

Information Systems Security Education: Redressing the Balance of Theory and Practice

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ABSTRACT

One of the perennial concerns in education is the ability of students to apply what they have learnt in a real world context. To tackle this issue, this paper proposes the adoption of a situated learning strategy as a mechanism for linking theory and practice for delivering information systems security education. There are two areas of focus in the research presented. First, we offer an example of an information systems security course applying situated learning strategy. Second, we examine student feedback on this particular teaching design. The exploratory findings suggest that situated learning has potential for knowledge development as well as for balancing theory and practice. Thus we recommend our example of an information systems security course for use as model of practice for other educators in this field.

Keywords: Information systems security education, situated learning, online education.

1. INTRODUCTION

In the era of the information society, the development and application of information technology proceeds relentlessly. At the same time, technological innovations bring in their wake new technical and managerial concerns over security. For educators in the field of information systems security (ISS), this has a profound impact on teaching strategies. In order to prepare students to survive and prosper in the dynamic environment of the real world, the teaching materials of ISS need to be adapted accordingly. An ISS course is required not only to be up to date but also to have the capability of demonstrating to students the practical relevance of concepts learnt in the classroom.

This article proposes the adoption of the situated learning strategy. Situated learning strategy, rooted in social constructivism, asserts the nature of knowledge as a “social product,” (Prawat and Folden, 1994), “evaluative,” (Henriques, 1999) and context-dependent. A learning theory enshrining this epistemological belief implies a learning environment in which the individual acquires the ability to put theories into practice, so vital in ISS education. Accordingly, our purpose in this paper is twofold: firstly, to demonstrate how to design an ISS course on the basis of a situated learning strategy, and secondly, to examine student feedback on the implementation of this particular teaching design.

The organization of this paper is as follows. The next section discusses the theoretical framework, followed by the description of an ISS course applying a situated learning strategy. The second half of the paper examines the choice of research methods and the analysis of case study findings. We conclude this paper by reviewing research limitations and contributions.

2. THEORETICAL FRAMEWORK

The call for a situated learning approach can be traced back to Brown *et al.* and Lave and Wenger in the late 1980s and early 1990s. Brown, Collins and Duguid (1989) coined the term and made a significant impact with their article *Situated Cognition and the Culture of Learning* in the 1989 issue of *Education Researcher*. Soon after the publication of this article, Lave and Wenger also published their book *Legitimate Peripheral Participation* in 1991. These publications triggered a palpable shift in contemporary teaching practice.

This new approach to learning was engineered to challenge teaching practices rooted in the assumption of a separation between knowing and doing. In a series of studies on workplace learning, Brown *et al.* (1989) argued that knowledge is inseparable from the situations in which learners find themselves. They further maintained that the inability, in a real world context, to

apply techniques or methods learnt at school is a direct consequence of this separation.

In contrast with the traditional approach to learning, Brown *et al.* (1989) saw knowledge as tools which can only be completely appreciated through use: triggering a change in the user's world view and hence the adoption of a new belief system in which the tools are employed. They illustrate this point with an example of the different use of a chisel by carpenters and cabinet makers (Brown, et al., 1989). According to their view, learning is a process of enculturation and involves three interdependent components: activity, concept and culture. From their perspective, enculturation is lacking in the current educational system and this lacuna is well demonstrated by looking at three types of learning activities. In their article, Brown *et al.* (1989) identified three ways of learning: Just Plain Folks (JPFs), Students, and Practitioners. As shown in Figure 1, both JPFs and Practitioners act on situations and conceptual situations respectively, while Students act on symbols. In terms of problem solving, JPFs and Practitioners resolve either emergent or ill-defined rather than well-defined problems as in the case of Students. Consequently, the first two types are able to produce negotiated meaning and socially constructed understanding, whereas the latter type only manages to produce fixed meaning and immutable concepts, which risk being meaningless or useless in the real world. Therefore, in order to deal with this shortcoming, situation learning advocates that education should embrace the enculturation process and allow students to learn by engaging in authentic activity i.e. through cognitive apprenticeship.

