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In this issue:

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Are High School Students Avoiding the Information Technology Profession Because of the Masculine Stereotype?

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Abstract

While there are numerous factors influencing a choice in a major area of study, preconceptions or stereotypical views about members of occupations may impact a student's decision to enter a particular field. The purpose of this study is to determine current perceptions of high school students regarding the personality traits of computer specialists. A Personality Factor (PF) Questionnaire is used to collect data. T-tests are then used to identify perceived personality traits of computer specialists. A data mining tool is also used to analyze data clusters. Comparisons are made between these two approaches. Results of the study suggest that high school students view the technology professional as emotionally stable, intelligent, tough-minded, secure and satisfied with themselves. They are also seen as males.

Keywords: stereotype, domain identification, personality, computer specialist, data mining, gender

1. INTRODUCTION

Many universities face declining enrollment in their Information Technology (IT), Computer Science, and Engineering Technology programs. The Higher Education Research Institute at UCLA states that the percentage of incoming undergraduates selecting a computer science major dropped more than 60% between Fall 2000 and Fall 2004. Interest in this major peaked in the 1980s but has declined by 70%. The decline in female interest is even greater than their male counterparts. Unlike most other fields, the proportion of women considering a major in computer science has plunged to levels of those in the 1970s (Vegso, 2005). The job market for information technology specialists may be viewed as a major contributing factor for the diminished interest in this discipline. However, based on the job advertisements online and in newspapers, the IT job market may not be as bleak as some media outlets have implied (Mahmoud, 2005). There remains a demand for well-trained students in computer related fields. Further analysis is needed to assist in determining the variables influencing IT career preparation in institutions of higher learning.

Domain Identification is one theory that may aid in the explanation of declining interest in technology as a major of field of study. This theory suggests that the more identified a

person is with a specific domain, such as computer specialists, the more likely he/she is to consider a future career in that field. High school students often have preconceptions about members of occupations prior to beginning their college studies. These preconceptions, or stereotypes, may actually impact their decision about their choice of major. If personal characteristics of computer specialists tie to a potential college student's domain identification, then these characteristics may determine whether the individual will consider the computer science field. The purpose of this study is to determine current perceptions of high school students regarding the personality traits of computer specialists.

2. LITERATURE REVIEW

While there are numerous factors influencing a choice in a major area of study, preconceptions about members of occupations may impact a student's decision to enter a particular field (Coate, Mitschow and Schinski, 2003). These preconceptions affect the likelihood of students seeing themselves in a particular career role or domain upon completing their formal education. Domain identification is an avenue of research to assist in understanding career choices and thus fields of study. As previously mentioned, this theory purports that the more identified a person is with a specific domain, the more likely he/she is to consider a future career in that field. Computer specialists have often been linked to an interest in math suggesting identification with a math domain. More recently, computer technology domain identification rather than math has been found to be a stronger predictor in career considerations (Smith, Morgan, and White, 2005). Research also suggests that men identified with computer technology more so than women. This difference in domain identification by gender may be due to stereotyping (Smith et al, 2005).

Stereotyping is used to simplify and conserve mental resources. Stereotypes are used for filtering, organizing, and remembering information (Macrae, Milne, and Bodenhausen, 1994; Sherman and Frost, 2000 in Sheldon, 2004). Computer specialists are not without their stereotypical characteristics. Movies and books portray the computer arena as a solitary and anti-social profession, dominated primarily by young, white males (ITAA, 2003). Some of the beliefs regarding programmers include that they (1) prefer non-management roles, (2) do not possess good management skills, (3) lack good communication skills, and (4) are introverts. These preconceptions, however, may be misconceptions. Field work reports that programmers expect promotion into management status roles, often manage teams, frequently have good communication skills, and interact as teachers, facilitators, and mentors of junior staff (Brooke, 1995).

While stereotyping applies to professional characteristics, it also governs our view of gender roles. Gershaw (1995) states, "In the U.S. there is a consensus on the stereotyped roles for the average man or woman. The traits in these stereotypes fall into two separate groups. The first expresses competence and independence, while the second focuses on warmth and expressiveness. Men are seen as having the competence traits, while women are seen as more expressive." Since the computer field is dominated by males, it is only natural for individuals to assign masculine traits to the profession such as being aggressive and tough-minded.

