

Engineering curriculum reform to introduce students to security and privacy in the Internet era

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ABSTRACT: The rapidly growing use of the Internet in a wide variety of application domains has made security and privacy issues more complicated and critical. This necessitates engineering curricula reform to familiarise students with the challenges and opportunities associated with the security and privacy in the Internet era, and to prepare them to make trade-off decisions in engineering design problems. The course and curricular development efforts by the author is directed at addressing this need. In this article, a new freshman course that the author has developed in this project is presented. The course is designed to introduce students to the security and privacy issues in the Internet era, the ethical and legal basis for privacy protection, and security and privacy enhancing technologies. The psychological, physiological, social and cultural impacts of both violation and protection of security and privacy, and the interrelation of the psychological, physiological, social and cultural factors on one's development across the lifespan are discussed in the course.

INTRODUCTION

Due to the ever-increasing use of the Internet for a wide variety of activities, security and privacy issues are becoming even more complicated and critical. This necessitates engineering curricula reform to familiarise students with the challenges and opportunities associated with the security and privacy in the Internet era. The course and curricular development efforts by the author is directed at addressing this need. This article presents a new freshman course the author has developed in this project.

Course Overview

The course is designed to introduce students to the following topics and help them learn how to examine, analyse and discuss these topics in writing and verbally:

- Security and privacy issues in the Internet era;
- Security and privacy enhancing technologies;
- Ethical and legal basis for privacy protection in the Internet era.

Moreover, the psychological, physiological, social and cultural impacts of both violation and protection of security and privacy in the Internet era are discussed in the course. This also entails an examination of the interrelation of the psychological, physiological, social and cultural factors on one's development across the lifespan.

This freshman course is also designed to provide students with the opportunity to:

- Understand the learning process, as well as their responsibility and role in it;
- Improve their critical thinking, reading and writing skills, information competence, and both written and

oral communication skills, and discern how these skills are important to their academic and personal development;

- Use appropriate social skills to enhance learning and to develop positive interpersonal relationships with diverse groups and individuals.

STUDENT LEARNING OBJECTIVES AND ACTIVITIES

This section presents student learning objectives for this new freshman course along with the set of course activities that enable students to achieve a particular learning objective. This is presented in Table 1.

COURSE ASSIGNMENTS

To meet the course learning objectives, this course includes in-class and out-of-class writing and reading assignments, as well as individual and team-based assignments. Course assignments require students to use problem solving and critical thinking techniques. The course includes cooperative and interactive learning activities, discussion and brainstorming in both small group and class settings.

Writing assignments in this course include a research paper, reflective papers, reports, interview summaries and minutes. Writing assignments are assessed for the contents, correctness of syntax and grammar, the meaning and clarity of words in a language and style appropriate to the discipline, and conciseness. Other assignments include oral reports, class presentations, discussions and brainstorming.

COURSE CONTENTS

This section presents the course contents. Table 2 contains the list of course topics.

Table 1: Student learning objectives and course activities.

	Student Learning Objectives	Course Activities
1	To recognise the security and privacy issues in the Internet era, the challenges involved in protection and enhancement of security and privacy, the ethical and legal basis for privacy protection, and the technological advances to protect privacy and enhance security in the Internet era	<ul style="list-style-type: none"> • Students do verbal, writing, and reading assignments on the course topics [1-33]. • Students participate in the discussion and analysis of these topics in both small group and class settings.
2	To recognise the psychological, physiological, social and cultural impacts of security and privacy violation on one's personal well being in the Internet era	<ul style="list-style-type: none"> • Each student interviews two victims of security and privacy violation offences, writes interview summaries, and discusses the psychological, physiological, social and cultural impacts of security and privacy violation on the victims' personal well being. • Students participate in the discussion and analysis of the psychological, physiological, social and cultural impacts of security and privacy violation on a victim's well being.
3	To recognise the interrelation of the psychological, physiological, social and cultural factors associated with violation and protection of privacy and security on one's development across his/her lifespan, especially in adolescence	<ul style="list-style-type: none"> • Each student interviews two victims of security and privacy violation offences, writes interview summaries, and discusses the interrelation of the psychological, physiological, social and cultural factors associated with violation and protection of privacy and security on the victim's development across the lifespan. • Students participate in the discussion and analysis of the interrelation of the psychological, physiological, social and cultural factors associated with violation and protection of privacy and security on a victim's development across the lifespan, especially in adolescence.
4	To recognise the interdependence of the psychological, physiological, social and cultural factors that contributes to the process of human development, and also determines the limitations, potential and options of individuals across the lifespan	<ul style="list-style-type: none"> • Students examine and discuss the interdependence of psychological, physiological, social and cultural factors of violation and protection of privacy and security. • Students participate in the discussion and brainstorming of how this interdependence contributes to the process of human development. • Students participate in the discussion and brainstorming of the limitations, potential and options of individuals across the lifespan, especially in adolescence. • Students examine and discuss how choices and lifestyles throughout one's lifespan can either diminish or enhance personal well being.
5	To understand the learning process and their own responsibility and role in it	<ul style="list-style-type: none"> • Students participate in the discussion of the learning process (eg how to take notes, make plans, conduct library research, study, prepare for tests and work in a team on a project). • Students participate in cooperative and interactive learning activities. • Students perform in-class and out-of-class writing assignments (eg writing a research paper using literature review and critical thinking). • Students participate in class discussions and activities. • Students write minutes to summarise key concepts of the class discussions and activities.
6	To develop university-level learning skills (eg methods of inquiry, critical thinking, study skills, research skills, and information literacy) and to explore application of those skills for academic and personal development	<ul style="list-style-type: none"> • Students perform critical reading and writing assignments (eg reflective writing, interviewing and writing interview summaries, presenting oral reports). • Students work in small teams on team-based assignments. • Students write reports, and give oral reports as well as class presentations of team-based assignments. • Each student undertakes library research and writes a research paper. • Students participate in class discussion and brainstorming. • Students discuss and critique solutions to a problem, and identify shortcomings and alternative approaches to the problems related to the course topics.
7	To use appropriate social skills to enhance learning, develop positive interpersonal relationships with diverse groups and individuals, appreciate topics and issues from different perspectives, and value individual experiences and views	<ul style="list-style-type: none"> • Students are encouraged to develop respect for one another, and use the class as a form of social support. • Students participate in class discussions, brainstorming, and activities. • Students interview diverse individuals, write interview summaries, and participate in class discussion of the course topics (refer to the Course Activities 2, 3 & 4). • Students work in diverse groups on team-based assignments, write team-based reports, and give class presentations. • Each student participates in the course activities and workshops, writes reflective papers on the course activities and workshops, present oral reports to the class, and participates in small-group and class discussions of social and cultural implications of the course activities and workshops.

