Security Education Training Program Characteristics needed to 
Development Task of Security Software in Security Majors of 
5 Universities of Seoul Region

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Abstract
In this paper, the technology and capabilities required for the job of developing security software recommended by the Cybersecurity Human Resources Development Framework of the National Initiative for Cybersecurity Education (NICE) were studied. In this paper, we describe what security skills are needed for the task of developing security software and what security capabilities should be held. The focus of this paper is to analyze the consistency between security technologies (core and specialized technologies) required for security software development tasks and the curriculum of information protection-related departments located in Seoul, Korea. The reason for this analysis is to see how the curriculum at five universities in Seoul is suitable for performing security software development tasks. In conclusion, if the five relevant departments studied are to intensively train developers of development tasks for security software, they are commonly required to train security testing and software debugging, how secure software is developed, risk management, privacy and information assurance.

Key Word: Cyber Security, Security Education, Security Workforce, Curriculum, Security Competency

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1. Introduction

Recently, the government emphasizes software development security. This background is that security weaknesses and vulnerabilities are increasing as the use of software programs increases. This phenomenon is caused by developer mistakes or logical errors. However, these mistakes or logical errors can be used for hacking or cause major security accidents.

In this paper, we became interested in the security technology and security capabilities of the developer required for the development of security software based on the discussion of the importance of software development security. Then security software developers need to discuss what technologies and capabilities they should have. Finding a more comprehensive, detailed, and well-organized security framework or security guide in this regard is not realistically easy.

Thus, in this paper, we sought to approach security software developers presented by NICE around the technology and capabilities of security required. This is because the NICE program is a guideline for National Institute of Standards and Technology (NIST)’s standard cybersecurity training curriculum being presented to foster cybersecurity workforce [1-7]. There are many security training programs going on in the country, but applying the standards of the NICE program to the development of education and training programs is still insufficient.

First, we would like to describe at the overall understanding of cybersecurity and prior research on education and training. Duan studied the design and development of cybersecurity curricula and experiments [8]. Akhtar Ludger and others studied innovative modular approaches for cybersecurity education [9] and presented that this module, proposed in an independent and loosely coupled, be applied as a target for cybersecurity training in all computer education [10]. Sayed Naqvi et al proposed a working-level digital forensics curriculum for next-generation training [11]. Shiva Azadgan et al studied the cyber-operating curriculum of the undergraduate course, which meets the stringent requirements of the National Security Agency (NSA) cyber-operating program [12]. Kim and others studied the analysis in a cybersecurity ecosystem using the NICE framework. The paper emphasized the lack of a comprehensive view of each domain of cybersecurity [13].

Miloslavskaya and others conducted studied tailored to the mapping of information security manual roles and the cybersecurity capabilities framework [14]. Conklin et al. focused on the results of the NICE study [15]. In Alsmadi’s paper, the NICE framework is analyzed around cybersecurity programs in Arab and Saudi Arabia countries, and recommendations are proposed [16]. Caulkins Bruce D. and others are focused on the National Cybersecurity Workforce Framework, the Department of Homeland Security, and the National Initiative for Cybersecurity Care and Studies Education Framework [17].

The prior studies so far have adequately studied realistic needs, along with the individual importance of cybersecurity education and training programs. However, research on whether the standard guidelines of education and training programs are properly applied at university sites is found to be insufficient in terms of fostering the development workforce of security software among tasks of cybersecurity. Therefore, in this paper, attention was paid to whether the measures presented in the standard guidelines are adequately presented and operated in the education and training programs at university sites.

This paper describes on the appropriateness of education training in cybersecurity from the
framework criteria of human resources cultivation in NICE cybersecurity area.

The paper determined that it was necessary to examine whether the education and training programs of security personnel operated by majors from five universities located in Seoul (one representative university located in Seoul, two cyber universities, and two women's universities) were appropriate based on the job skills and capabilities provided by the standards of the NICE framework. In this paper, among the criteria presented by NICE, we studied what technologies are required for the job of developing security software and what capabilities are required. From this, we studied the relevance of skills and skills to the security education and training courses currently run by universities and the tasks presented by NICE.

However, the current study lacked discussion about whether the capabilities required for the development of secure software were adequately developed in the university's security major's education program. However, university sites require objective judgement as to what criteria they were created by and whether the technology directly overrides this security software development task when they open a cybersecurity curriculum. It is also necessary to review from this standard whether the curriculum is properly organized and operated.

