academic performance in Math and Science, they consistently showed a trend toward increased interests in the career dimensions of Technical and Science/Technology.

The results of this study have important implications for practice and research. Because evidence was found for gender, race, and academic performance differences in STEM career interests, parents, career counselors and other educational professionals should acknowledge this fact and make additional efforts to encourage more female and black students to develop career interests in the Technical and Science/Technology domains. On the other hand, because academic performance is related to career interests, increased emphasis should be placed upon strategies for improving students' performance in Math, Science, and Reading as a way to strengthen their career interests in the Technical and Science/Technology domains. Furthermore, because it was found that, when students' academic performance in Math or Science improved, only male students demonstrated changes in STEM career interests, it may be that a focus on improving academic performance as a way to strengthen STEM career interests would not necessarily impact the career choices of female students. In order to change the level of STEM career interests for female students, more effective intervention programs concerning career interests and choices should be considered.

Additionally, future research should examine some other social factors, such as parents' careers and the family's economic status, in order to provide a comprehensive view of factors associated with career interest development during adolescence. On the other hand, for the same group of students included in the current study, when they are 12th graders, it will be interesting to collect more data, including their subsequent major and academic achievement. Such research would contribute to our understanding of how interests change from grade 8, through high school seniors and into college.

No study comes without limitations and this study is no exception. For instance, there is an issue regarding the representativeness of sample size. For either grade 8 or grade 10 in the Memphis City Schools, there should be over eight thousand students attending the school; however, the data in this study included only about three thousand students because they were the ones who provided the complete set of information required by the study. Because we are not sure why the relevant information of other students excluded from the study is not available, accordingly we are not sure if the sample size of the current study is representative of other students who did not participate in the study.

Secondly, there is an issue about the external validity or generalizability of the research results in the study. Due to the fact that the academic performances of students in Memphis City Schools rank lower than most of the school districts across the nation, even without the first limitation mentioned above, we are still not sure if the study results can be generalized to the whole broad population of the nation.

Conclusion

The results of this study revealed that gender, race and academic performance were all related to early career interests related to the Technical and Science/Technology domains. Male students showed significantly greater interest in these two career interest dimensions than female students, white students showed greater interest than black students, and students with high performance in Math, Science and Reading showed greater interest than students with low performance in these three academic subjects. The results also indicated that, from grade 8 to grade

10, students' career interest in the Technical domain increased dramatically, whereas their career interest in Science and Technology did not show significant changes. On the other hand, even though students did not move toward career interests in Science and Technology when they improved their academic performance in Science from low to high, this group of students did demonstrate a significant increase in this career interest. Finally, when students improved their academic performance in Math, only males exhibited a significant increase in the career interest of Technical and Science & Technology; and when students improved their academic performance in Science, only males exhibited a significant increase in the career interest of Technical.

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Appendix

The UNIACT Interest Inventory

(Version for College Students and Other Adults)

THE PURPOSE

- to find out what your interests are and to be able to "translate" these into possible occupations
- to shorten the time needed to complete the Inventories section

THE TASK

The things you like to do now can help you identify occupations to explore. First, consider whether you would like or dislike doing each of the activities listed below, not your ability to do it. For each of the 90 activities, use the following key:

Circle your choice: **L** - If you would **LIKE** the activity. **I** - If you are **INDIFFERENT** (don't care one way or the other) about the activity. **D** - If you would **DISLIKE** the activity.

There are three choices for each activity, but try to circle "like" (L) or "dislike" (D) for as many activities as possible. Do all six parts. Do not fill in the boxes at the bottom of each column until you have finished all six parts. Further directions will be given later

PART A			
L	I	D	Study biology
L	I	D	Read about the origin of the earth, sun, and stars
L	I	D	Use a microscope or other lab equipment
L	I	D	Study the causes of earthquakes
L	I	D	Attend the lecture of a well-known scientist
L	I	D	Study plant diseases
L	I	D	Learn how the brain works
L	I	D	Learn about star formations
L	I	D	Explore a science museum
L	I	D	Study the effects of vitamins on animals
L	I	D	Learn how birds migrate
L	I	D	Read about a new surgical procedure
L	I	D	Observe and classify butterflies
L	I	D	Study the wildlife in a pond or lake
L	I	D	Use personal observations to predict the weather
			Scores for Part A