Figure 1: Situated Learning Strategy

	<i>JPFs</i>	<i>Students</i>	<i>Practitioners</i>
Reasoning with	Casual stories	Laws	Causal models
Acting on	Situations	Symbols	Conceptual situations
Resolving	Emergent problems and dilemmas	Well-defined problems	Ill-defined problems
Producing	Negotiated meaning and socially constructed understanding	Fixed meaning and immutable concepts	Negotiated meaning and socially constructed understanding

Sources: Brown et al. (1989)

The role of the teacher is thus to help students construct knowledge instead of giving them a particular set of knowledge with a pre-defined instruction structure. Hence the designers of situated learning should try to incorporate authentic tasks: "real-life problem solving including ill-structured goal and opportunity for the detection of relevant versus irrelevant information" (Young, 1997).

Furthermore, Brown *et al.* (1989) suggested that knowledge should generate understanding through a community of practice and legitimate peripheral

participation, embracing social and cultural factors within the learning process.

Legitimate peripheral participation through community of practice is another important component embedded in the concept of situated learning. This conceptual notion refers to the social process in which a novice starts with peripheral activities through observation and guidance from experts, and gradually progresses to master skills and ultimately become an expert or past master (Hay, 1993; Lave, 1988; Lave and Wenger, 1991). It implies the shift of a newcomer's peripheral position in a socio-cultural community of practice, to becoming "progressively more engaged and more active within that socio-cultural practice" (Hay, 1993).

Proponents of the community of practice notion disdain the idea of classroom training, i.e. where professionals remain out of a context in which such knowledge might be applied. For these researchers, skill or professional knowledge is acquired and transferred in a real situation in which students or apprentices have a chance to observe and engage with experts and others. Examples of this kind of knowledge transformation process are seen in apprenticeships (Lave and Wenger, 1991), physical working environments (Brown and Duguid, 1991; Brown and Duguid, 1992; George, et al., 1995) and virtual teamwork (Robey, et al., 2000). In a teaching and learning context, teachers should use narrative and stories to allow students to enter the culture, help them progress from the role of listener to active participant, and engage in problem solving in the stories that mimic real life settings.

As discussed above, situated learning contrasts with conventional teaching practice, which separates knowing and doing. Pointing instead to workplace learning and professional apprenticeship of different kinds, advocates of this approach recommend that teachers should abandon rigid and predefined instruction design and the idea that learning is a response to teaching (Harley, 1993). Instead, teachers should endeavor to incorporate authentic tasks, replace abstract concepts by stories, and promote social interaction and collaboration as a means of supporting student sense-making and the knowledge creation process.

We consider that situated learning strategy is particularly useful in delivering ISS education. The rapid rate of change in technology and business requires educators to prepare students adequately to meet the professional challenges they are likely to face once at work. Although textbooks and lecturing provide introductory concepts of ISS, this approach to learning does not teach students how to apply classroom knowledge in real world environments. Hence, to achieve a better learning outcome, educators need to cultivate a set of learning elements that fosters the process of enculturation and legitimate peripheral participation.

The following section first illustrates an example of an ISS course using techniques from this learning strategy, and continues with the examination of its educational effectiveness in an empirical case study.

3. A SITUATED LEARNING-BASED ISS COURSE

The course, "Security of Information Systems in Organisations", forms one of the optional courses in a graduate IS degree at a traditional U.K. university. The core of the syllabus is "to identify and develop durable principles and to illuminate underlying concepts for the management of security which cover the full range and scope of information systems in organisations." The aim of this course is not to develop technical skills in security, but to introduce students to the social and organisational dimension of information systems security.

Following the framework of a situated learning strategy, the rationale is to create a learning environment facilitating the process of enculturation, legitimate peripheral participation, and group interaction. We consider two important elements in achieving the process of enculturation and legitimate peripheral participation: authentic tasks and interaction with experts. Thus the strategy is to use a number of empirical cases in the lectures and to invite industry speakers to interact with students. To promote and facilitate group interaction, we create tasks that require students to work together as a community. Two techniques are adopted to this end: the group essay and online group discussion. The group essay provides an opportunity for students to work as a team on a realistic ISS situation; while online discussion offers the environment in which constant social interaction and collaboration can take place.

Consequently, the course design comprises face-to-face teaching and the use of an online learning environment over a 10-week period. Lecturing, group assignments and security colloquia constitute the face-to-face teaching activities. Each two-hour lecture covers different topics ranging from theories in IS security, risk management, security policy to certification and accreditation. Following the principle of enculturation in situated learning design, the lecturer endeavours to incorporate empirical cases or examples into the teaching. For example, the lecturer has used the case of the Barings Bank collapse and that of Russian funds laundered through the Bank of New York to demonstrate the problems in ISS management in the global financial services industry over the past few years.