3. THE STUDY

The following section first describes the content of the questionnaire and the selection of the respondents. The results of the analysis using t-tests are then presented. Following these results, we discuss the use of a data mining tool used to analyze data clusters and compare the conclusions of these two approaches.

Instrument and Sample Selection

A survey instrument was developed and pretested based on a Personality Factor (PF) Questionnaire that has been used extensively in other research and professions. For example, Davidson and Etherington (1995) used the PF Questionnaire to ascertain whether differences in personality profiles could be found between accounting students and accounting practitioners. Further, Davidson and Dalby (1993) used the same questionnaire when they found that accounting practitioners' personalities are different from those of the general population.

The purpose of this study is not to determine actual personality traits of computer and

information systems analysts, but rather to ascertain student perceptions of those traits for that occupational category. The questionnaire utilized primary personality factors and their definitions as provided by Davidson and Etherington (1995). The instrument was administered to 82 college-bound junior and senior high school students who are attending a magnet school with a business focus, located in south Texas. These students are on the threshold of their university academic careers and have chosen to concentrate in business studies during their high school years, demonstrated by opting to attend a magnate school of this nature. As a general rule, they should be more familiar with business professions than high school students in the general population. Slightly more than half of the participants were female (55%) and 45% were male, which is representative of their respective current ratios at many colleges and universities.

Students were presented with 15 pairs of personality trait terms that could be descriptive of a member of each of six occupations. Each pair of terms is separated by a seven-line measuring stick and students selected which of each pair of words they felt is more descriptive of a member of the occupation indicated. Definitions of all terms were provided on each page of the survey. Students were told to think of a member of the respective profession and then to place a mark between each pair of descriptive terms, based on the strength of the occupation's association with the term. For example, the terms "Cool" and "Warm" were presented to the students in the following format.

	Very	Fairly	Slightly	Neither	Slightly	Fairly	Very	
Cool	____	____	____	____	____	____	____	**Warm**

The sixteenth comparison was gender. Students were asked to indicate whether they felt a member of the occupation was more likely to be male, female or neither. Because personal role models and experiences gained by interacting with individuals can affect one's perception of members of an occupation, students were also asked whether they personally knew anyone who was a member of each profession that was being studied.

The 15 pairs of descriptive terms are listed and defined (Davidson and Etherington, 1995) in Exhibit 1 located in Appendix I. The six occupations provided on the questionnaire were accountant, engineer, lawyer, physician, insurance broker/agent and computer and information systems specialist.

4. RESULTS

T-scores for the results for the computer and information systems specialist are presented in Table 1 located in Appendix I. The statistically significant term has been underlined in each case. A positive t-score indicates that the students perceived a member of the CIS occupation to have the attribute on the right. A negative t-score indicates that the students perceived a member of the CIS occupation to have the attribute on the left.

As shown in Table 1, the high school students perceive computer and information systems specialists as abstract thinkers, emotionally stable, tough-minded, trusting and self-assured. Additionally, they overwhelmingly believe that the stereotypical member of this occupation is male. No other pair of terms was statistically significant. The statistically significant personality attributes are generally favorable. According to the definitions provided to the students, individuals who are (1) abstract thinkers are more intelligent, (2) emotionally stable are calm and face reality, (3) tough-minded are self-reliant, non-nonsense and realistic, (4) trusting are accepting of conditions and easy to get along with and (5) self-assured are secure, feel free of guilt, are untroubled and self-satisfied.

To determine how perceived personality traits of computer and information specialists compare with those of members of the other occupations, t-scores were determined. Results are shown in Table 2. Negative t-scores indicate that the computer and information specialist is perceived to have the personality trait on the left, compared with a member of the occupation to which it is being compared. The statistically significant term(s) have been underlined in each case.

