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# A Cross-Institutional Faculty Research Mentorship Program in Information Security and Assurance

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**Abstract** – ***This article examines the impact of a cross-institutional faculty research mentorship program in Information Assurance (IA) on teaching and research at participating institutions. In this NSF funded project, security researchers invite community college and junior faculty to work jointly on research problems in IA and security. The program aims to enhance teaching in security at institutions in the Maryland Alliance for Information Security and Assurance (MAISA) through research. Its underlying philosophy is that research should inform teaching and teaching should, in turn, inform research. To date, the program has supported six research teams consisting of a total of six research fellows recruited from community college faculty and from non-research active faculty at four year colleges, and eight research mentors. Each team consists of at least one research fellow and at least one research mentor from one of our research universities. The duration of each research project is two academic semesters, or one academic semester and a summer. The program has also supported two research externships, where one of our senior researchers collaborates with an industry partner on an IA-related topic.***

**Index terms – Research, Teaching, Faculty development**

## I. INTRODUCTION

In 1998, the Boyer Commission on Educating Undergraduates in the Research University issued a report stressing the importance of strengthening the research-teaching nexus in enhancing undergraduate education at "research universities" [1]. Prince et al. [2] define the research-teaching nexus as "ways in which research supports teaching and teaching supports research." Research universities consists of the so-called "Research I" and "Research II" universities. The Carnegie Foundation for the Advancement of Teaching [2] defines Research I universities as those which "offer a full range of baccalaureate programs, are committed to graduate education through the doctorate, and give high priority to research. They award 50 or more doctoral degrees each year. In addition, they receive $40-million or more in federal support." The foundation defines Research II universities as those receiving "between 15.5-million and $40-million" but are otherwise like Research I universities.

Although the Boyer Commission focused primarily on strengthening the research-teaching nexus for the research universities, increase faculty research activity [2] not only at research universities but also at institutions with teaching as their primary mission [3] including community colleges [4], there is ample evidence that the need is even more urgent and is needed at non-research institutions. This increase research activity has been attributed to growing dependence on external research funding to support basic operations and the intense desires of administrators and faculty members for high national ranking.

Yet for years, there has been a raging debate between those who support the hypothesis that faculty research enhances teaching—primarily faculty members and administrators—[6][7][8], and others who question this view [9][10][11][12]. However, Prince et al. [2] argue that the two sides are in essence debating two different propositions: "(1) research has the potential to support teaching, and (2) research has been shown to support teaching in practice." The authors further explain that, those who argue that research supports teaching offer evidence in support of proposition 1. Most of those who argue the other way readily concede that teaching and research *can be* complementary but take the negative position on proposition 2, citing numerous studies that have consistently showed negligible correlation between research productivity and teaching performance.

The contention that there is not a significant and strong correlation between research and teaching seems to be borne out by a number of authors. Rugarcia [13] and Felder [9] explains that the main reason for this lack of (or weak) correlation is that research and teaching have different goals and require different skills and attributes. Most of the analyses in the literature seem to come to the

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conclusion of Feldman [14], Hattie and Marsh [15] and Jenkins [11] which may be summed up as follows: "while research productivity does not preclude quality teaching, the two are unrelated at the individual faculty level. Some professors excel at both teaching and research, many excel at one and not the other, and some are unexceptional in both" [3]. Astin [16] demonstrates that the claim of synergy between research and teaching at the institutional level is even more difficult to justify.

Hattie and Marsh [15] point out that the solution does not lie in a more sophisticated analysis of the data, but instead in addressing the question of how to develop techniques to enhance the relation between teaching and research (i.e., the research-teaching nexus). This approach has been supported by several other authors and studies [1][11][17]. It has become even more relevant in recent years given that the expectations for faculty research have risen at the same time that higher education is facing demands for increased public accountability [1] [11] [18].

Prince et al. [3] present the following as three commonly proposed strategies for strengthen the research-teaching nexus: "(1) bringing research into the classroom; (2) involving students in research projects; (3) broadening the model for academic scholarship." To bring research into the classroom, an inductive rather than a lecture based teaching model is encouraged [2] [19]. Inductive methods include problem-based and inquiry-based approaches.