PART B			
L	I	D	Compose or arrange music
L	I	D	Write a movie script
L	I	D	Prepare drawings to illustrate a magazine story
L	I	D	Write reviews of Broadway plays
L	I	D	Play jazz in a combo
L	I	D	Write short stories
L	I	D	Compose theme music for movies
L	I	D	Design a metal sculpture
L	I	D	Play in a band
L	I	D	Make creative photographs
L	I	D	Design sets for a play
L	I	D	Read about the writing style of modern authors
L	I	D	Sketch and draw pictures
L	I	D	Select music to play for a local radio station
L	I	D	Act in a play
			Scores for Part B

PART C			
L	I	D	Work on a community improvement project
L	I	D	Help rescue someone in danger
L	I	D	Take part in a small group discussion
L	I	D	Help settle an argument between friends
L	I	D	Work on a project with others
L	I	D	Help people during emergencies
L	I	D	Show children how to play a game or sport
L	I	D	Give directions to visitors
L	I	D	Counsel people who use drugs
L	I	D	Find out how others believe a problem can be solved
L	I	D	Give first aid to an injured person
L	I	D	Teach people a new hobby
L	I	D	Give a tour of an exhibit
L	I	D	Help someone make an important decision
L	I	D	Entertain others by telling jokes or stories
			Scores for Part C

PART D			
L	I	D	Plan work for other people
L	I	D	Manage a new sales campaign
L	I	D	Hire a person for a job
L	I	D	Work on a city council
L	I	D	Promote the opening of a new shopping center
L	I	D	Manage a small business
L	I	D	Interview workers about company complaints
L	I	D	Develop new rules or policies
L	I	D	Make business trips
L	I	D	Conduct a meeting
L	I	D	Explain legal rights to people
L	I	D	Read business magazines or newspapers
L	I	D	Campaign for a political office
L	I	D	Conduct business by phone
L	I	D	Assist people making financial decisions
			Scores for Part D

PART E			
L	I	D	Calculate the interest on a loan
L	I	D	Keep expense account records
L	I	D	Prepare income tax returns
L	I	D	Find errors in a financial account
L	I	D	Set up a bookkeeping system
L	I	D	Prepare and interpret financial statements
L	I	D	Figure shipping costs for catalog orders
L	I	D	Take inventory in a store
L	I	D	Handle money transactions
L	L	D	Look for errors in the draft of a report
L	I	D	Sort, count, and store supplies
L	I	D	Collect installment payments
L	I	D	Prepare a budget for a service, civic, or similar group
L	I	D	Make charts or graphs
L	I	D	Plan a monthly budget
			Scores for Part E

PART F			
L	I	D	Build a picture frame
L	I	D	Pack things into boxes
L	I	D	Adjust a clock to keep accurate time
L	I	D	Build furniture
L	I	D	Learn to cut and polish gemstones
L	I	D	Operate electronic equipment
L	I	D	Watch a technician repair a television
L	I	D	Engrave lettering or designs on a trophy or plaque
L	I	D	Design a bird feeder
L	I	D	Grind lenses for eyeglasses
L	I	D	Write instructions on how to operate a machine
L	I	D	Assemble a cabinet from written instructions
L	I	D	Watch for forest fires
L	I	D	Inspect products for defects
L	I	D	Repair damage to a tree after a storm
			Scores for Part F

Next, tally your scores. Begin with Part A. Count the number of L's you circled and enter the total in the box beneath the L column. Then enter the number of I's you circled in the box beneath the I column, and the number of D's in the box beneath the D column. Do the same for Parts B-F.

Enter the scores you wrote down for Parts A through F in the appropriate boxes below. Use two digits for all the numbers (for example, enter 01 for 1, 06 for 6, etc.). The total for the three columns (L's, I's, and D's) should be 15 for each of the six parts. Check the total for each part, and if it is not 15, recount your answers.

	L	I	D	
Part A				= 15
Part B				= 15
Part C				= 15
Part D				= 15
Part E				= 15
Part F				= 15

THE NEXT STEPS

Enter these UNIACT scores into DISCOVER by following these steps.

- From the DISCOVER Home page, select "Inventories."
- Select "Interest Inventory" from the menu bar.
- Select "Interest Inventories Taken On Paper."

Select "UNIACT from Printed Form."

Enter your scores from Parts A - F.