The group essay is another technique embodying the concept of situated learning. This method reinforces the notion of community of practice and addresses the importance of group interaction as part of the learning process. As a group, students are asked to answer one of four essay questions in respect to relevant security issues

drawn from actual cases. For example, one question asked students to discuss the relative contribution made to ISS in an organisation by the technical, formal and informal systems. Further it asked "how can a security manager evaluate the level of resources to allocate to each when requesting budget spend?". This strategy aims to enhance the knowledge each student has forged in the constant intellectual confrontation and interaction with other students in the course.

In addition to the lectures and group tasks, the lecturer organised a series of information security colloquia. This aims to strengthen the dialectic between theory and practice. In a two-hour long colloquium session, students have an opportunity to engage with IS security experts from industry and government. The content of the talk is usually related to in the topic of the lectures or to current ISS debates. For instance, to accompany the lecture on accreditation and certification, a security - standards professional was invited to give his personal account of the role of security standards in the European Union (EU) countries. Another example is law and information security policy. In order to help students understand the importance and complexity of laws concerning ISS, a government policy adviser was invited to talk about her work and the current direction of ISS policy development nationally. (See Figure 2.)

In addition to face-to-face interaction, the lecturer also set up online teaching and learning components. The online learning environment serves the purpose of offering recorded lectures and guest talks, course information, communication and other learning tools. Working within limited budget and resources, the online learning environment was designed using WebCT and Real Media technology. Both technologies constitute commercial off-the-shelf software. Their ease of use allowed the lecturer to rapidly set up a simple online learning environment.

The objective of the recorded face-to-face sessions, including both lectures and colloquia, is to allow students to have a chance to review and enhance their understanding of various security concepts, reflecting both theory and practice. Consequently, students have a chance of being exposed to expert views and of studying their textbook materials with a real context in mind. The online group discussion fosters an environment in which students can interact and achieve knowledge development as a community, without the usual time and space constraints. Over the course of 10 weeks, students were asked to participate in group discussions, facilitated by an online class teacher. The teacher posted questions on a weekly or fortnightly basis. Each question was related to what was taught in the lecture or discussed in the colloquium sessions. The style of questions was open-ended and "discussion- based," allowing the input from different perspectives. Students were also invited to post any of their own questions that they would like to discuss among their coursemates.

Lecture Topic	Lecture Content	Security Colloquium Series
Social Science approach to IS Security	Introduction to Course; Sources and Methods	
Changing patterns of risk - from "computer" security to "information" security	Statistics of IS breaches etc; other sources of data. Can we produce a definitive, ordered list of threats?	
Security management, organisation and resources formal, informal and technical dimensions	Are security policies always the same in every organisation? How can we engender security awareness (culture) and how important is it?	Security Policy Development in Organisation
Risk Management: methods and limitations; insurance and contingency planning	Evaluation of specific types of risk management; literature of contingency planning; value of software aids	Risk Management
Security Technology: evaluation (access control, firewalls, IDS etc)	Which security technologies are likely to be most popular over the next few years, and why?	Computer Forensics
Use of Cryptosystems	Confidentiality, authentication, protection of intellectual property rights	Penetration Testing
Public Key Infrastructures	Principles of PKI; Certification Authorities, Inter-operation; applying theory in PKI	
Secure electronic commerce	Policy: government, corporate and consumer	
Certification and Accreditation	IS security certification in general; Assessment schemes.	Role of Security Standards (BS7799 and EESSI)
Law and Information Security Policy.	The public/private responsibilities in information security. Legal framework. General policing policy. CMI policy.	Information Security and Public Policy; International Initiatives and Domestic Policies

Figure 2: Description of ISS Lecture Topics And The Security Colloquium Series

4. CASE STUDY FINDINGS

This study employs the exploratory case study method, utilizing both qualitative and quantitative methods to examine the educational effectiveness of a learning strategy in delivering ISS to a group of 36 MSc. students. In particular, this study aims to find out whether the adoption of this learning strategy helps students to understand the nature and importance of the concepts underlying ISS management. With regard to data collection, we adopted the technique of semi-structured interview, survey, online learning activity observation and students' reports on teaching evaluation. In order to establish the validity, instead of inventing new ones we mostly drew upon survey variables common in educational research, as suggested by several researchers (Leidner and Jarvenpaa, 1995; Webster and Hackley, 1997). A five-point Likert-type

