

# A Framework for Understanding Minority Students' Cyber Security Career Interests

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## ABSTRACT

Recently, a demand toward IT workforce in a cyber security arena is showing an increasing trend. However, under-representation of minority workforce in the IT industry is one of reasons for the scarcity of skilled labors in the information security industry. This paper presents various factors that contribute to students' motivation and interest in a cyber security career by exploring career choice theories. This paper investigates, based on the social cognitive theory, the factors that affect students' intrinsic motivation to pursue an information security careers. It further suggests a theoretical framework that explains relationships among students' cyber security career self-efficacy, barriers and cyber security career interests. Finally, this study proposes a research framework that explains minority students' cyber security career choices.

## Keywords

Cyber security, Career choice, Self-efficacy, Career interest, Perceived Career Barriers, Minority

## INTRODUCTIONS

Cyber security is developing as one of the critical areas in the age of Information Technology. An increase in the realization of the risks of information breaches in a cyberspace corresponds to an increased in the demand for cybersecurity professionals. To address the challenges of information assurance, the Department of Homeland Security has identified cyber security as a critical area of national security in *The national strategy to secure cyberspace*. It states that a cybersecurity training program is one of its five national priorities and one mission is to address the shortfalls in the number of trained and certified cyber security workforce ([http://www.dhs.gov/interweb/assetlibrary/National\\_Cyberspace\\_Strategy.pdf](http://www.dhs.gov/interweb/assetlibrary/National_Cyberspace_Strategy.pdf) February 2003). IDC, one of the largest market research companies, report of information security workforce (Carey 2004) predicts a very high career growth potential of information security, along with U.S job market growth of 19 percent annually through 2008, which is driven, in part, by efforts to integrate security on enterprise-wide bases.

The issue of the growing demand of information security professionals, along with the shortage of skilled and certified workers, is compounded with the under representation of minority workers in the Information Technology (IT) fields. The report of the IT workforce by the Department of Commerce indicates that one of the underlying causes of this deficit in the IT workforce is under representation of minorities in the math and computer science related education pipeline (Mitchell et al. 1998). Science and Engineering (S&E) Indicators 2006 present that African-Americans account for 6.9% of S&E workforce and Hispanics constitute 3.2%. The indicators provide alarming information that though 24% of the U.S. total population is minorities, only 13 % of college graduates are minorities and 10% of college graduates in S&E occupations are minorities. Moreover, African Americans represent only 4% of computer scientists and mathematicians (<http://www.nsf.gov/statistics/seind06/c3/c3s1.htm#sb3>).

Prior research has studied the IT labor markets but has not explored the cyber security (CSec) field specifically; thus, there are few studies about a student's motivation to choose information security career and even a smaller number that investigate the reasons of under representation of minority students in such a field.

The objective of this study is as follows:

1. Identify factors that affect college students' cybersecurity career interests
2. Present a conceptual framework for explaining students' cybersecurity career interests
3. Explore causes of under-representation of minority workforce in information security professions
4. Investigate the effect of cybersecurity education on college students' interests toward cybersecurity professions

Using a social cognitive theory, we investigate the factors that affect students' intrinsic motivation to pursue cybersecurity careers. By achieving the above stated objectives, we better understand a minority student's cybersecurity (CSec) career interest. Furthermore, we are prepared to formulate a solution to reduce the under-representation of minority workforce by well constructed research frameworks.

## **THEORETICAL BACK GROUND**

### **(1)Social cognitive Theory**

#### *Self-efficacy and Outcome expectation*

Bandura's (1986) Social cognitive theory presents a theoretical background to explain individual behavior. It assumed that personal factors in the form of cognitive, affective and biological events, behavior and environmental events all operate as interacting determinants that influence each other. According to this theory, an individual's behavior can be affected by the interplay among given environments, individual and cognitive and personal factors. An individual selects the situation or environment in which they exist and then are influenced by that environment.

Furthermore, behavior in the given situation and the environment then affect each other. Finally, behavior is influenced by cognitive and personal factors (Compeau & Higgins 1995). In this reciprocal relationship among environment, behavior and individual, Bandura (1986) introduces self-efficacy as a major cognitive force guiding individual behavior. He defines self-efficacy as people's judgment of their own capabilities to perform a task. Self-efficacy is concerned with judgments of what one can or cannot do with one's skills. Self-efficacy has received growing attention as a useful measurement to analyze career development process (Lent & Hackett 1987). According to Bandura, Barbaranelli, Caprara, and Pastorelli (2001), perceived occupation self-efficacy is working strongly to determine individual's career choice.