Of particular note is the students' perception that a member of this occupation is more likely to be male than is an accountant or a physician. In some cases, the computer and information specialist compares favorably with members of the other profession. For example, a computer and information specialist is perceived to be cooler than are en-

gineers and physicians. However, in other cases, such as computer and information specialists being more concrete thinkers than engineers, the comparison is not favorable.

Finally, two statistical tests were used to determine whether male and female high school students hold differing perceptions of members of this occupation. Table 3 located in Appendix I presents t-scores testing for differences and illustrates that only one difference is statistically significant: the gender of a member of this occupation.

Differences in gender stereotype promoted further analysis. As can be seen in Table 4, male respondents typically view the computer and information technology specialist as male. Only one quarter of the females perceive the specialist as female. Table 4 located in Appendix I presents chi-square statistics used to further analyze these phenomena.

Only 12 of the 71 respondents (17%) felt that it would be more likely for this person to be female; 27 (38%) thought it was neither a male or female dominated stereotype; 32 (45%) felt it would be more likely for this person to be male. Note that 11 respondents did not answer this question. Chi-Square statistics were used to evaluate the distribution of these responses. The calculated value of 5.71 with $p = .057$ at alpha = .05 we cannot conclude that a difference exists between male and female respondents' perceptions about whether the stereotypical CIS professional is male or female.

5. UNSUPERVISED CLUSTERING

Unsupervised clustering is a data mining technique that builds models without first predefining classes or categories. A primary goal of unsupervised clustering is to discover which instances or cases to include in each cluster. Data instances are grouped together based on a similarity scheme defined by the clustering system rather than the researcher. However, the meaning of the formed clusters must be evaluated and determined by the researcher. There are three purposes for using the unsupervised clustering strategy:

1) To determine if meaningful relationships in the clusters can be formed from the data instances.
2) To uncover interesting relationships between the data attributes.
3) To describe the characteristics which define the discovered clusters.

Many unsupervised clustering systems require the user to provide an initial best estimate about the total number of clusters in the data. Other clustering systems use an algorithm in an attempt to determine a best number of clusters. In our research, the latter approach was used to group instances into clusters of significant interest. This allows for comparison with the results of the t-scores initially calculated and presented above.

The data mining process was performed using the iDA software package, a Microsoft Excel add-on. The iDA package uses examples from the data in order to learn and categorize or cluster cases without making any assumptions about the data. When learning is unsupervised (no restrictions on the number of clusters by the user), several optimizing heuristic evaluation functions are used to cluster input data into naturally occurring groups. This is a similar process used in human learning. Research has shown that much of human learning involves the storage and retrieval of data records or instances of data of learned concepts. Humans use these examples to categorized newly encountered instances of unknown origin. The data mining tool employed works in a similar fashion by utilizing examples stored in categories (Roiger & Geatz, 2003).

6. RESULTS OF UNSUPERVISED CLUSTERING

The data instances for the high school college-bound juniors and seniors were analyzed for data clusters. The unsupervised clustering used the 15 pairs of personality trait terms, the respondent's gender, their major, and the students' answer to the question asking if they personally know anyone who is a computer and information systems specialist. Two data clusters were produced. The first cluster is identified as Cluster A and the second as Cluster B. Results are shown in Table 5 located in Appendix I. Note that in Table 5 a positive mean indicates that, on average, members of a cluster felt the term on the right is more descriptive

of someone in this occupation. Conversely, a negative mean indicates that, on average, members of a cluster felt the term on the left is more descriptive of someone in this occupation.

Members of Cluster A have the following characteristics:

1) The majority (90.32%) of the members in this cluster are male.
2) Less than half (38.71%) of the members of this cluster felt that a member of this occupation was neither "affected by feelings" or "emotionally stable."
3) All (100%) of the members in this cluster felt that a member of this occupation was slightly "conscientious."
4) Less than half (38.71%) of the members of this cluster felt that a member of this occupation was neither "shy" or "bold."
5) Over half (61.29%) of the members in this cluster felt "slightly" that a member of this occupation was male.
6) All (100%) of the members of this cluster have one or more of the above characteristics.

