

IT Security Education – A Case Study in Developing an End-To-End Pathway to Success

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Abstract

This paper reports on a project to provide an end-to-end educational solution in information security targeted to students who are unaware of the academic options and opportunities for access that are available, or who may lack sufficient financial, mentoring or social support systems. The project helps students in the target population to realize the dream of an affordable, high quality college education by leading them through a roadmap from high school, through a career studies certificate at a community college, an associate's degree, and finally a bachelor's degree in information security or IT management at a respected university. A literature review explores the challenges and recommendations in the areas of recruitment, retention and financing of students. The case study discusses program formalization, development of promotional materials, program outreach and advocacy, and additional activities help potential participants develop a holistic view and share the dream of an educational journey leading to a bachelor's degree in information security or information systems.

Keywords: IT Security Education, Information Systems Education, Community College Transition, IT Education Pathways.

1. INTRODUCTION

This paper discusses development and implementation of an end-to-end educational solution for high school students interested in a career in information security. The specific target population includes those who are unaware of the academic options and opportunities for access that are available, or who may lack sufficient financial, mentoring or social support systems. The program posits itself to provide access to students in that demographic with the technical ability to be academically successful in information security or information systems.

Even for those students not burdened by the aforementioned hurdles, it is difficult for high school juniors, seniors and graduates to navigate postsecondary education options available in today's market. The popularity of alternative credentials in the form of digital badges, verified

certificates, commercial certifications and other non-degree credentials continues to increase. While there is large variance in the value of these alternatives, they increase the complexity of the options of high school graduates seeking to enter the workforce merely by virtue of their existence. Other options such as for-profit higher educational programs also suffer high levels of variance in their value, and often leave participants with large amounts of debt.

The problem is how to offer a decent education with well-regarded and widely accepted competencies, without incurring large amounts of debt, to average or underprivileged students. The target audience are those high school students who are not aware of, do not qualify for, or cannot afford a traditional college experience or vocational training. Although some of this demographic have successfully navigated the reefs and shoals from high school to bachelor's

degree, these are attributed to dedication, individual mentoring, and a large degree of luck.

The requirement is to develop an end-to-end program resulting in a pathway for students in the target population to realize the dream of an affordable, high quality college education by leading them through a roadmap from high school, through a career studies certificate at a community college, an associate's degree, and finally a bachelor's degree in information security or IT management at a respected university. The intent is that they will succeed, as they will have a concrete plan to follow, and a program to participate in. The value in developing this program is a unique progression from workforce development certificate to associate's degree to bachelor's degree, while maintaining programmatic continuity and relevance.

2. LITERATURE REVIEW

Recruitment

One of the challenges involved in motivating the target population to continue their education past secondary schooling is to recruit and make them aware of the opportunities and possibilities. Hinton-Smite (2009) notes that efforts to widen participation in higher education through the 1960's focused on traditional students. She suggests that due to changing demographics and other reasons, institutions must look to previously untargeted populations such as minorities and underprivileged students for continued growth, or perhaps merely survival.

It has been the focus of government and institutional initiatives to incentivize recruitment to improve access and diversity. However, at the grass roots level, while it is well and good to target these populations, programs must also target the populations most likely to attend to maximize return on investment of recruiting funding.

Retention

Although educational access has improved in the past few decades, it is widely accepted that completion rates have not kept pace. In 1989, Brint and Karabel found that students who started their higher education careers at two year colleges were less likely to complete bachelor's degrees than those who started at four year institutions. This continues to hold true (Brint, 2003). Brint, 2003, further states that while 70% of community college students indicate that they intend to complete a bachelor's degree, the reality is that only about 15% actually do. Tinto

(1993) states that colleges focus more on recruitment than retention, and (1999) further states that most colleges do not take retention seriously.