Outcome expectation is another important variable in social cognitive theory. Bandura (1986) describes outcome expectation as an anticipation of physical, social and self-evaluated outcomes. Lent, Brown and Hackett (1994) define outcome expectation as personal beliefs about probable outcome which involve imagined consequence of performing particular behavior.

Lent, Hackett and Brown (1996) suggest that career outcome expectation plays a central role in developing students' academic and career interests and occupational options. Their research also discusses how an individual's career possibility can be restricted by occupational outcome expectation in early age because people have a tendency to exclude careers in which they did not expect a positive result.

#### *Career Interest*

Career interest has been discussed as a critical factor in an individual's career choice and goal formation process in several studies. Lent, Brown and Hackett (1994) introduced career interest to study a student's career development model. They define vocational interest as patterns of likes and dislikes, and indifference regarding career relevant activities and occupations.

Schaffner and Jepsen (1999) explored how career interests will affect an individual's career choice. They found out that career interest directly affects career choice. Another study suggests that career interest and work-relevant experiences are important predictors for choice selection (Lent, Brown, Talleyrand, McPartland, Davis, Chopra, Alexander, Suthakaran and Chai 2002).

### **(2) Perceived barriers in seeking a career**

Among the many factors which influence an individual's career choice, perceived barriers toward a career is discussed by numerous researchers as a critical obstacle which may hamper one's entrance into or continuation of a career (Luzzo 1993; Swanson and Toker 1991a, 1991b). Luzzo (1993) presents four barriers categories by interviewing 375 college students.

They are family related barriers (e.g., balancing work, family responsibilities, finding day care for children), study skills barriers (e.g., poor study habits, lack of basic skills education), ethnic identity barriers (e.g., job discrimination on the basis of race, different treatment by teachers based on ethnicity), and financial barriers (e.g., lack of funds for higher education).

Other research about career choice barriers suggests that personal difficulties such as problems adjusting to college, depression, and time management problems are substantial barriers that influence career choice. Additionally, negative social/family influences, concerns about role conflict, excessive educational requirements, negative school/work experiences, and work conditions/reinforces are also introduced (Lent et al. 2002).

### **(3) Cybersecurity Education**

Recently, many colleges provide cybersecurity related courses such as information assurance, computer and internet security and wireless network security. Some researchers advocate a role of education experience and relating activities on self-efficacy (Schunk 1995; lent et al. 1996). They insist that education opportunity and experience affect efficacy-building process. If students have a certain kind of cybersecurity related education or training experience (e.g. intern ship training, college course), they have more chance to build up self-efficacy compared with one does not have any experience.

## **RESEARCH MODEL AND HYPOTHESIS**

Based on prior research about social cognitive theory and career choice models, we can extract key factors as important determinants of minority students' information security job interest. We set up the research model and hypothesis according to the factors. In this model, we focus on which factors will have an effect on students' interest on having a CSec career. The research model of this paper is presented in figure 1.

