

# Developing an Interdisciplinary Health Informatics Security and Privacy Program

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**Abstract**—Health informatics is one of the nation's largest growing industries. To protect health information systems, it is extremely important for health informatics professionals to be well educated and trained in information assurance, and to understand the many concerns of security, privacy, integrity and reliability. To meet this demand, we are creating a new, interdisciplinary curriculum model of Bachelor of Science in Computer Science (BSCS) concentration in Health Informatics Security and Privacy (HISP) at North Carolina Agriculture and Technical State University (NC A&T). To establish this BSCS concentration in HISP, we developed a new course on health information systems in the Department of Computer Science, a new course on Mathematics for Health Informatics in the Department of Mathematics, and modified an existing course in the Department of Management to include topics on business practices relating to health information technology. We also developed three course modules on health informatics security and privacy and are integrating these course modules into the existing information assurance courses in the Department of Computer Science. This paper describes the new curriculum, the new courses, and the three course modules we have developed.

**Keywords**—health informatics, health information systems, security and privacy, HIPPA curriculum.

## I. INTRODUCTION

Health informatics is one of the nation's largest growing industries. Compared to other data intensive industries, the health care industry is underinvested in information technologies. Recently, President Obama has made the use of information technology and electronic health records a top goal to cut down costs in the US healthcare system, offering up to \$27 billion in government funds aimed at speeding the switch from paper to electronic medical records [1].

Together with many other factors, mandated electronic recordkeeping and tightened patient privacy regulations are making health informatics a sought-after skill. US News & World Report named Healthcare Informatics as one of the top careers. According to Don Detmer, CEO of the American Medical Informatics Association (AMIA), the main professional body relating to health informatics in the U.S., approximately 70,000 health informatics specialists are needed [2]. According to the US Bureau of Labor Statistics, employment of medical records and health information technicians is expected to grow by more than 20% through 2018, resulting in over 207,000 jobs creation by 2018 [3].

With the government's increasing interest in electronic health records and growing investment by healthcare organizations in technology, a degree in health informatics or health information systems will give graduates some of the strongest career opportunities in today's economy. To protect health information systems, it is highly important for health informatics professionals to be well educated and trained in information assurance, and to understand the many concerns of security, privacy, integrity and reliability. To meet this demand, we are creating a new, interdisciplinary curriculum model of Bachelor of Science in Computer Science (BSCS) concentration in Health Informatics Security and Privacy (HISP) at North Carolina Agriculture and Technical State University (NC A&T).

This project is the joint effort of the Department of Computer Science, the Department of Mathematics and the Department of Management at NC A&T. To establish this BSCS concentration in HISP, we developed a new course on health information systems in the Department of Computer Science, a new course on Mathematics for Health Informatics in the Department of Mathematics, and modified an existing course in the Department of Management to include topics on business practices relating to health information technology. We also developed three course modules on health informatics security and privacy and are integrating these course modules in the existing computer security and information assurance courses in the Department of Computer Science. Such a curriculum will produce computer science graduates who have skills in health informatics, as well as skills in security and privacy in health information systems. It will also allow students in the field of nursing or health care to learn about health informatics and health information systems, allow students in mathematics to apply mathematics to health informatics, and allow students in management to learn about the business aspects of health informatics. This project leverages the strength of the existing information assurance program at the Department of Computer Science, and the existing collaboration among Department of Computer Science, Department of Management, and Department of Mathematics. The three departments collaboratively established the University's Center for Cyber Defense, a national Center of Academic Excellence in Information Assurance Education (CAE/IAE) designated by the Department of Homeland Security and the National Security Agency.

This paper describes the three new courses we developed, the three new course modules, and the new

curriculum of Bachelor of Science in Computer Science concentration in Health Informatics Security and Privacy at NC A&T. The curriculum model and instructional materials produced through this project can be adopted by educators in multiple disciplines such as computer science, information assurance, health informatics, information technology, mathematics, and business.

Some institutions such as Walden University [2], DeVry University [3], and University of Illinois at Chicago [5] offer bachelor's programs in health informatics. However, most of them are based either on information systems or information technology with only a few core health informatics related courses. There is not enough emphasis on security and privacy issues in health information systems. Topics like security policies, architectures, risk management, disaster recovery and business continuity, network security, and cryptography are not commonly covered by these degree programs. Knowledge of security is a key requirement for graduates to function effectively in mid- to high-level specialist positions in a health care organization. Our program is unique in that it is interdisciplinary, and it emphasizes health informatics security and privacy.