scale was adopted to measure all items, with 1= structured interview, survey, online learning activity observation and students' reports on teaching evaluation. In order to establish the validity, instead of inventing new ones we mostly drew upon survey variables common in educational research, as suggested by several researchers (Leidner and Jarvenpaa, 1995; Webster and Hackley, 1997). A five-point Likert-type scale was adopted to measure all items, with 1= Strongly Agree (SA) to 5 = Strongly Disagree (SD). Before handing the questionnaire out to all students, we first tested it by checking their understanding of the wording. Thirty out of 36 questionnaires were collected at the end of the course. The findings of the empirical study are presented in two sections: 1) feedback on the face-to-face course design; and 2) the value of the online learning system in enhancing student understanding of ISS.

4.1 Feedback on the ISS Course Design

In this section we describe findings on the student feedback for the face-to-face dimension of the ISS course, including the lecture, the security colloquium and group assignment.

On the subject of lectures and the associated content, students reported that the course had transformed how they conceived security. Before commencing the course, most perceived information systems security as a technical problem, which can only be resolved by the use of technology. However, students commented that the many empirical examples given in the lectures helped them to understand why security management concerns more than just technology.

The realization of the social and organizational dimension of security seems to be reinforced by the security colloquia. We observed that there was a high level of participation in the colloquium sessions with students engaging in interactive discussion with the industry experts. In our interviews, we asked what they thought of the security colloquium series. One student replied,

‘The guest seminars are very a good thing and give an opportunity to students to get direct contact with the "real" world!’

As regards the group assignment, the majority seemed to enjoy the task over the period of ten weeks although some students reported problems in working together. We also found that the quality of assignment produced by groups was better than that produced by individuals in the previous year. In the group work there were more in-depth discussions and analysis. One student put it thus:

“I have learnt not only to appreciate other people’s comments, but also how to work together, which was a bit difficult at the beginning. But we did have lots of interesting discussion in the group.”

4.2 Online Learning System

In this part, we examine the value of the online learning system for facilitating the situated learning strategy.

As discussed earlier, part of the situated learning strategy is to promote group interaction and a cooperative learning process. In the preceding section, we indicated that group assignment and online discussion helped to achieve interaction among students. Here we are interested in whether such interaction online has also facilitated the students’ knowledge development process. The survey results show that there is a significant agreement ($\alpha=.05$) on three educational benefits in particular of the system, namely, increasing critical thinking skills, identifying central issues in

security and stimulating further thinking regarding the subject area. (See Figure 3.)

Furthermore, the teachers commented that students had been better at integrating the old and new knowledge in online discussion, than those in the previous face-to-face classroom situation. This statement was consistent with the review of online messages that revealed certain online discussions to be very thorough and analytical. A number of students described how the system helped their knowledge development.

Figure 3: Learning Outcomes

Survey Items	Mean	S.D
Ability to critical thinking	1.97	0.89
Integrate facts	2.47	0.97
Analytical skill	2.20	1.06
Value other viewpoint	2.43	0.86
Interrelate ideas	2.67	1.06
Understanding concepts	2.30	0.99
Identify central issues	2.27	0.87
Interest of discussion	2.53	1.2
Do some thinking	2.03	0.81

“The greatest benefit I get from the online learning environment is the wide variety of schools of thoughts that I can read and discuss. The online form allows me to have sufficient time to think, to reflect, and to put my well-organized arguments.”

“I used to think learning most of time is very individual, but this (online learning) changes it. It is more like group learning. I mean not just from reading, but from other people as well.”

In addition, we discovered that in the online discussions, students who were novices to the subject obtained help and support from students who had working experience as security professionals:

“ for this course, I am a bit worried that there were too much theories, no practical knowledge. But all these references from other people and teachers really helped me to understand some issues.”

“oh, with this open discussion, I have learnt so much from Marc (a student who has a strong industrial experiences)..about what security management is all about. You know, I have to say, the references he put up and discussion with him was one of highlights of my experiences of using the system.”

On the subject of message content and system access, we also identified some situated learning activities. As regards messages exchanged by students and teachers, there were many instances when students or teachers made a reference linking what had been taught in the lecture to current events, in form of web links either to

related organizational web sites or to newspaper reports. Students further indicated that the design of recorded media used for lectures and expert talks gave them an opportunity to review and apply what they had learnt in the lectures. Furthermore, the online forum reverberated with constant discussion on topical security issues, usually initiated by the students themselves.

