

# Information Systems Security Education at Polytechnic University of Puerto Rico

Houssain Kettani, *Polytechnic University of Puerto Rico*

**Abstract** – *Information Systems Security (ISS) has become increasingly an integral part of our lives. Accordingly, there is the need of increasing awareness of this issue in the society, increasing the workforce capable of meeting the corresponding challenges, and increasing the diversity of such workforce. Academic institutions are in the forefront of this challenge and are best equipped to fulfill the aforementioned goals. Understanding this need, Polytechnic University of Puerto Rico (PUPR) has taken various steps to address this problem. In this paper, we share the advances of ISS education at PUPR and the steps taken to be recognized as a national center of Academic Excellence in Information Assurance Education (CAE/IAE).*

**Index terms** – **Computer security education, Polytechnic University of Puerto Rico, diverse workforce.**

## I. INTRODUCTION

Polytechnic University of Puerto Rico (PUPR) is a Hispanic Serving Institution (HSI) with an enrollment of about 6,000 students, and is the largest private Hispanic Serving Engineering School in the United States. PUPR's student enrollment is Hispanic U.S. citizens of which about 90% are undergraduates and about 25% are females [1]. PUPR is located on a ten-acre piece of land in the heart of the financial district of the capital San Juan of the Caribbean island of Puerto Rico, which is a U.S. territory, about the size of the state of Connecticut, and with a population of about four million, the vast majority of which are Hispanic U.S. citizens [3]. PUPR operates on a semester-hour-equivalent trimester in which 45 contact hours corresponds to three credits. Accordingly, a three-credit-hour undergraduate (graduate) course meets twice (once) weekly for a total of four contact hours. The minimum number of credit hours that an undergraduate (graduate) student can take to be considered a full-time student is twelve (six) per trimester. Classes are taught in Spanish or English, but textbooks are in English, and it is expected that students present most of their written work in English. PUPR offers baccalaureate degrees in

engineering (civil, chemical, computer, electrical, environmental, industrial, and mechanical), computer science, architecture, business administration, management, and land surveying. PUPR also offers masters in engineering (civil, computer, electrical, manufacturing), computer science, engineering management, manufacturing competitiveness, environmental management, landscape architecture, and business administration. PUPR has the highest number of ABET accredited undergraduate programs in Puerto Rico [6].

The Electrical and Computer Engineering and Computer Science (ECECS) Department has more than 1,400 students, about 25% of PUPR's student enrollment, of which 93% are in the Bachelor's program, 7% are in the Master's program, and 14% are female [1]. In terms of its enrollment, the ECECS Department ranks the second in the United States. The Master of Science in Computer Science program in the ECECS Department currently has an enrollment of about sixty students. This program is the first and only of its kind in Puerto Rico, and has a specialization in Information Technology Management and Information Assurance (ITMIA) that has about forty students. Graduate courses in IA include: Cryptography Protocol, Introduction to Information Security, Computer Security, CISSP Exam Preparation, Network Security, Information Security Management, Database Security and Auditing, IT Auditing and Secure Operations, Homeland Security: Cyber terrorism, among others. PUPR also offers undergraduate courses on security such as: Computer Forensics, Ethical Hacking, Network Security, and Reverse Engineering, among others. Accordingly, the Department has offered more than twelve courses in the area of security at both undergraduate and graduate level.

PUPR is proposing a Graduate Certificate in Information Assurance and Security (GCIAS) to highlight the ITMIA specialization as well as to prepare other Information Technology, Computer Engineers, and Information System professionals who are working in the development and/or maintenance of information and computer security systems or products, such as graduate engineers, scientists, or managers in related fields. This certification is in the process of being evaluated by the Council of Higher Education of Puerto Rico. It will

---

*H. Kettani is with the Department of Electrical and Computer Engineering and Computer Science, Polytechnic University of Puerto Rico, San Juan, PR 00919, USA (e-mail: hkettani@pupr.edu). This work was supported in part by the United States Nuclear Regulatory Commission under grant number NRC-27-09-310.*

prepare the student and professional with Information Assurance and Security skills that are already of great demand in today's fast paced, high-tech, competitive work areas.

## II. NATIONAL RECOGNITION AND CHALLENGES

### A. Accreditations

The quality of PUPR's academic programs is demonstrated by the accreditation from the following agencies:

- The Middle States Association of Colleges and Schools (MSACS).
- The Council of Higher Education of Puerto Rico (CHE-PR).
- The National Architectural Accrediting Board (NAAB).
- The International Assembly for Collegiate Business Education (IACBE).
- The Accreditation Board for Engineering and Technology (ABET) accredits all of our undergraduate engineering programs (civil, chemical, computer, electrical, environmental, industrial, and mechanical), and land surveying and mapping program.
- PUPR is an associate member of Oak Ridge Associated Universities.

### B. National Standing

In addition to various accreditations that PUPR successfully obtained, in May 2008, the Chronicle of Higher Education reported that "The nation's top producers of Hispanic engineers are the public University of Puerto Rico at Mayagüez and the private Polytechnic University of Puerto Rico. Together they account for about a fifth of the 4,614 bachelor's degrees in engineering that American institutions awarded to Hispanic students in 2005. Most of the other institutions with high rankings on that list are public universities in Florida and Texas," [2].