The remainder of this paper is organized as follows: Section II describes our BSCS Concentration in Health Informatics Security and Privacy. The new courses and course modules developed for the BSCS concentration in HISP are described in Section III and IV. Section V concludes the paper.

## II. THE BSCS CONCENTRATION IN HEALTH INFORMATICS SECURITY AND PRIVACY

The BSCS concentration in Health Informatics Security and Privacy requires the following core courses:

- COMP323: Introduction to Healthcare Information Systems
- MATH 410: Mathematics for Health Informatics
- MIS640: MIS Topics
- An Information Assurance elective (choose from: COMP320: Fundamentals of Information Assurance *or* COMP321: Computer Systems Security *or* COMP420: Applied Network Security *or* COMP421: Security Management for Information Assurance)

In the regular BSCS program at NC A&T, a student normally needs four years and with 124 total credit hours to graduate [6]. The course requirements are listed by category in Table I. The proposed BSCS concentration in HISP requires the same number of total credit hours as the regular BSCS program, and the same number of credit hours in each subject category as shown in Table I.

In the 59 computer science credit hours, 9 credit hours are computer science electives. For the BSCS concentration in HISP, the 9 credit hours will be used for taking the following courses: COMP323: Introduction to Healthcare Information Systems, MATH 410: Mathematics for Health Informatics and an Information Assurance elective course.

In the 27 General Education credit hours, 3 credit hours are required for approved Business Electives. For the BSCS concentration in HISP, the course MIS 485: MIS Topics will be used to satisfy the Business Electives requirement.

TABLE I. BSCS PROGRAM REQUIREMENTS

Subject Category	Credit Hours
Computer Science	59
Mathematics	20
Science	12
General Education	27
Free Elective	6
Total	124

Currently the three new courses have been developed, and have been approved by the University. The course "COMP323: Introduction to Healthcare Information Systems" was offered in the Fall 2012 semester. The courses "MIS 485 MIS Topics" and "MATH 410: Mathematics for Health Informatics" are being offered in Spring 2013 semester. The BSCS concentration in HISP is in the final stage of being approved by the University Curriculum Committee. The following sections will describe the three new courses and course modules for the concentration.

## III. THE NEW COURSES FOR THE BSCS CONCENTRATION IN HEALTH INFORMATICS SECURITY AND PRIVACY

This section describes the new courses we developed for the BSCS concentration in Health Informatics Security and Privacy.

### A. Course 1: COMP323 Introduction to Health Information Systems

This course introduces broad aspects of health care information systems. The goal is to prepare students with knowledge for effectively managing health care information systems. The main topics of this class include: types of health care information and data, regulations, standards, and laws of health care information, history of health care information systems, main features of EHR systems, information technologies in health care information systems, health care information systems certifications, security in health care information systems, and management of health care information systems.

This course was offered in the Fall 2012 semester for the first time. The textbook is Healthcare Information Systems by Karen A. Wagner [7]. Four projects were given to the students. These projects are described below.

#### Project 1

Research available job openings in Healthcare Information Systems (Informatics) or closely related areas. Find one or two job types that most interest you. Find out what the education requirements and skills needed for the job(s) are. State why you are interested in this/these particular job(s).

#### Project 2

Search the Internet and find five healthcare information

system vendors that offer EMR products. Compare and contrast the functions and features of each product. Submit at least a three- page report explaining your findings. Also submit a presentation slide for your homework.

#### *Project 3*

Search the Internet for health organizations and find out which ones are using Web 2.0 technologies to establish connections with patients or other consumers. Describe how they are using Web 2.0 technologies.

#### *Project 4*

This is a hands-on project on using an open source health information system (OpenEMR [8]) to create a health care practice and keep track of patients' medical records. The detailed description of the project is as follows.

In this project, you are given the following scenario:

For the past two weeks, Travis has been having severe headaches. He decides to schedule an appointment with Dr. Gregory Wallace at McLeod Health Center for the 25th of November. On the day of his appointment, Travis arrives and checks in with the front desk clerk, Ms. Susan Jones. Because this is his first visit, Travis must be added into the system. After giving all of his information to Ms. Jones, Nurse Wise calls him to the back and begins filling out a new patient encounter form for him. She checks his vitals, family history, and enters a brief consultation description. She then walks Travis into exam room 4, where he waits for Dr. Wallace. Dr. Wallace enters the exam room after about twenty minutes and begins the examination. He asks Travis about his migraines, and asks many other questions. Dr. Wallace concludes that Travis needs a prescription for apaprox. He is given a prescription for 30 pills of 200 mg that he is to take in the morning orally. Travis then walks to the front desk to pay for his visit and to get a receipt. Ms. Jones informs Travis that because of his insurance he only has to pay a co-pay of \$25.00. Travis pays his co-pay and takes his receipt and leaves to go pick up his prescription.