Members of Cluster B have the following characteristics:

1) The majority (88.37%) of the members in this cluster are female.
2) A little more than half (53.49%) personally know someone who is a computer and information systems specialist.
3) Over half (51.16%) of the members of this cluster felt a member of this occupation were slightly, fairly, or very "emotionally stable."
4) More than half (67.79%) of the members of this cluster felt that a member of this occupation was either neither "shy" nor "bold," or were slightly, fairly or very "bold."
5) More than half (60.47%) of the members of this cluster felt a member of this occupation was either slightly " tough-minded" or neither "tough-minded" nor "tender-minded."
6) All (100%) of the members of this cluster have one or more of the above characteristics.

Unsupervised clustering does not indicate whether mean differences in attributes between the two clusters are statistically significant. However, it is interesting to note that in many cases, on average, members of both clusters have the same perceptions of the personality traits associated with a computer and information systems specialist. Thus, on average, members of both clusters agree that the more descriptive terms are (1) cool, (2) abstract thinker, (3) emotionally stable, (4) dominant, (5) enthusiastic, (6) conscientious, (7) bold, (8) tough-minded, (9) trusting, (10) self assured, (11) conservative, (12) self-sufficient (13) relaxed and (14) male. These results are in accordance with the results of Student's t-test previously discussed.

Cluster A, which is male dominated, has a higher mean score for the sixteenth personality trait, female-male, and Cluster B, which is female dominated, has a lower mean score. This also concurs with the results of Student's t-test in Table 3 and the Chi-Square results shown in Table 4. As shown in Table 4, male respondents were more likely to feel that a member of this occupation would be male (18 of 31 respondents), and female respondents were more likely to feel that neither a male nor a female (16 of 40). General disagreement between the members of the two clusters occurred only for the paired personality traits of (1) practical/imaginative, and (2) forthright/shrewd. Cluster A members (90.3% male) felt the more descriptive terms were imaginative and shrewd, but Cluster B members (88.4% female) felt the more descriptive terms were practical and forthright.

7. DISCUSSION

Though our sample was limited to one institution, the results of this study suggest that high school students have preconceptions of the personality traits of an information systems professional, despite the fact that less than half the participants actually reported knowing a computer specialist. As our statistical analysis indicates, a technology professional is seen by these future scholars as emotionally stable or calm in situations that may be annoying, intelligent as depicted by

their ability to think in the abstract, and tough-minded as opposed to sensitive. In addition, computer specialists are perceived as secure and satisfied with themselves. It is not surprising that they are also seen as males since the personality traits that students used to describe them are sometimes referred to as "masculine." The added analysis using the unsupervised clustering technique for data mining supports these findings. The students in the two clusters agreed that computer specialists are perceived as being emotionally stable, abstract thinkers, tough minded, self assured, self sufficient and male.

Domain identification theory suggests that these high school respondents will seek a career in which they can envision themselves based on similarities with preconceptions or stereotypes. Our research suggests that personality may be one form of comparison. Students who see themselves as intelligent, emotionally stable, and tough-minded may be more apt to select careers in the information systems field. Gender identification may have a primary role in higher educational major choices as well. The fact that the male respondents typically perceive the IS professional as a male has implications for the career selection process. Though our female respondents did not necessarily picture the computer specialist as male, neither did they view the individual as female. This does suggest, however, that males will more likely choose computer programs in institutions of higher education than females.

In order to increase enrollment in our information systems and computer programs at the university level, preconceptions of the gender and personality traits of individuals in the field need to be addressed at the high school level. Certainly the mentoring programs that have evolved can assist in this effort. These efforts can provide role models that have traits not typically depicted in the media, suggesting to students that the profession is not comprised solely of anti-social, young, white males with poor communication skills. Efforts may also be directed to the myriad tasks that technology professionals perform. While there is still a demand for the labor intensive programmer, tasks often require extensive interaction with information users, relying on good communication and management skills.

Dispelling the negative image of the IT professional may require stronger efforts at the high school level. Practitioners and academicians should be encouraged to join outreach programs that target those contemplating this major field of study after high school. Professional IT organizations should encourage high school students to attend their meetings. Computer camps should incorporate creativity techniques which entice students that are group-oriented and imaginative. Improving the perceived personality traits of the technology specialist will help minimize the stereotypes that constrain an individual's choice of career and ultimately impact our higher educational program enrollments.