Dowd and Meguizo (2010) and others (Choy, 2008; Crisp, 2010) indicate that community college students are more likely to drop out than students starting at four year colleges. In a paper on general access to higher education among non-traditional students in the United Kingdom, Reay, Ball and David find that government "rhetoric on widening participation and responsiveness to local communities needs to move beyond rhetoric into policies which provide possibilities for realization" (p. 17).

Tinto's (1987, 1993, 1998) seminal work on student retention describes a departure model based on the premise that academic and social integration lead to student persistence, particularly in the first year of school. Townsend and Wilson, 2006, investigate academic and social integration of community college transfer students, finding that this students need additional assistance, especially during their transition period. Kane & Rouse (1995) indicate that insufficient academic integration and social support contribute to community college attrition. Okeefe (2013) suggests the ability of a student to find a sense of belonging in the institution as a critical retention factor.

In a 2010 paper, Brock notes that students at two year institutions are less likely to succeed at their programs as those at four year schools, and that the education system must do more to facilitate their success, particularly in three specific areas: remedial education, support services and financial aid. Fike & Fike (2008) find that many four year colleges do not value developmental education. However, they note that developmental courses are critical to retention of community college students. Yorke & Thomas, 2003, state that strong policies on access and retention are necessary, combined with action to improve retention of students in lower socio-economic groups.

Providing students with an end-to-end program to help them navigate a complex, multiple program, multiple institution

Finance

Community college students are significantly more likely to suffer the deleterious effects of the financial aid system (Kane & Rouse, 1995; Rouse, 1994).

Lynch, Engle & Cruz, 2011, note that despite financial assistance, the percentage of family income going toward educational debt burden is significantly higher in low-income families. Kamenetz (2006) states that increasing tuition cost and decreasing entry-level salaries puts students financing their educations through loans at significant risk.

Avery and Turner (2012) indicate that for graduating students on the lower end of the wage spectrum, their earnings may not support their debt levels. In exacerbation, Haveman & Smeeding, 2006, find that the lifetime earnings of graduates with higher socio-economic backgrounds exceeds lower income graduates. Boswell and Wilson, 2004, note that the shift from grants to loans and from need-based to merit based funding has also hurt underprivileged students.

3. Discussion

The Pilot Job Market

Information systems, and more specifically, Information security was chosen for the pilot project due to a strong local and national industry need. In a 2013 report on the cyber security job market, Burning Glass International found that cyber security job growth exceeded growth in overall computer jobs by 3.5 times, and has exceeded growth in the general job market by 12 times.

It was found that this growth is widely spread across industries. The findings indicate that demand for cyber security professionals in the area has risen from 1000 to 8,500 between 2007 and 2012, an increase of 250%. With employers having difficulty filling cyber security positions, these jobs provide a salary premium of \$12,000 over other computer jobs. Many of the high profile employers hiring cyber security professionals have a presence in the local area, with numerous enterprises headquartered in the area, many with large security or information systems staffs.

Nationally, over 200,000 cyber security jobs remained unfilled in 2016 (Morgan, 2016). Anecdotal evidence from local employers, recruiters and consultants suggests that the trends in the area mirror those nationally, with many IT security job openings going unfilled due to a lack of qualified applicants.

Access

The community college has an open door admissions policy, with anyone over the age of 18 with a high school diploma or equivalent able to take courses. The two institutions have a strong articulation agreement whereby SPCS guarantees acceptance of any student from the community college who has completed an Associate of Applied Arts, Associate of Arts and Sciences or Associate of Applied Sciences degree, with a cumulative grade point average of 2.0 on a 4 point scale from all college work attempted. Up to 60 credits of community college coursework can be transferred into the bachelor's degree program. This agreement is designed eliminate barriers, and to help make the transition smooth, administratively, financially and socially.

Transition

As suggested in the literature, it is well known that the transition from community college to four year institution presents challenges for many students. It is believed that to prepare students for transition, having a formalized, documented pathway with all courses and requirements listed, and with the knowledge that acceptance is guaranteed, will mitigate the stress felt by participants.