You are to create Travis's visit from beginning to end using OpenEMR. You must accomplish the following tasks:

- Create a practice
- Create a pharmacy
- Create three users: Dr. Gregory Wallace, Nurse Patricia Wise, and Ms. Susan Jones
- Create patients demographics
- Enter patient vitals
- Enter patient history
- Enter prescription
- Enter Patients receipt

#### *B. Course 2: MIS485 MIS Topics*

This course is a capstone course for undergraduate MIS majors and for other students who are interested in MIS topics. It focuses on emerging information systems (IS) and information technology (IT) topics. The topics covered in this course may vary from business data communications, the business practices relating to health information

technology, health informatics, Internet security and privacy, electronic business and electronic commerce, data mining and data warehousing, strategic information systems, IS/IT project management, to IT infrastructure.

This course is being offered in Spring 2013. The textbook for this course is "Handbook of Informatics for Nurses & Healthcare Professionals" (5th edition), by Toni Lee Hebda and Patricia Czar [9]. This course covers the following main topics:

- Informatics in Healthcare Professions
- Ensuring Quality and Best Use of Information
- Professional Use of Electronic Resources
- Healthcare Information Systems
- Selecting a Healthcare Information System
- Information Security and Confidentiality
- System Integration and Interoperability
- The Role of Standardized Terminology and Languages in Informatics
- Telehealth
- Evidence Based Practice and Research

In this course, each student is assigned with a group of articles that focus on one area in Health Informatics. For each article, he/she is required to cite one paragraph that best represents the spirit of the article, and then write a 1-2 page proposal for corporate use of Health Informatics using the concepts/techniques/models provided in these articles and relating them to the lectures. Based on the given articles each student will prepare a presentation that summarizes those articles in 15-20 minutes.

This course was taught in the Spring 2013 semester. The instructor's observation of this course is that, Health Informatics topics were well received by the students. Students are aware of the demands of IS/IT in health industry, the importance of health informatics, as well as the shortage of healthcare IS/IT professionals.

#### *C. Course 3:MATH410 Mathematics for Health Informatics*

This course examines the mathematics of health informatics. It covers mathematical core competencies that are needed for advanced research in health informatics. Topics include cryptography, biostatistics and linear programming. In addition the course covers new developments in the application of mathematics to health informatics privacy and security.

This course was offered in the Spring 2013 semester. It covers the following topics:

- Descriptive biostatistics and sample distribution
- Probability distributions and Estimation
- Testing hypothesis, regression analysis, nonparametric and distribution-free statistics
- Heath information privacy and security

Four projects are assigned to the students. They are described below:

- *Project 1:* This project involves writing R programs to compute basic statistic such as mean, variance and percentiles, and plotting statistical graphs. R is a free programming language used for statistic computing and graphics.
- *Project 2:* This project involves using R packages abd, asbio and tsmodel, and analyzing breast tissue data.
- *Project 3:* In this project, students use R for Poisson distribution, Estimation and Hypothesis testing.
- *Project 4:* In this project, students select a topic on their own in health information security and write a paper on that.

The instructor found it challenging to teach and design suitable projects for students. Students seem engaged and excited about the topics covered and the projects given in the class.

#### IV. THE COURSE MODULES

##### A. Course Module 1: Health Information Assurance and Security

This course module introduces information assurance as it relates to health information systems. It discusses laws including Pre-HIPAA (Health Insurance Portability and Accountability Act) legislation, HIPPA, Gramm Leach Bliley Act, Sarbanes-Oxley Act of 2002, Patient Safety and Quality Improvement Act of 2005, and Health Information Technology for Economic and Clinical Health (HITECH). It also investigates strategies and process models for securing information and discusses information assurance and security industry standards such as ISO 17799, Control Objective for Information and Related Technology (COBIT), the Health Information Trust Alliance (HITRUST) Control Security Framework (CSF), ISO/IEC 27002:2005, ISO/IEC 27001:2005, ISO 27799:2000, NIST (National Institute of Standards and Technology) Special Publication 800-53, ISO 27799:2008, ISO 17090:2008, and ISO/TS 25237: 2008 [10, 11]. A number of scenarios or mini-case studies are designed to help students have deep understanding of HIPPA. An example scenario is listed in Table II.