8. CONCLUSIONS

The declining enrollment in IT fields of study has caused academicians to search for explanations for this trend. There are a variety of theories and environmental factors that are known to influence a high school student's choice of careers. Domain identification theory provides just one additional explanation for the recent disinterest in computer related professions. Preconceptions, or stereotyping, of IT professionals may be stifling desirable individuals from exploring a field where tasks are diverse and varied personality traits are advantageous. Future research into the effective personality traits of those in the IT profession may prove beneficial for recruiting and communicating job characteristics of computer specialists.

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Appendix I

Exhibit 1
Personality Traits Terms and Definitions Provided to the Students

1. **Cool:** Reserved, impersonal, detached, aloof	**Warm**: Outgoing, kindly, easy-going, participating, likes people
2. **Concrete Thinker**: less intelligent	**Abstract Thinker**: More intelligent
3. **Affected by Feelings**: Emotionally less stable, easily annoyed	**Emotionally Stable**: Faces reality, calm
4. **Submissive**: Humble, mild, easily led, accommodating	**Dominant:** Assertive, aggressive, stubborn, competitive, bossy
5. **Sober:** Restrained, prudent, taciturn, serious	**Enthusiastic**: Spontaneous, heedless, expressive, cheerful
6. **Expedient:** Disregards rules, self-indulgent	**Conscientious**: Conforming, moralistic staid, rule-bound
7. **Shy:** Threat-sensitive, timid, hesitant, intimidated	**Bold**: Venturesome, uninhibited, can take stress
8. **Tough-minded**: Self-reliant, no-nonsense, realistic	**Tender-minded**: Sensitive, overprotected, intuitive, refined
9. **Trusting**: Accepting conditions, easy to get on with	**Suspicious**: Hard to fool, distrustful, skeptical
10. **Practical**: Concerned with "down to earth" issues, steady	**Imaginative**: Absent-minded, absorbed in thought, impractical
11. **Forthright**: Unpretentious, open, genuine, artless	**Shrewd**: Polished, socially aware, diplomatic, calculating
12. **Self-assured**: Secure, feels free of guilt, untroubled, self-satisfied	**Apprehensive**: Self-blaming, guilt-prone, insecure, worrying
13. **Conservative**: Respecting, traditional ideas	**Experimenting**: Liberal, critical, open to change
14. **Group-oriented**: A joiner and sound follower, listens to others	**Self-sufficient**: Resourceful, prefers own decisions
15. **Relaxed:** Tranquil, composed, has low drive, not frustrated	**Tense**: Frustrated, overwrought, has high drive

Table 1
Results for Student's t-Tests for Perceived Personality Traits
College-bound High School Students at Least 16 Years of Age

Attributes	Computer and Information Systems Specialist
1. Cool/Warm	-1.40
2. Concrete Thinker/Abstract Thinker	*2.09
3. Affected by Feelings/Emotionally Stable	**4.28
4. Submissive/Dominant	1.91
5. Sober/Enthusiastic	0.52
6. Expedient/Conscientious	1.73
7. Shy/Bold	0.87
8. Tough-minded/Tender-minded	**-2.71
9. Trusting/Suspicious	**-3.99
10. Practical/Imaginative	-1.69
11. Forthright/Shrewd	0.14
12. Self-assured/Apprehensive	*-2.23
13. Conservative/Experimenting	-0.51
14. Group-oriented/Self-sufficient	0.53
15. Relaxed/Tense	-0.30
16. Female/Male	**3.34

**significant at 1%
*significant at 5%

Table 2
Results of Student's t-Tests for Comparison of Computer and Information Systems Specialist with Other Occupations College-bound High School Students at Least 16 Years of Age