Students are sent to the university by community college advisors who are familiar with the university curriculum and requirements, and a handoff is made to the university undergraduate advisor. The university employs dedicated advisors who are familiar with the program requirements. These advisors meet with the students as they start their programs, and follow the students, meeting with them at least once per semester.

Affordability

Both institutions have the typical financial aid provisions. The community college tuition follows that of the state community college system, and is very affordable. The university, although a private institution, offers tuition rates similar to the local public university. Both community college and university offer scholarships. In the case of the university, many small scholarships are offered, often by individual donors. These typically amount to the cost of one course each semester. The state also offers a stipend to each student attending a private school fulltime, also amounting to the cost of a course each semester.

Of significance is the fact that the pathway starts with students first earning a career studies certificate in computer programming, cyber

security, web design, computer applications or network administration. Appendix 1 contains a diagram of the process flow. Appendix 2 contains course listings for each certificate. By achieving this professional competence, the students become immediately employable. Once they have a job, whether full or part-time, they can minimize the amount of student loans they require. University students are also eligible for student jobs on campus. The combination of these opportunities makes the program much more affordable than a haphazard approach.

Retention

Once students are enrolled at the community college, it is important to keep them engaged and focused on the long term pathway goal. To that end, efforts must be made to include them in pathway activities such as round table discussions, meetings with other stakeholders, presentations, and invitations to university campus activities such as club meetings, lectures and sporting events. It is envisioned that a mechanism for early acceptance to SPCS, predicated on completion of their community college programs, may be devised. It was thought that such a program would require higher level approval, perhaps to the university board of trustees, but upon reflection, it may be possible to merely inform students that they will be admitted pending graduation from the community college.

Vision

Based on the student who comes from an underprivileged background, who has the capability to succeed but lacks information or role models, it was resolved to develop and advocate for a formal program to provide vision, structure and support for these students to help them succeed. This endeavor consists of (1) developing and formalizing the program; (2) developing and procuring marketing materials; (3) conducting outreach and advocating for the program; and (4) conducting activities (such as campus visits) to help students clearly share the vision.

The Plan

This end is achieved by developing, documenting and making students aware of a concrete roadmap leading to employment and academic success. This roadmap starts at high school graduation, with students first earning a Career Studies Certificate (CSC), then completing an Associate of Applied Science (AAS) and continuing on to complete a Bachelor of Science in Professional Studies (BSPS) with majors in IT

Security or Information Systems. IT courses required of all associate's students beyond those in the certificates are listed in Appendix 2. The project sets students up for success through non-traditional processes without incurring large amounts of student debt - they become employable immediately upon completion of their CSC, and can then work on their AAS, using a well-defined, formalized and accessible roadmap. Finally, students will transfer to obtain their bachelor's degree. Transfer is guaranteed upon completion of their AAS. Majors courses required for the BSPS in Information Security may be found in Appendix 3.

Developing

Program development consists largely of preparing promotional materials documenting the program already in place. There has long been interaction between administrators and faculty between the schools, and the pathway generally works well. The challenge is to get potential participants to see the potential outcomes from a holistic view. The one significant change is for the community college to consolidate their associate's degrees, and to make the CSC's part of the associate's degree at the front end - again, to make students employable upon completion of the CSC, leading to less reliance on financial aid, as well as to improve completion rates at the institution. Development consists of documenting the program, defining information of import to potential participants, then turning the programmatic information over to the marketing departments from both institutions for collaboration and approval of the promotional materials. It is hoped that this opportunity to market the program jointly will have a synergistic effect on marketing efforts.

Advocating and Outreach

The program makes provision to provide honoraria and travel funding for stakeholders and advocates to go out into the community to meet with and address school counselors and students to explain and build interest in the program. It is envisioned that each high school in the community college catchment area be at least provided with promotional materials. Depending on funding, the schools with the most need or potential receive visits by advocates as available.