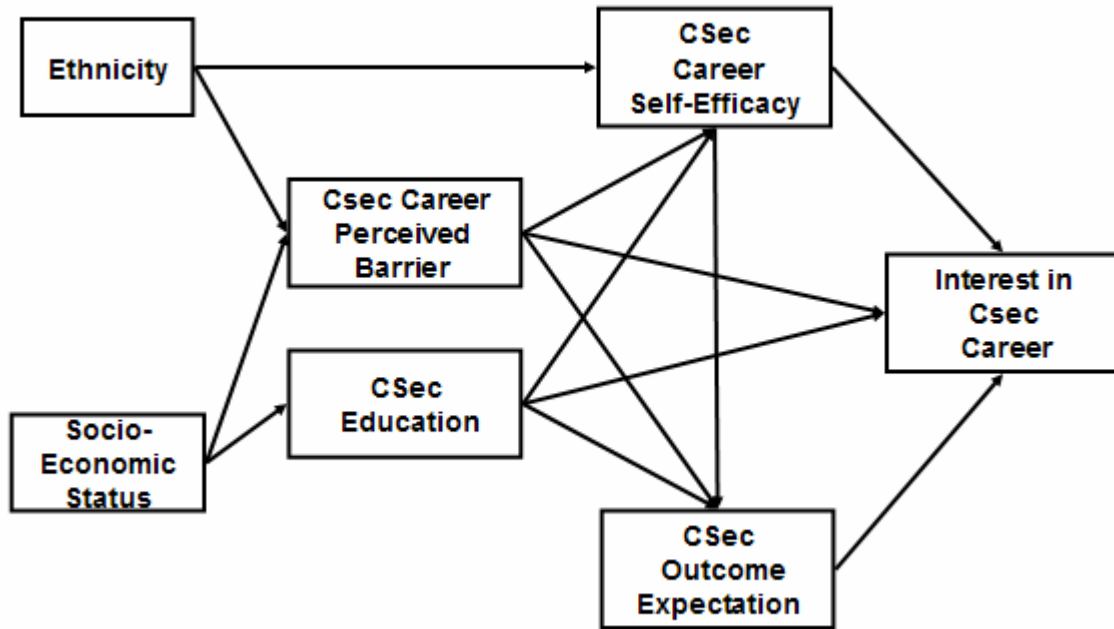


Figure 1. Research Model

In our research model, students' perceived self-efficacy of a CSec career has a positive impact on students' perceived outcome expectation of a CSec career. Lent et al. (1996) suggest that students' interest in a career can be cultivated by building up their self-efficacy and outcome expectations, and maximizing skill development. An individual's occupational or academic interests are reflective of his or her simultaneous self-efficacy beliefs and outcome expectations (Lent et al. 1994).

From above research findings, we hypothesize that students, who think they can do well in the cyber security job, have more positive outcome expectation and higher interest in a cyber security career.

**H1: Perceived career self-efficacy has a positive relationship with CSec career outcome expectation**

**H2: Perceived career self-efficacy has a positive relationship with interest in a CSec career**

Career outcome expectation also plays an important role in developing students' academic and career interests as well as occupational options. People's occupational outcome expectation might restrict their range of career possibility in their early age (Lent et al 1996). If one does not expect a good performance outcome in the CSec career, he or she has not only low interest but also less intention to have a CSec career.

**H3: Career outcome expectation has a positive relationship with interest in a CSEC career**

Perceived barriers have been known as significant factors in career development (Farmer 1976). Students who feel barriers about CSEC occupations are less likely to have a CSec career. Russell and Rush (1987) point out family/social concerns, femininity concerns, and limited education or experiences are major perceived barriers of pursuing management careers reported by college women. From these research findings, we contend that perceived barriers to a CSec career has a negative impact on student's perceived self-efficacy and CSec career interest.

**H4: Perceived barrier toward a CSec career has a negative relationship with perceived career self-efficacy**

**H5: Perceived barrier toward a CSec career has a negative relationship with CSec career interest**

### **H6: Perceived barrier toward a CSec career has a negative relationship with CSec career outcome expectation**

In this study, we assume that cybersecurity related education will have some effects on students' choice of cybersecurity profession. As we discussed earlier, some researchers (Schunk 1995; Lent et al. 1996) presented research results that proved positive relationship between education and self-efficacy building process. Based on their research results, we developed below hypothesizes.

### **H7: Students' CSec related education has positive impact on students' perceived career self-efficacy**

### **H8: Students' CSec related education has positive impact on students' interest in cyber security career**

### **H9: Students' CSec related education has positive impact on students' career outcome expectation**

Students' ethnicity has a strong influence on formulation career goals (Mcwhirter 1997). In a study of ethnically diverse engineering students, Hackett, Betz, Casas, and Rocha-Singh (1992) find that majority students express stronger self-efficacy regarding the engineering curriculum than do Mexican-American students. Another research contends that science and engineering career interest is predicted by mathematics self-efficacy, influenced by ethnic identity, academic achievement, and socioeconomic status (Kopala et al. 1999). Luzzo (1993) finds out that African American students express more perceived ethnic identity barriers (e.g., job discrimination on the basis of race, different treatment by teachers based on ethnicity), compared to Asian Americans and Hispanics. In that research, financial barriers (e.g., lack of funds for higher education) are also reported as a significant barrier. In the transition from career interest to career goals, socioeconomic conditions work as strong influencers because one's educational opportunity and financial barriers which are predictors of career self-efficacy and career interest can be restricted by their socioeconomic status (Lent et al. 1994, 1996).

Their research results lead us to the following hypothesis:

### **H10: Perceived ethnicity has an impact on perceived barriers of a CSec career**

### **H11: Perceived ethnicity has an impact on CSec career self-efficacy**

### **H12: Socio-economic status has an impact on perceived barriers of a CSec career**

### **H13: Socio-economic status has an impact on CSec education opportunity**

## **CONCLUSION & FUTURE RESEARCH**

In this paper, we propose a research model and hypotheses to explain students' Cybersecurity career interest. We focus on effects of students' perceived ethnical background on their Cybersecurity career self-efficacy and Cybersecurity career interest. From various prior research findings, we assume that minority students may have different perceived barriers, self-efficacy, and interest about cyber security occupations. Education related to Cybersecurity will also be a critical factor that affects students' interests in Cybersecurity career. Future research of this study will be empirical data test. We expect to find out different self-efficacy levels of various ethnic groups by data experiment. Our research framework can have practical usefulness in understating minority students' Cybersecurity career choice by conducting further research.