Computer and Information Systems Specialist compared to	Acc	Eng	Law	Phy	Ins
1. Cool/Warm	-0.59	*-2.55	-1.37	**-3.87	-1.58
2. Concrete Thinker/Abstract Thinker	-0.95	*-2.20	-1.35	-0.95	1.68
3. Affected by Feelings/Emotionally Stable	0.14	-0.50	-1.76	0.47	1.68
4. Submissive/Dominant	1.60	0.14	**-2.93	-0.24	0.71
5. Sober/Enthusiastic	1.59	0.82	1.71	-1.69	1.60
6. Expedient/Conscientious	*-2.60	-0.56	-1.36	**-2.68	0.00
7. Shy/Bold	-0.34	-1.70	**-4.57	*-2.54	-0.83
8. Tough-minded/Tender-minded	1.10	1.62	**3.03	**-2.68	0.00
9. Trusting/Suspicious	0.57	0.63	*-2.35	**2.64	-1.23
10. Practical/Imaginative	**3.05	0.22	1.19	*2.31	1.33
11. Forthright/Shrewd	1.17	0.06	-0.85	1.60	1.02
12. Self-assured/Apprehensive	1.60	1.67	*2.21	**2.64	0.47
13. Conservative/Experimenting	**2.82	-1.02	0.74	*2.05	1.52
14. Group-oriented/Self-sufficient	0.05	*2.39	-0.40	**4.17	*2.06
15. Relaxed/Tense	-0.80	-0.06	*-2.06	1.95	-0.06
16. Female/Male	**2.89	-1.86	0.17	**2.90	0.82

*significant at 5%
**significant at 1%

Table 3
Results for Student's t-Test for Gender Differences in Perceived Personality Traits College Bound High School students at Least 16 Years of Age

Attributes	Computer and Information Systems Specialist
1. Cool/Warm	-0.19
2. Concrete Thinker/Abstract Thinker	-0.92
3. Affected by Feelings/Emotionally Stable	-1.37
4. Submissive/Dominant	-0.21
5. Sober/Enthusiastic	0.26
6. Expedient/Conscientious	-0.67
7. Shy/Bold	-0.10
8. Tough-minded/Tender-minded	-0.16
9. Trusting/Suspicious	1.23
10. Practical/Imaginative	1.60
11. Forthright/Shrewd	1.38
12. Self-assured/Apprehensive	1.02
13. Conservative/Experimenting	0.45
14. Group-oriented/Self-sufficient	0.22
15. Relaxed/Tense	0.31
16. Female/Male	**2.50

**significant at 1%

Table 4
Gender Differences
Chi Square Test for Differences Between Male and Female Respondents And Perceptions About Whether the Stereotypical CIS Professional is Male or Female

	Female	Neither	Male	Totals
Male Respondents	2	11	18	31
Female Respondents	10	16	14	40
Totals	12	27	32	71

Table 5
Results of Unsupervised Clustering College-Bound High School Students at Least 16 Years of Age

Cluster	A	B
Total Number in the Cluster	31	43
Number of males in the Cluster	28	4
Number of females in the Cluster	3	38
Number indicating they actually know a Computer and Information Systems Specialist	18	23
Most common anticipated college major	Unknown: 8 Non Business: 8 Accounting: 6 Business: 3	Non Business: 19 Unknown: 8 ISM: 4
Cluster Mean Scores for Personality Attribute Comparisons:		
1. Cool/Warm	-.0607	-0.125
2. Concrete Thinker/Abstract Thinker	0.032	1.000
3. Affected by Feelings/Emotionally Stable	0.581	0.949
4. Submissive/Dominant	0.355	0.375
5. Sober/Enthusiastic	0.065	0.132
6. Expedient/Conscientious	0.516	0.175
7. Shy/Bold	0.067	0.225
8. Tough-Minded/Tender-Minded	-0.500	-0.463
9. Trusting/Suspicious	-0.600	-0.951
10. Practical/Imaginative	0.065	-0.610
11. Forthright/Shrewd	0.241	-0.122
12. Self Assured/Apprehensive	-0.600	-0.282
13. Conservative/Experimenting	-0.103	-0.122
14. Group Oriented/Self Sufficient	0.233	0.125
15. Relaxed/Tense	-0.103	-0.073
16. Female/Male	0.600	0.049

Note: Not all students answered every question or supplied all personality trait comparisons.