This course module was integrated into the existing Computer Science course “COMP320 Fundamentals of Information Assurance,” in the Spring 2013 semester.

##### B. Course Module 2: Access Control in Healthcare Information Systems

This course module introduces Role-Based Access Control (RBAC) based on the NIST model [12], and exposes students to current open source health information systems OpenMRS [13]. The NIST RBAC model is organized into four step sequences of increasing functional capabilities, which are Flat RBAC, Hierarchical RBAC, Constrained RBAC, and Symmetric RBAC [12]. A series of scenarios are developed to assist students to understand the above four types of RBAC models. Some scenarios are used for in-class discussion, and others are used as

homework. An exemplified scenario and discussion questions are listed in Table III [14].

TABLE II. AN EXEMPLIFIED SCENARIO FOR TEACHING HIPPA

##### Scenario:

*Joe applies for a job in a robot factory and must take a pre-hire drug test. Before taking the test, he signs a HIPAA authorization allowing the drug test results to be given to the factory. While taking the test, one of the lab technicians notices that Joe is exhibiting symptoms of another medical problem. When she tells Joe about her observations, Joe decides to take another test. Unfortunately, this second test reveals that Joe has a serious illness.*

##### Question:

*Under HIPAA, should the technician disclose this information to the factory?*

TABLE III. AN EXEMPLIFIED SCENARIO FOR TEACHING HIERARCHICAL RBAC

##### Hierarchical RBAC Scenario:

*Because a Doctor role can create a Secretary role, Doctor Kelly makes a Secretary role for John a new hire brought in to update patient information. Often, Larry logs in as an LT (Lab Technician) and performs his assigned lab procedures. Doctor Hart is a Doctor. However, Doctor Hart's thirty years of experience has allowed him to be selected as the hospital administrator and is thereby responsible for all hospital staff. He now logs in as a HA (hospital administrator) role.*

##### Questions:

- 1) Map out the roles connecting them with lines in either a tree or inverted tree structure. Next, map the users to the corresponding roles.
- 2) Can a Doctor share resources with an LT? Explain why or why not.
- 3) Could Doctor Hart, while in the HA role, create a Secretary role like Doctor Kelly did?

Student will be asked to create roles and permissions on the OpenMRS system given a scenario. The students will also learn how RBAC is implemented using J2EE architecture in OpenMRS.

This course module was also integrated into the existing Computer Science course “COMP320 Fundamentals of Information Assurance” in the Spring 2013 semester.

##### C. Course Module 3: XML Security in Health Information Systems

This course module provides a basic introduction to XML (Extensible Markup Language) which is widely used in representing health information. Health Level 7 (HL7) versions 3, whose specifications are completely based upon XML is introduced. HL7 is a non-profit organization that provides standards for the exchange, integration, sharing, and retrieval of electronic health information that support clinical practice and the management, delivery and

evaluation of health services. Techniques used to secure the data being transmitted in XML format, such as XML signature, and XML encryption are discussed [15].

As a case study, the students are also introduced to Microsoft HealthVault [16] – a cloud based system that helps people collect, store, and share health information with family members and participating healthcare providers. It connects with a variety of third-party applications and devices to help people manage their fitness, diet, and health data. The students will learn how health information is represented in XML format in Microsoft HealthVault. This course module will be integrated into the Computer Science existing course “COMP621 Web Security.”

## V. CONCLUSION

This paper describes the new curriculum of Bachelor of Science in Computer Science (BSCS) concentration in Health Informatics Security and Privacy (HISP) we are developing at NC A&T. This is through the joint effort of three departments: the Department of Computer Science, the Department of Mathematics, and the Department of Management. For this interdisciplinary program, three new courses and three course modules have been developed. These new courses and new course modules are described in this paper. One course was taught for the first time in the Fall 2012 semester, and the other two new courses are being taught in the Spring 2013 semester. One course module has been taught, and two course modules will be taught in the near future. The BSCS concentration in HISP is being approved by the university. Our future work will include advertising this program to computer science students, as well as advertising the new courses to students in related disciplines such as mathematics, management, information systems, nursing, biology, etc.

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