Therefore, this paper first identified the security capabilities and technologies required by the development tasks of security software presented by NICE. And we judged that the criteria that NICE presents could be objective criteria that can be applied to security practice sites. This is because they do not find other criteria that are better than the criteria that NICE presents. Thus, in this paper, the skills and capabilities of security required for the job of developing security software among classification of NICE security tasks were analyzed. From this point on, the appropriateness of education and training programs for related tasks conducted by university majors was studied.

The composition of this paper is as follows. First, Chapter 2 describes the security task classifications that NICE presents. Among these categories, the technology required for the task of developing security software was first described as a need technology and the skills required for the task. In addition, IT technology and security technology were divided into required competences. Chapter 3 analyzed security training courses (security technology areas) of universities located in Seoul. Security technologies and capabilities required by security software development task were compared to education and training programs run by universities. And we come to a conclusion in Chapter 4.

2. Technology Characteristics of Task in Security Software Development

2.1 Need Technology for task of security software development

The task of developing security software can be presented with information assurance engineers, information assurance software developers, information assurance software engineers, secure security software engineers and security engineers. The preferred technologies for security are information assurance, legal code ethics, personal safety and security, information system and network security, vulnerability assessment, computer network defense, security principle, cryptography, criminal law, computer forensics, public safety and security, and information system security certification, communication
security management technology. As shown in Table 1, the capabilities required for the design of secure software require such capabilities as vulnerability assessment, information assurance, cryptography, and risk management.

Table 1. Security Competence for task of security S/W development

<table>
<thead>
<tr>
<th>Competence</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Security technology</td>
<td>Cryptology, risk management, legal ethics, information system security, network security, vulnerability assessment, information assurance, security</td>
</tr>
</tbody>
</table>

2.2 Needs Technologies for Task of Security Software Development

The workforce developing secure software should have capabilities in such technologies as computing network and protocol technology, network security technology, security development methodology, risk management, legal policy ethics, cybersecurity principles, cybersecurity technology, and vulnerability technologies. Security software developers should have an understanding of enterprise information security structures and information assurance, security evaluation and verification. In software development, an understanding of information assurance is needed. Understanding the principles of information assurance should be understood in confidentiality, integrity, availability, reliability and denial-of-service. Understanding of personal information identification, data security standards, and privacy impact assessment is necessary. Understanding of penetration testing principles and tool techniques is necessary and understanding of security environment settings, security threats and vulnerabilities, ID management technology, and protection requirements. When designing secure software, it also requires understanding and analysis of secure coding technologies, code analysis tools, black box security testing capabilities, secure test planning and design capabilities, software debugging, and safe software development methodology. Understanding of the requirements and procedures of supply chain security and risk management policies, in-depth defense applications and network security structures is necessary.

3. Security Education Program for Information Security majors

The security curriculum at Seoul-based 5 universities was compared and analyzed with the required technology based on the NICE workforce classification (Security Software Development Task). Security core technologies common to the security software development tasks presented by NICE are network security technologies, security development methods, risk management, legal policy ethics, cybersecurity principles, cybersecurity threats, and vulnerability technologies. Security software developers must have these security technologies. Table 2 compares the core common skills that security software developer should have and the subjects that university security-related majors are offering. For Korea University’s Information Protection Convergence major, if you compare programs run by Korea University against the capacity required for the job of developing security software based on NICE, you can present them as shown in Table 2 (*). However, among the core technologies, additional subjects such as security development methods and law, policy and ethics are needed. For the “Big Data Information Protection” major at Cyber University in Seoul, additional courses such as security development methods, risk management and vulnerability subjects are needed among core technologies. For Sungshin Women's University's Convergence Information Technology (**), additional subjects such as security development methods and risk...
management courses are required among key technologies. For the information protection engineering department at Sejong Cyber University (**), additional opening of subjects such as security development methods, risk management and vulnerability is necessary. Ewha Womans University’s cybersecurity major (*****), requires additional opening of subjects such as security development methods and law policy ethics among core technologies. However, it is believed that education on cybersecurity threats and vulnerabilities is being replaced by cybersecurity and practice, cybersecurity projects, internships, and cybersecurity field training.

The following Table 3 lists the special technologies that security software developers should have first. It also indicates whether the university’s security majors are offering a subject related to the technology. If the following majors want to focus on fostering developers of secure software, complementary training on the following technologies is required on the basis of NICE criteria. For Korea University’s Information Security Convergence major, supplementary education is required for technologies such as personal information identification and privacy, security management, security testing and software debugging, secure security development methods, supply chain security and risk management, DiD application security, and information assurance (assessment and verification of software). For the Convergence Information Engineering Department (***) of Sungshin Women’s University, supplementary training is required for technologies such as personal information identification and privacy, intrusion detection, secure coding, security testing and software debugging, secure security development methods, supply chain security and risk management, and information assurance.