One of the long-term goals of the Maryland Alliance for Information Security and Assurance (MAISA) is to strengthen the research-teaching nexus in Information Assurance (IA) throughout MAISA institutions. Although there are currently no research universities, as defined by The Carnegie Foundation for the Advancement of Teaching [2], that are members of MAISA, some of our institutions have very active research programs. It is for this reason that we have developed the idea of teams consisting of faculty members from our research active universities and our non-active research faculty and from community colleges to conduct research, and to ultimately strengthen our nexus. Our efforts can be divided into two parts: (1) develop the faculty for research, and (2) strengthen our existing research-teaching nexus. This article concentrates mainly on the first component. A future article will discuss the second component. The remainder of the paper is organized as follows: Section II provides an overview, Section III discusses our team creation and management method, Section IV discusses the research topics for each of the teams, Section V presents our evaluation method.

## II. Overview

The goal of this paper is to discuss the impact of a cross-institutional faculty research mentorship program in Information Assurance on teaching and research at participating institutions. The program is one component of an NSF supported project, "A Second Generation Faculty Development Program," that pairs security researchers with community colleges and junior faculty to work jointly on research problems in information assurance and security. The program aims to enhance teaching in security at institutions in the Maryland Alliance for Information Security and Assurance (MAISA) through research. Its underlying philosophy is that research should inform teaching and teaching should, in turn, inform research.

To date, the program has supported six research teams consisting of a total of six research fellows recruited from community college faculty and from non-research active faculty at four year colleges, and eight research mentors. Each team consists of at least one research fellow and at least one research mentor from one of our research universities. The duration of each research project is two academic semesters, or one academic semester and a summer. The program has also supported two research externships, where one of our senior researchers collaborates with an industry partner on an information assurance-related topic.

## III. The Research Collaborations Process

The aim of our faculty research collaboration is to enhance teaching in security and IA at the various MAISA institutions through research. Research plays a pivotal role in enhancing understanding for both instructor and student. By conducting research, an instructor is able to take a more in-depth look into a variety of topics in security while keeping abreast with the state-of-the-art in the field. Students can then benefit from a more informed and knowledgeable instructor who can share this research experience in a myriad of ways, including through interesting problems and projects. Moreover, collaborative research is an effective approach for faculty with heavy course loads because it enables the work to be shared among them.

During the project, the research mentor and the research fellow met regularly, with the mentor taking the lead role in their collaboration. We supported both the research mentor and the research fellow throughout the course of their joint project. By creating these collaborative research projects we helped both the research fellow as well as the research mentor. Indeed, research fellows had

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the opportunity to work with an established researcher, where all of the necessary equipment and facilities were already present. Working on the joint research project helped the research fellow become an expert in a particular area of information assurance, and to gain valuable experience. Further, by supporting the research fellows as they present their results at regional or national research conferences, we helped the research fellows form connections with the wider IA community.

These collaborative projects also helped the research mentors by exposing them to new collaborators and new ideas. It is important to note that, although many community college faculty have only a Master's degree, many have extensive experience in industry, and that new perspective will help the research mentor.

These projects have also been of benefit to the wider IA community by forging connections between faculty members. Moreover, because all of the project participants are in relatively close geographic proximity, we expect that the partnerships formed will persists long after the formal project has ended.

In addition, to these faculty collaborations, we also have an externship component where an experienced faculty researcher collaborates with an industry partner on a research project of mutual interest. We supported two such collaborations in 2008 and 2009, respectively. These will also be discussed in the next section.

## IV. The Research Teams and Their Projects

In 2008, the Principal Investigators (PIs) solicited applications for three research projects, each pairing a research mentor with a research fellow, and in 2009, we solicited an additional three projects.

The first project, "Emergency Evacuation and Rapid Depopulation Model with Secure Wireless Implementation Considerations," was carried out by a junior and senior research member of the Morgan State University faculty. The researchers present a clear and solvable problem statement. They identified the absence of an effective approach by the Federal authorities to link terrorist threats, strategy and available resources to fight terrorism and proposed two solutions to reduce any deficiencies in the current strategy. Their first approach was to develop a model of an optimal route to move people from train stations to the outskirts of urban areas in the event of a disaster. The second solution proposed to investigate the feasibility of a secure wireless gateway to support a secure digital alerting and information management system.