Additional Activities

It is planned that to help students fully understand the possibilities of the program, field trips will be provided to show them what is possible. A typical field trip involves a morning visit to the community college, with a campus

tour and address by faculty and administrators. Lunch at the university's dining facility and a university tour fill the afternoon.

Pilot Program

The pilot program is targeted towards students in the community college catchment area. The plan is to document and formalize the pathways process, then develop and obtain informational and promotional materials for distribution to high school students, counselors, teachers and administrators, as well as graduates. Next, external outreach advocates (industry personnel, alumni, instructors and other stakeholders) are sent to high schools to inform and advise administrators, counselors and students on the benefits of the program. Finally, students would take field trips to both campuses with lunch at the university dining facility would be offered to groups identified as the most likely targets by the marketing departments.

The initial goal for the pilot was set to provide informational material to a minimum of 75% of the targeted population, and to directly interact with 25% of the targeted population. Advocates would try to meet and exceed those targets as funding permitted. Field trips would follow, also based on funding, with no set goal identified. A budget was developed based on those goals.

Program Implementation Funding

A budget was developed to meet the requirements of the pilot project:

Expense	Budget
Printing & Outreach Materials	7000
Travel & Communications	4700
Campus Visits	3000
Total	14700

Figure 2. Initial Pilot Budget.

It was found that neither program had funding available at the proposed level to implement the program. At the community college, marketing was done at the institution level, while at the university, this population is one where recruiting was not traditionally conducted, since students would not typically be ready to transition for at least two years. However, since all involved felt the project to be a worthwhile endeavor as well as the right thing to do, the university dean approved funding for a small amount of promotional to be printed for a pilot project.

Grant

Program developers were made aware of the local branch of a national bank interested in providing grants for workforce development. In collaboration with the university Office of Foundation, Corporate and Government Relations, a grant proposal was submitted. The grant was approved, and funding in the amount of \$5,000 was received. The funds were reallocated as follows:

Expense	Budget
Printing & Outreach Materials	2500
Travel & Communications	1250
Campus Visits	1250
Total	5000

Figure 3. Grant Funding for Pilot

The grant funding allows the program to be put in place starting in the fall of 2017. It is anticipated that the first participants will start at the community college in the fall of 2018, following their graduation.

Continued Work

There is much left to be done to ensure the ultimate success of the program and the students by implementing all of the recommendations found in the literature. The support for retention and transition described in the literature must be put in place as students begin enrolling, and efforts must be made to continually improve their academic, social and financial support.

4. FUTURE RESEARCH

As the program begins to see results of the advocacy effort and students start to enroll, metrics must be developed to determine the success of the program. Neither institution currently collects information on student admittance sources. Additional demographic information is also required to determine the effects of the program, and how improvements may be made.

5. SUMMARY

The author proposes an end-to-end program for high school students interested in information security careers, but who are not aware of, do not qualify for, or cannot afford a traditional college experience or vocational training. The literature contains numerous recommendations to help these students succeed. This roadmap starts at

high school graduation, with students first earning a Career Studies Certificate (CSC), then completing an Associate of Applied Science (AAS) and continuing on to complete a Bachelor of Science in Professional Studies (BSPS) with majors in IT Security or Information Systems.

This endeavor consists of (1) developing and formalizing the program; (2) developing and procuring marketing materials; (3) conducting outreach and advocating for the program; and (4) conducting activities (such as campus visits) to help students clearly share the vision.

6. CONCLUSIONS

While the full effects of this program will not be felt for years, it is anticipated that it will contribute to helping students recognize the opportunities available to them, and help those students realize the dream of a bachelor's degree and a career in information security.