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## **REFERENCES**

1. Bandura, A.(1986) *Social Foundations of Thought and Action* Prentice Hall, New Jersey.
2. Bandura, A., Barbaranelli, C., Caprara, G.V., and Pastorelli, C.(2001)"Self-Efficacy Beliefs as Shapers of Children's Aspirations and Career Trajectories," *Child Development* ,72,1, pp 186-206.
3. Carey, A. (2004), "(ISC) 2 Global Information Security Workforce Study," IDC, pp. 1-30.

4. Compeau, D.R., and Higgins., C.A. (1995) "Computer self-efficacy: Development of a measure and initial test," *MIS Quarterly*, 19, 2, pp 189-211.
5. Farmer, H.S.(1976), "What inhibits achievement and career motivation in women?" *The Counseling Psychologist*, 6, pp 12-14.
6. Hackett, G., and Betz, N.E.(1981), "A self-efficacy approach to the career development of women," *Journal of Vocational Behavior*,18, pp 326-339.
7. Hackett, Betz, Casas, and Rocha-Singh. (1992), "Gender, Ethnicity, and Social Cognitive Factors Predicting the Academic Achievement of Students in Engineering," *Journal of Counseling Psychology*, 39, 4, pp 527-538
8. Kopala, M., Martinez-Pons, M., and O'Brien, V.(1999), "Mathematics Self-Efficacy, Ethnic Identity Gender, and Career Interests Related to Mathematics and Science," *The Journal of Educational Research* , 92, 4, pp 231-235.
9. Lent, R.W., Brown, S.D., and Hackett, G.(1994), "Toward a Unifying Social Cognitive Theory of Career and Academic Interest, Choice and Performance," *Journal of Vocational Behavior* , 45, pp 79-122.
10. Lent, R.W., Brown, S.D., and Larkin, K.C.(1987), "Comparison of Three Theoretically Derived Variables in Predicting Career and Academic Behavior: Self-Efficacy, Interest Congruence, and Consequence Thinking," *Journal of Counseling Psychology*, 34, 3, pp 293-298.
11. Lent, R.W., Brown, S.D., Talleyrand, R., McPartland, E.B., Davis, T., Chopra, S.B., Alexander, M.S., Suthakaran, V., and Chai, C.-M.(2002), "Career Choice Barriers, Supports, and Coping Strategies:College Students' Experience," *Journal of Vocational Behavior*, 60, pp 61-72.
12. Lent, R.W., Hackett, G., and Brown, S.D.(1996), "A Social Cognitive Framework for Studying Career Choice and Transition to Work," *Journal of Vocational Education Research* , 21, 4, pp 2-31.
13. Lent, R.W., Hackett, G.(1987), "Career Self-Efficacy: Empirical Status and Future Directions" *Journal of Vocational Behavior* , 30, 3, p347-82.
14. Luzzo, D.A.(1993), "Ethnic Differences in College Students' Perceptions of Barriers to Career Development," *Journal of Multicultural Counseling and Development* , 21, 4, pp 211-226.
15. Mcwhirter, E.H.(1997) "Perceived Barriers to Education and Career: Ethnic and Gender Differences," *Journal of Vocational Behavior* , 50, pp 124-140.
16. Mitchell, G., Carnes, K., and Mendonsa, C.(1998) "America's new deficit: the shortage of information technology workers," Office of Technology Policy, Department of Commerce, pp. 1-35.
17. Russell, J.E.A., and Rush, M.C.(1987), "A comparative study of age-related variation in women's views of a career in management," *Journal of Vocational Behavior* , 30, pp.280-294.
18. Schaefer, K.G., Epperson, D.L., and Nauta, M.M.(1997), "Women's career development: Can theoretically derived variables predict persistence in engineering majors?" *Journal of Counseling Psychology*, 44, pp 173-183.
19. Schaffner, M., and Jepsen, D.(1999), "Testing a Social Cognitive Model of Career Choice Development within the Context of a Minority Teacher Recruitment Program," United States Department of Education, Washington, DC, pp. 1-29.
20. Schunk, D.H.(1995), *Self-efficacy and education and instruction* Plenum, New York.
21. Swanson, J.L., and Tokar, D.M.(1991a) "College students' perceptions of barriers to career development," *Journal of Vocational Behavior* ,38, pp 92-106.
22. Swanson, J.L., and Tokar, D.M.,(1991b), "Development and initial validation of the Career Barriers Inventory," *Journal of Vocational Behavior* , 39, pp 344-361.