The second research project, "Security Awareness, Ethics and Behaviors of College Students," was conducted by a senior research faculty from Bowie State University and a junior researcher from the Community College of Baltimore County (CCBC). This research has been useful in identifying the level of security awareness among a non-random sample of 63 students taking an introductory computer security course at a Historically Black University and a Community College. The goal of this research was to use their findings to aid in designing future awareness training courses which can reduce the level of risky behaviors among the students.

The third research project, "Securing Speaker Recognition Systems," was by a senior researcher from Bowie State University and a research fellow from Morgan State University. This research reports on difference measures in cross-channel data in speaker identification, and suggests ways to incorporate these differences in speaker recognition to help to improve speaker identification.

The fourth research project, conducted a study to obtain the level of security, ethics and behavior awareness among African-American Males (AAMs) ages twelve to seventeen. The subjects participated in a two-week Computer Programming Camp during the summer of 2009 at a University located in a suburban county in Maryland. Students completed a modified questionnaire used by Kumar and Zenebe, who worked on the second research project, "Security Awareness, Ethics and Behaviors of College Students," during the previous year. It is generally accepted in the field that younger African-American males can be labeled as 'dis-identified' with academic achievement and success in the STEM (Science, Technology, Engineering and Mathematics) area. This research examined an atypical group in the STEM areas. Results reveal young AAMs participating in the computer programming camp had very little knowledge of computer security beyond viruses and firewalls. Students were unsure when asked about topics such as: software vulnerabilities, invalid input, what stage security should be implemented in software life cycle, and the difference between security software and software security. The participants in the study were aware of the importance of a strong password. Most reported their home computer contains anti-virus software and they rarely download files, while on the Internet. When in chat rooms, students claim that they did not use their real names. Most of the students maintained a mySpace page, but access is restricted to users inside their circle of friends.

A fifth research project by several faculty members from Towson University and a faculty member from the Community College of Baltimore County – Essex

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provides a literature review on virtual worlds, which have become an important area of research in recent times. It discusses the issues such as: (1) the many active internet users that are using virtual worlds, such as Second Life for social interactions, (2) that such mediums are a growing trend for online communication, (3) the impacts of using these technologies, and (4) the leading areas of concern related to the use of virtual worlds focusing on security, legal and ethical implications.

A six research project by a faculty member from Bowie State University and another from Garrett College discussed the conflicting goals of satisfying the security and privacy needs of users' personal data versus businesses desire to increase profits and the popularity of their business through liberal sharing of information among users.

In 2008, the project supported one faculty externship project "A New Class of Steganographic & Steganalysis Algorithms for Wireless Sensor Networks (WSN)." This project paired one of our faculty from Bowie State University with Dr. Dwight Richards of RSoft Design Group, Inc. The research focused on developing steganographic and steganalysis algorithms for the wireless sensor networks environment (WSN). The motivation for the research is attributed to the absence of such algorithms due to the challenges encountered in their development. The research team cited availability of limited power and limited computational capabilities of the nodes in the WSN environment as two of the research challenges.

As a result of the externship, the faculty member authored and presented the article "A Steganographic Computational Paradigm for Wireless Sensor Networks," which was accepted and published in the conference proceedings for Innovations in Information Technology (Innovations'09). The article proposes a routing algorithm that uses redundancy, "divide and conquer" and other techniques to meet the challenges of routing steganographic data through a WSN. Elements of this project were also presented at a MAISA workshop held in January, 2010.

In 2009, the PIs supported a second externship project. A Towson University (TU) faculty member worked with Bradley P. Allen of Symantec Research, presenting research in the area of "Dynamic Traffic Driven Architectures and Algorithms for Securing Networks". During this period work was initiated on a collaborative research project with the Security Technology and Response team at Symantec Research, CA on the design of a "Reputation based framework for anti-virus software application". This project involved detailed data analysis, reputation framework design and testing on real-time data available from Symantec Research. Furthermore, this research effort will involve continuing collaboration of TU faculty and student(s) over a period of one year. This project is aimed at designing models and algorithms for applying reputation based security framework in an existing antivirus software application. The anti-virus package uses different mechanisms such as static file scanning, behavioral monitoring, heuristics, rules implementing proactive and reactive measures etc for protecting the users system. However, these efforts seem to be insufficient as malware authors tend to keep up with the development in the technology. Malicious contents can evade signature or heuristics based protection.