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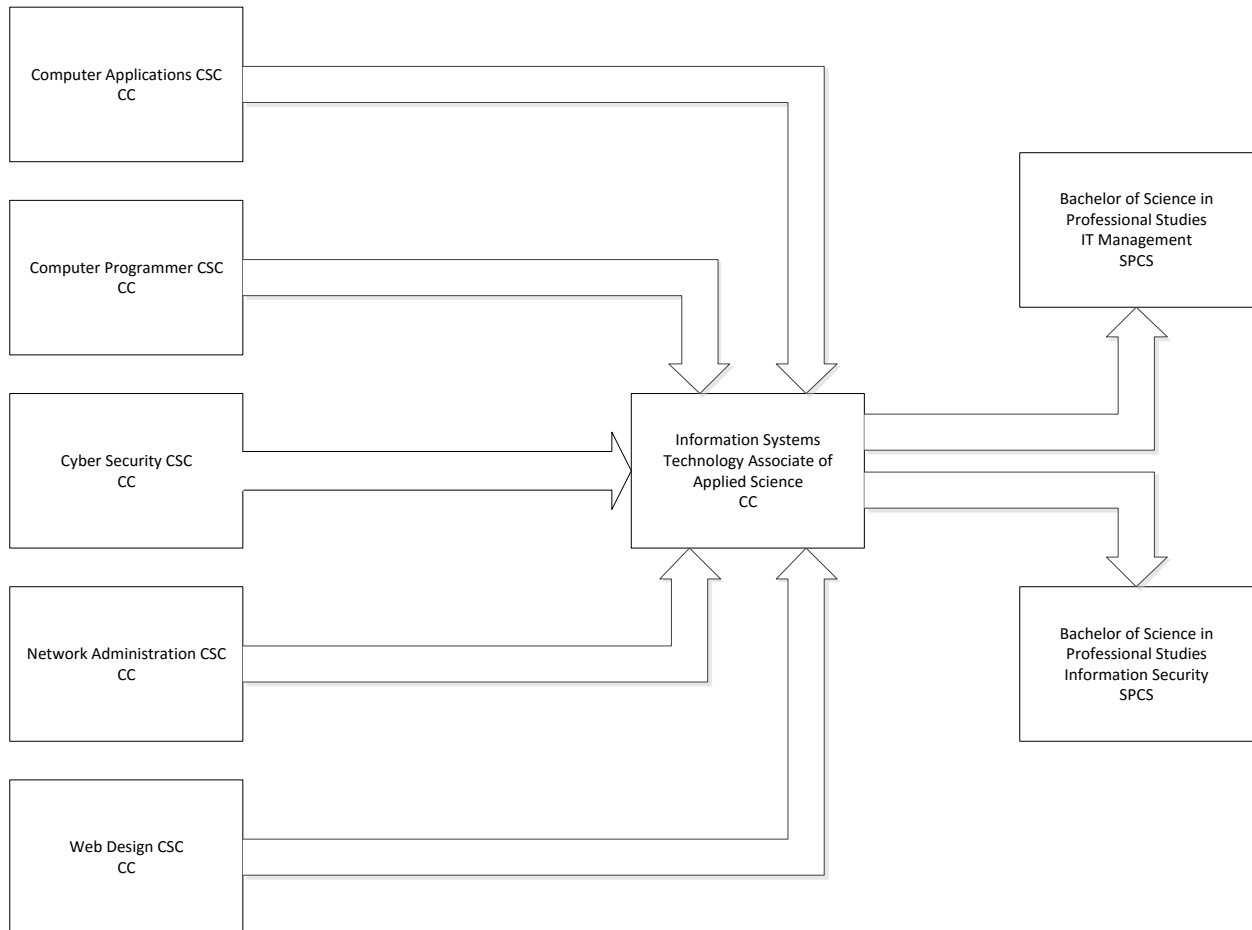
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Appendices



Appendix 1. Pathway program diagram.

Appendix 2. Career studies Certificates and Associate's Degree.