Table 2: Course topics.

Introduction to ubiquitous computing and the three waves in the history of the Internet
Introduction to security and privacy issues in the Internet era
Security: <ul style="list-style-type: none"> • Taxonomy of security threats; • Authorisation: <ul style="list-style-type: none"> - What is authorisation? - A three-step distinction between authorised and unauthorised users. • Authentication: <ul style="list-style-type: none"> - What is authentication? - Authorisation versus Authentication. • Confidentiality, Integrity, Availability: <ul style="list-style-type: none"> - What they are and what differences they have; - Examples of violation of confidentiality, integrity and availability; - Aspects of confidentiality. • Confidentiality, integrity, and availability of wireless traffic; • Protecting confidentiality and the laws & regulations; • Anonymity, traceability and traffic analysis; • Legitimate use versus illicit use of Internet anonymity; • Denial of service attacks and tracing the sources and protecting availability; • Software security for open sources; • Piracy; • International software piracy; • Preventing piracy; • Copyright laws; • Data integrity protection.
Privacy: <ul style="list-style-type: none"> • Society cannot function without privacy; • Threats to one's personal privacy in the Internet era; • Privacy on the Web; • Privacy protection in the Internet era; • Ethical and legal basis for privacy protection.
Non-technical hurdles to implementing effective security policies
Physiological, psychological, social, and cultural impacts of violation of security and privacy on one's personal well-being
Physiological, psychological, social and cultural impacts of protection and enhancement of security and privacy on one's personal well-being
Interrelation of the psychological, physiological, social and cultural factors associated with violation and protection of privacy and security on one's development across lifespan, especially in adolescence
Interdependence of the psychological, physiological, social, and cultural factors that contributes to the process of human development, and the limitations, potential and options of individuals across the lifespan
Security and privacy enhancing technologies for the Internet
Encryption: <ul style="list-style-type: none"> • What is encryption? • What can be protected by encryption? • What cannot be protected by encryption?
Biometric: <ul style="list-style-type: none"> • What is biometric? • Authentication through biometrics; • Biometric recognition and related security and privacy concerns.
Face recognition technology: Security versus privacy

FINAL REMARKS

Balancing security enhancement and personal privacy protection in the pervasive computing environments – the emerging next generation computing world – will become even more complicated and critical as individual devices can collect data for various purposes at different times, and combining the data collected by these devices can reveal information that could violate one's personal privacy [34].

Thus, it is essential for engineering graduates to be able to:

- Recognise the key technical and non-technical issues associated with security and privacy in the Internet era;
- Examine, analyse, discuss and brainstorm the issues;
- Make trade-off decisions in dealing with the issues;
- Assess and develop solutions to the real-world problems associated with security and privacy in the Internet era.

This necessitates engineering curriculum reform to familiarise students with the challenges and opportunities associated with security and privacy in the Internet era, and to prepare them to make trade-off decisions in engineering design problems. The course and curricular development by the author is directed at addressing this need.

The new freshman course presented in this article has been evaluated favourably by students, domain experts and educators. It is being offered regularly.

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