The project aims to apply a new approach that would correlate data between multiple identities to protect against new security threats in software applications. Currently, technology uses the concept of black listing and white listing to identify good and bad files. This approach works fine for files with signatures that are highly prevalent; however, the approach often fails, as there is a sufficiently large number of files with very low prevalence. This project will involve detailed data analysis, reputation framework design and testing on real-time data available from Symantec Research. This project is aimed towards peer-reviewed publication and future collaborative funding opportunities.

## V. Evaluation

The research evaluation process was performed in two stages—evaluation of research abstracts and evaluation of research reports or published articles. Prior to the start of the research, each research team submitted a research abstract that summarizes the goals and objectives of the research. Upon conclusion of the review of the research abstracts, the project evaluator reported his observations and advised the PI/Project Manager about his strategy for evaluating research reports. The evaluator expects each research report to clearly answer at least the following five questions:

*1. The Problem Statement:* Is the problem statement stated such that it can be solved? An open-ended problem statement would make it very difficult to know when a solution has been obtained.

*2. Literature Review:* Did the researcher perform any review of the literature to find any prior work? This is very critical to avoid any duplication of effort. The literature review should inform the researcher of prior art, research challenges, lessons learned, and future work. The researcher can use the information from the literature review to develop research topics that can resolve some of the research challenges, correct improper assumptions, or

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employ new methods for solving the same research problem.

*3. Methodology:* Is the research based on established theory or is the goal to develop a theory at the conclusion of the research? To enable other researchers to validate the research findings, each researcher needs to document their methodology including assumptions. If the research is based on established theory, it is fairly easy to replicate the research process. However, for empirical research, the research process must be detailed enough to enable replication.

*4. Findings and Interpretation:* What is the significance of any findings? Did the researcher present any reasoning, methodology, or ability to replicate the experiment as a basis for generalization? The researcher needs to provide research results and the contributions of research findings to the literature. If possible, the researcher should also be able to report on divergent findings (i.e., how the results support existing research findings) or divergent findings (i.e., how it contradicts or expands on current beliefs).

5. *Conclusion:* Did the research answer the "So what?" question? How does the research benefit the teaching, research, and student communities, or the society at large? The researcher should be able to provide a convincing argument that supports the merit of the research effort and its findings.

The project evaluator used the five evaluation criteria listed above to evaluate the research reports and a published paper. He reported his findings to the PI/Project Manager. Using the research evaluation process is similar to employing the scientific method to guide a research and development process. It provides a reasoned framework for research mentors whether in information assurance or STEM areas. The research teams whose work has been evaluated are conducting their research using the evaluation framework as a guide.

## VI. Conclusion

This article examines the impact of a cross-institutional faculty research mentorship program in Information Assurance on teaching and research at participating institutions. In this NSF funded project security researchers invite community college and junior faculty to work jointly on research problems in information assurance and security. The program aims to enhance teaching in security at institutions in the Maryland Alliance for Information Security and Assurance (MAISA) through research. Its underlying philosophy is that research should inform teaching and teaching should, in turn, inform research. To date, the program has supported six research teams consisting of a total of six research fellows recruited from community college faculty and from non-research active faculty at four year colleges, and eight research mentors. Each team consists of at least one research fellow and at least one research mentor from one of our research universities. The program has also supported two research externships, where one of our senior researchers collaborates with an industry partner on an information assurance-related topic.

Our research fellows emerged from this project with a deeper appreciation for the research process, and are more knowledgeable in the area of information assurance in which they have conducted their research. We believe that this understanding has great potential to strengthen the research-teaching nexus. Also, research mentors and fellows continue to collaborate on research in IA. These relationships are likely to continue for the foreseeable future. Finally, senior research faculty who participated in our externship program continue to have on-going relations with their industry partners. Industry partners offer advice about the state-of-the-art in research and technology, and about best-practices in curricula development.