Table 3. Core technologies for Security S/W Capabilities

<table>
<thead>
<tr>
<th>Core Technology</th>
<th>Opened subjects in related major of Universities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Network security</strong></td>
<td>NS, NS, NSP, IS, Wns, IoTs, NS</td>
</tr>
<tr>
<td><strong>SDM</strong></td>
<td>IS, IS, IS</td>
</tr>
<tr>
<td><strong>RM</strong></td>
<td>RM, RM</td>
</tr>
<tr>
<td><strong>Law Policy Ethics</strong></td>
<td>IS, IS, IS, IS, CS, CS, CS, CS, CS, CS</td>
</tr>
<tr>
<td><strong>cybersecurity Principle</strong></td>
<td>IS, IS, IS, CS, CS, CS, CS, CS, CS, CS</td>
</tr>
<tr>
<td><strong>cybersecurity Threat</strong></td>
<td>IS, IS, IS, CS, CS, CS, CS, CS, CS, CS</td>
</tr>
<tr>
<td><strong>Vulnerability</strong></td>
<td>IS, IS, IS, CS, CS, CS, CS, CS, CS, CS</td>
</tr>
</tbody>
</table>

* Software Development Method(SDM), Risk management(RM)
* Korea University: Network Security(NS), Risk Management(RM), Information Security(IS), Security Management & Law(SML), Internet Security(IS), Cyber Security(CS), Hacking & Security(H&S), Malicious Code(MC)
* Seoul Cyber University: Network Security(NS), Internet Security(IS), Security management & Law(SML), Information Security(IS), Cyber Security(CS), Hacking & Security(H&S), Malicious Code(MC)
* Sungshin Womans University: Network Security Practices(NSP), Information Security Law & Standard(ISL&S), Privacy & Ethics(P&E), Information Security(IS), Hacking program(Hp), Malicious code analysis(Mca)
* Sejong Cyber University: Network Security(IS), Wireless network security(Wns), IoT security(Iots), Information Security Law & cyber Law(ISL&C), Cyber Security(CS), Security & hacking(SSh), Cyber terror & response(Ct&r)
* Ewha Womans University: Network Security(NS), Risk Management(RM), Cyber Security(CS), cybersecurityproject design(Csp), cybersecurityproject design(Csp), CybersecurityField training(Csft)
complementary training is required on technologies such as personal information identification and privacy, security testing and software debugging, how to develop secure software, supply chain security and risk management, and information assurance (including evaluation and verification of software).

Table 3. Special technologies to develop Security S/W Competence

<table>
<thead>
<tr>
<th>Special Technology</th>
<th>Opened subjects in related major of Universities</th>
</tr>
</thead>
<tbody>
<tr>
<td>PII &amp; privacy impact evaluation, data security standard</td>
<td>Da&amp;s</td>
</tr>
<tr>
<td>Intrusion test/Tool</td>
<td>la&amp;i</td>
</tr>
<tr>
<td>Sec management</td>
<td>SCS ISMS Scs ISSEM Scs Scp</td>
</tr>
<tr>
<td>Secure coding, code analysis and tool</td>
<td>SS SC</td>
</tr>
<tr>
<td>Security testing S/W debugging</td>
<td></td>
</tr>
<tr>
<td>Secure software development method</td>
<td></td>
</tr>
<tr>
<td>Supply chain security and risk management</td>
<td>RM</td>
</tr>
<tr>
<td>DID application program and NW security architecture</td>
<td>NS HP la&amp;i Ca&amp;i Sc</td>
</tr>
<tr>
<td>Application firewall</td>
<td>As</td>
</tr>
<tr>
<td>Encryption and DS based on PKI</td>
<td>IS</td>
</tr>
</tbody>
</table>

4. Conclusion

In this paper, the technology and capabilities required for the job of developing security software recommended by the Cybersecurity Human Resources Development Framework of the National Initiative for Cybersecurity Education (NICE) were studied. The focus of this paper is to analyze the consistency between security technologies (core and specialized technologies) required for security software development tasks and the curriculum of information protection-related departments located in Seoul, Korea. It is to analyze the relevance between the curriculum. In conclusion, if the majors discussed in this paper want to cultivate talent in developing competent security software, education on technologies such as information assurance, risk management and vulnerability assessment should be strengthened. In future research, we would like to analyze the educational curriculum and its characteristics of information security majors at domestic women’s universities.

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