PUPR's five-year undergraduate and two-year graduate programs have gained an outstanding reputation in Puerto Rico over the years for producing highly skilled and workforce-ready talent. Consequently, PUPR graduates are placed in graduate schools, while others join government or private sector scientific facilities. PUPR graduates progress well in their chosen careers. Accordingly, numerous fortune 500 and fortune 100 companies, federal agencies such as Federal Highway Authority, Patent and Trademark Office, Army Research Office, Department of Defense, NASA, NSA, to mention a few, and local industry and government are recruiting PUPR graduates every year.

### C. Under-representation

Nationally, the under-representation of Hispanics in science, technology, engineering and mathematics (STEM) careers has been a topic of research and concern for educators and policy makers. Research has consistently shown the benefits of a workplace that reflects the diversity of the broader community. Many national committees are formed to help focus on removing obstacles preventing minority and women participation in STEM careers. Many universities utilize pipeline models to help carry students interested in a STEM domain from one level of participation to more advanced levels in order to help students gain experience and knowledge. Unfortunately, minority participation in STEM related disciplines remains a serious challenge. For example, while Hispanics make up about 15% of the U.S. population [3], they only account for about 5% of the STEM workforce [4]. Thus, given the fact that PUPR produces one out of ten Hispanic engineers [2], it is of great importance to support such institution to fulfill the national need.

### D. Geopolitics

The geopolitical state of Puerto Rico makes it harder for students to relocate to the U.S. Mainland. The fact that it is an island makes it harder and more expensive for its residents to visit the U.S. Mainland and increases the isolation. Moreover, Puerto Rico is a U.S. territory and not a state, which makes it unable to access federal funds that are otherwise available for states. Furthermore, the first language in Puerto Rico is Spanish, which makes the students hesitate to communicate in English as it is not their language of daily use. In addition, unlike the case in the U.S. Mainland, in Puerto Rico lower socio-economic income students generally attend private colleges and universities and middle and upper middle class students attend the public university system. As a result, private higher education institutions on the Island have historically provided access to higher education for lower income students. This has been both a source of pride and challenge for the University. As a result, PUPR serves students from a target area that is characterized by economic deprivation, large concentration of disadvantaged population, and a low educational attainment.

### E. Retention Rate

The geographic and socio-economical conditions of the region present barriers against completion of high school and subsequent college enrollment and graduation. Accordingly, PUPR's students typically have to struggle to pay for their school and other expenses which force them to work full-time outside the University campus while being registered as full-time students. This hardship

forces other students to register part-time while working full-time to support their education and make ends meet. Thus, about half of PUPR's student enrolment is part-time [1]. The tendency of the students to work outside campus negatively impacts their grades, time to perform any research-related task, and their inclination to join a graduate school. This is if students were able to stay in school and continue their education. The grim reality is that the undergraduate retention rate at PUPR is less than 35% [5]. According to an institutional report [5], the average annual withdrawal for first year students (1995-2005) is 22%, for second year students (1995-2004) is 20%, for third year students (1995-2003) is 10%, for fourth year students (1995-2002) is 7%, and for fifth year students (1995-2001) is 5%. Therefore, with some support, PUPR can double or triple its production of Hispanic engineers from one out of ten to fulfill the national need and better serve the local population of Puerto Rico.

### III. CENTER OF INFORMATION ASSURANCE

The Center of Information Assurance for Research and Education (CIARE) of Puerto Rico has been established in January 2009. It has the mission of promoting research, undergraduate and graduate education, and public outreach to benefit the Information Assurance academic community and public in general, serving as a forum for students, faculty, and IA professionals from different sectors of the economy. CIARE will help produce more professionals with IA expertise in various disciplines to secure and protect local and national information resources and cyberspace infrastructures. In particular, the goals of CIARE are to:

- Reduce the vulnerability of the nation's information infrastructure by promoting higher education in information assurance (IA) with the development of graduate and undergraduate education programs for professionals in information assurance and security;
- Provide a forum that can be used by professors, professionals, industries and students to collaborate in the identification and solution of issues on IA and cyber security;
- Be a vehicle for information assurance training, research, invention, innovation, education, public awareness, entrepreneurship, economic development, and dissemination of best practices, among others; and
- Maintain collaboration programs with top universities nationwide and strengthen the existing and new industries and the overall economic development in the state of Puerto Rico by developing joint research projects between industry and academia in computer security, and encouraging the practice of

emerging security standards within minority institutions.

There is a great demand for professionals that can bring solutions through collaboration, public awareness and the introduction of new methods of Information Assurance (IA) and cyber security. Information Assurance is an area that presents great challenges requiring solutions that can only be obtained by means of research and innovation, which leads to the introduction of new products and services. Accordingly, CIARE provides a forum that can be used by faculty, students, and professionals from the public and private sectors. The Center is a vehicle for training, research, invention, innovation, education, public awareness, entrepreneurship, economic development, and dissemination of best practices. The Center emphasizes on the participation of underrepresented groups. We plan to develop joint research projects in computer security, data integrity, and encourage the practice of emerging security standards with minority institutions.