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## VIII. References

[1] Boyer Commission on Educating Undergraduates in the Research University, "Reinventing Undergraduate Education: A Blueprint for America's Research Universities," State University of New York at Stony Brook for the Carnegie Foundation for the Advancement of Teaching, Stony Brook, NY, 1998.

[2] Michael J. Prince, Richard M. Felder, and Rebecca Brent, "Does Faculty Research Improve Undergraduate Teaching? An Analysis of Existing and Potential Synergies," *Journal of Engineering Education*, vol. 96, no. 4, pp. 283-294, 2007.

[3] J.M. Budd, "Faculty Publishing Productivity: Comparisons over Time," vol. 26, pp. 230-239, 2006.

[4] G.L. Sligh, "Community College Research: An Ivory Tower," National Council of Teachers of

English, 2002.

[5] M. Weimer, "Integration of Teaching and Research: Myth, Reality, and Possibility," *New Directions for Teaching and Learning*, vol. 72, pp. 53-62, 1997.

[6] R. Neumann, "Perceptions of the Research-teaching Nexus: A Framework for Analysis," *Higher Education*, vol. 23, pp. 159-171, 1992.

[7] A.H. Halsey, *Decliine of the Donnish Dominion: The British Academic Professions in the Twentieth Century*. Oxford, England: Clarendon Press, 1992.

[8] Peter J. Gray, R.M. Diamond, and B.E. Adam, "A National Study on the Relative Importance of Research and Undergraduate Teaching at Colleges and Universities," Center for Instructional Development, Syracuse University, 1996.

[9] Richard Felder, "The Myth of the Superhuman Professor," *Journal of Engineering Education*, vol. 82, no. 2, pp. 105-110, 1994.

[10] H.W. Marsh and J. Hattie, "The Relation Between Research Productivity And Teaching Effectiveness: Complementary, Antagonistic, or Independent Constructs?," *Journal of Higher Education*, vol. 73, pp. 603-641, 2002.

[11] A. Jenkins, "A Guide to the Research Evidence on Teaching- Research Relations," The Higher Education Academy, Heslington, England, 2004.

[12] P. Ramsden and I. Moses, "Associations between Research and Teaching in Australian Higher Educatio," *Higher Education*, vol. 23, pp. 273-295, 1992.

[13] A. Rugarcia, "The Link Between Teaching and Research: Myth or Possibility?," *Engineering Education,* vol. 81, pp. 20-22, 1991.

[14] K.A. Feldman, "Research Productivity and Scholarly Accomplishment of College Teachers as Related to Their Instructional Effectiveness: A Review and Exploration," *Research in Higher Education,* vol. 26, pp. 227-298, 1987.

[15] J. Hattie and H.W. Marsh, "The Relationship Between Research and Teaching: A Meta-Analysis," *Review of Educational Research*, vol. 66, no. 4, pp. 507-542, 1996, http://www.jstor.org/stable/1170652.

[16] A.W. Astin, *What Matters in College? Four Critical Years Revisited*. San Francisco, CA: Jossey-Bass Inc., 1994.

[17] Jenkins, A.H.; Healy, M., "Institutional Strategies to Link Teaching," The Higher Education Academy, UK, 2005.

[18] Claude Turner et al., "Cooperative Information Assurance Capacity Building," in *Proceedings of the 13th Colloquium for Information Systems Security Education*, Seattle, Washington, June 2009, pp. 1-3.

[19] A. Zubrick, I. Reid, and P. Rossiter, "Strengthening the Nexus Between Teaching and Research," Commonwealth of Australia, Canberra, Australia, 2001.

[20] M.J. Prince and R.M. Felder, "Inductive Teaching and Learning Methods: Definitions, Comparisons, and Research Bases," *Journal of Engineering Education*, vol. 95, no. 2, pp. 123-138, 2006, http://www4.ncsu.edu/unity/lockers/users/f/felder/public/Papers/InductiveTeaching.pdf.

[21] T. Heath, "Predicting the Educational Aspirations and Graduate Plans of Black and White College and University Students: When Do Dreams Become Realities?," in *Association for the Study of Higher Education Annual Meeting*, Minneapolis, MN, 1992.

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