Web Design Career Studies Certificate		
Course	Title	Credits
ITE 115	Introduction to Computer Applications and Concepts	3
ITE 221	PC Hardware and OS Architecture	4
ITD 110	Web Page Design I	3
ITD 112	Designing Web Page Graphics	3
ITD 130	Database Fundamentals	4
ITD 212	Interactive Web Design	4
ITD 210	Web Page Design II	4
ITD 298	Seminar and Project: Web Design Capstone	4
Total		29
Computer Applications Career Studies Certificate		
Course	Title	Credits
ITE 115	Introduction to Computer Applications and Concepts	3
AST 141	Word Processing I	3
ITE 130	Introduction to Internet Services	3
ITE 140	Spreadsheet Software	3
ITE 150	Desktop Database Software	3
ITE 221	PC Hardware and OS Architecture	4
ITD 110	Web Page Design I	3
ITE 298	Seminar and Project: Microcomputer Applications Capstone	4
Total		26
Computer Programmer Career Studies Certificate		
Course	Title	Credits
ITE 115	Introduction to Computer Applications and Concepts	3
ITP 136	C# Programming I	4
ITP 236	C# Programming II	4
ITP 251	Systems Analysis and Design	3
ITD 130	Database Fundamentals	4
ITP 244	ASP.Net-Server Side Programming	4
ITP 298	Seminar and Project: Programming Capstone	4
	Total	26

Network Administration Career Studies Certificate		
Course	Title	Credits
ITE 221	PC Hardware and OS Architecture	4
ITN 101	Introduction to Network Concepts	4
ITN 171	UNIX 1	3
ITN 110	Client Operating Systems	4
ITN 111	Server Administration	4
ITN 260	Network Security Basics	4
ITN 254	Virtual Infrastructure: Installation and Configuration	4
Total		27
Cyber Security Career Studies Certificate		
Course	Title	Credits
ITN 101	Introduction to Network Concepts	4
ITN 260	Network Security Basics	4
ITN 261	Network Attacks, Computer Crime, and Hacking	4
ITN 262	Network Communication, Security, and Authentication	4
ITN 263	Internet/Intranet Firewalls and E-Commerce Security	3
ITN 266	Network Security Layers	3
ITN 276	Computer Forensics I	3
Total		26

Note: To complete the IST Associate of Applied Science, all students must complete the following majors courses regardless if required for their certificate.

Additional IT Courses required for IST AAS		
Course	Title	Credits
ITE 115	Introduction to Computer Applications and Concepts	3
ITN 101	Introduction to Network Concepts	4
ITN 260	Network Security Basics	4
ITP 251	Systems Analysis and Design	3
Total		14

BSPS in Information Security		
Professional Core		
Course	Title	Credits
LDSP 368U	Leadership in the Global Environment	3
HUM 300U	Applied Ethics	3
MATH 300U	Critical Thinking	3
Required		
Course	Title	Credits
ISYS 302U	Local Area Networks (LAN)	4
ISYS 303U	IT Security	3
ISYS 491U	IT Security Planning and Risk Management	3
Focus (11 Semester hours of these minimum)		
Course	Title	Credits
ISYS 306U	Systems Analysis	3
ISYS 311U	Database Design	3
ISYS 355U	Computer Programming in Java	4
ISYS 360U	Electronic Commerce	3
ISYS 365U	Cloud Computing: Infrastructure & Services	3
ISYS 370U	Introduction to Ethical Hacking and Pen Testing	3
ISYS 375U	IT Control and Audit	3
ISYS 398U	Selected Topics:	3
	Digital Forensics	3
	Malware Reverse Engineering	3
	Big Data	3
	Intro to Python/Black Hat Python	3
ISYS 399U	Independent Study	3
ISYS 450U	IT Project Management	3
ISYS 490U	Managing IT	3
ISYS 492U	Consulting and Design of Online Systems	3
LAW 325U	Cyber Law	3
MGMT342U	Managing Business Processes	3

Appendix 3: Majors courses for Bachelor of Science in Professional Studies with major in Information Security.