### IV. CENTER OF ACADEMIC EXCELLENCE

The first step in establishing a Center of Academic Excellence (CAE) in Information Assurance Education (IAE) that is approved by the National Security Agency (NSA) and the Department of Homeland Security (DHS) is to map the courses that we offer in IAE domain to two standards of the Information Assurance Courseware Evaluation (IACE). Accordingly, in November 2008, the Review Committee of IACE has validated the mapping at 100% for the Committee on National Security Systems (CNSS) National Standards: Information Systems Security (INFOSEC) Professionals, NSTISSI No. 4011, and System Administrators (SA), CNSSI No. 4013 Entry Level. Thus, PUPR will receive recognition and an official certificate during the June 2009 CNSS Awards Ceremony, which will be held at the 13th Colloquium for Information Systems Security Education (CISSE), Seattle, Washington. This certificate, signed by the CNSS Chair, will be valid through June 2014.

The IACE Program provides consistency in training and education for the information assurance skills that are critical to our nation. It is worth noting here, that PUPR is the first Academic Institution in the Caribbean to be certified by CNSS. This certification is the first step toward recognition of PUPR by NSA as a CAE/IAE under NSA's Information Assurance Program. As a result of this certification, PUPR is looking forward to become the first CAE/IAE in Puerto Rico and the Caribbean, designated by NSA and DHS. As a requirement to earn this recognition, PUPR needs to establish the center first. Thus, in January 2009 CIARE was established and PUPR applied to the 2009 NSA/DHS Centers of Academic Excellence in Information Assurance Education Program to be designated as CAE/IAE. Currently, there is a total of

94 colleges and universities that are designated all across the U.S. by NSA and DHS as CAE/IAE [7]. PUPR is in a strategic position in the Caribbean where there is no designated institution close by. This is in addition to PUPR's excellent resources to support the initiatives of increasing national defense, as our highly skilled faculty and students are mostly bilingual Hispanic American citizens, who are traditionally under-represented in IA domain.

PUPR is interested in receiving this designation, and strengthening the curriculum for the Information Technology Management and Information Assurance (ITMIA) specialization in our Master in Computer Science (MS CS) program, giving graduate students the opportunity to specialize and obtain a certification in such a demanding area of great concern, as is Information Assurance and Security. With this designation the Institution can obtain the necessary infrastructure to provide an exceptional educational experience in Information Assurance and be recognized as the first institution in Puerto Rico to be designated as a CAE/IAE. This designation will enable PUPR to obtain scholarships that can help outstanding students pursue graduate studies in IA, enabling them to work with the Federal Government or other federal institutions and agencies. The Institution would be able to apply for Scholarships for Service (SFS) awards from the National Science Foundation; funds for faculty and student research; and many other benefits that are available for designated centers nationwide.

#### V. CONCLUSION

Towards the establishment of a Center of Academic Excellence (CAE) in Information Assurance Education (IAE) that is approved by the National Security Agency (NSA) and the Department of Homeland Security (DHS), Polytechnic University of Puerto Rico (PUPR) has followed several steps. We have strengthened our IA course offerings at both the undergraduate and graduate levels in our computer science program by offering more than twelve courses in IA domain. This course offering was certified by the Committee on National Security Systems (CNSS) and successfully mapped to National Standards 4011 and 4013 Entry Level. We have also established the Center of Information Assurance for Research and Education (CIARE) and applied to have it designated by NSA and DHS as one of the nation's Centers of Academic Excellence in Information Assurance Education (CAE/IAE), which is expected to be the first in Puerto Rico. Such recognition will enable PUPR to strengthen its IA capabilities in education and research, and increase the diversity of the IA workforce due to its very large Hispanic enrolment.

#### VI. REFERENCES

- [1] "Factbook 2006-07", Office of Planning and Institutional Research, Polytechnic University of Puerto Rico, August 2007.  
<http://www.pupr.edu/pdf/FactBook.pdf>
- [2] P. Schmidt, "Report Urges Engineering Schools to Work Harder at Diversity," The Chronicle of Higher Education, May 1, 2008.  
<http://chronicle.com/news/article/4411/>
- [3] "The World Factbook," Central Intelligence Agency, July 2009. <https://www.cia.gov/library/publications/the-world-factbook/>
- [4] "Science and Engineering Indicators 2008," National Science Board, National Science Foundation, January 2008. <http://www.nsf.gov/statistics/seind08/>
- [5] "Undergraduate Programs Retention Rate 1995-2006", Office of Planning and Institutional Research, Polytechnic University of Puerto Rico, August 2006.
- [6] "Accredited Program," The Accreditation Board for Engineering and Technology (ABET), October 2008.  
<http://www.abet.org/schoolstate.asp>
- [7] "Centers of Academic Excellence – Institutions," National Security Agency, January 2009.  
[http://www.nsa.gov/ia/academic\\_outreach/nat\\_cae/institutions.shtml](http://www.nsa.gov/ia/academic_outreach/nat_cae/institutions.shtml)