As stated in Section 3, one of the aims of the online learning environment is to promote and facilitate group interaction. Hence in the questionnaire, we also examined the level of community bonding among students as result of the online discussion forum. The questionnaire demonstrated favourable results. (See Figure 4.)

Figure 4: Group Interaction

Survey Items	Mean	S.D
Cooperation	2.47	0.47
Friendship	2.25	0.5
Depend on each other	2.27	0.87
Support	2.13	0.53

5. DISCUSSION

In the previous section, we described the course structure and presented exploratory findings in relation to the effectiveness of the situated learning strategy. Here we reflect on these findings and offer in-depth analysis.

Combining lectures with security colloquia goes some way towards balancing theory and practice in delivering ISS education. The success of this teaching strategy was indicated by the high level of interaction in the colloquia and by the high rates of access to the talks recorded in the online learning system. Incorporating substantial numbers of real world examples into lectures allows students not only to learn the fundamental concepts of security but also their relevance and implication for the context of practice. Given that one of the teaching objectives was to change student perceptions of security, we believe that this is particularly important. As indicated in the findings, at the outset many students considered security as a purely technical affair. Notwithstanding that the course objectives clearly stated that the focus was on the management issues of security, many students still expected an emphasis on technical security knowledge. Nevertheless, we found that the inclusion in the lectures of empirical data and the demonstration of case-based problems constituted a first step in broadening their horizons to include the socio-technical approach to ISS. Students gradually began to realize that a secure organization needs to build on a firm foundation of both technology and work practice. Further knowledge reinforcement was also achieved through a series of security colloquia in which students had opportunities to listen to or interact with experts and

learn how theoretical concepts were applied in practice. Consequently, students were able to engage in a knowledge transformation process, relating knowledge to the context in which it would be applied.

Moreover, we suggest that the security colloquium series has two additional benefits. First, it can support the establishment of collaborative programs involving industry and academia. The argument is that through interaction between students and practitioners in the colloquium sessions, students can gain a deeper understanding of the security industry, and at the same time, practitioners can learn more about academic work in this area. As a result, students may be more inclined to consider a career as a security professional. This can lead to an increase in professional effectiveness and reduction in training costs. Secondly, in the context of a situated learning strategy, security colloquia can be more cost and time effective than industrial placements. The underlying reason is that it can be difficult to arrange for all students to take part in industry programs that have a short duration, e.g. 10 weeks in this case study example. Nevertheless, the security colloquia can be organized at a lower cost as well as having the advantage of involving all the students and different professional specializations within the security industry.

On the issue of online resources and discussion, it seems that, as demonstrated by our findings, the online learning system has considerable potential for fostering a situated learning environment. The Internet contains a wealth of resources and references created by different experts in a wide range of fields. Through the WWW, students are able to understand their views, observe their techniques through media files, and even ask questions using e-mail or computer conferencing. Indeed, students under instruction using computers and the Internet can access various communities of practice and consequently acquire context-dependent knowledge. This was well illustrated in our case study findings, where students constantly made references to other relevant websites or news reports. Accordingly, we would argue that incorporating online resources into teaching materials enhances opportunities for legitimate peripheral participation and possibly for creating apprenticeship relationships less constrained by time and space considerations.

Originating as it does from a common school of thought, the idea of community of practice shares a similar philosophy to collaborative learning. Collaborative learning stresses that the ongoing process of discussion, negotiation, reflection and collaboration in a group has a significant effect on the development of higher-order and critical thinking (Sullivan, 1996). It was evident from our case study that both group interaction and the group assignments enhanced student understanding of ISS. Furthermore, the online discussion provides an opportunity for legitimate peripheral participation. Although this MSc. course did not have any professional

prerequisites for entry, some students already had some work experience in the ISS area. By participating in online discussions, the less experienced students first learnt where to obtain additional information by observing or studying the materials posted by the more experienced students. They also learnt more about the subject by reading the responses of the more experienced. Gradually, they developed their relevant information and began to engage in or even initiate an in-depth discussion. This facility is cultivated in interaction and communicating with others as a community, not from classroom teaching. Thus we argue that the online forum further strengthens the educational values embedded in the situated learning strategy.

6. CONCLUSION

Because of the nature of the subject, balancing theory and practice is crucial in the area of ISS education. In order to achieve this educational aim, this paper proposes the implementation of a situated learning strategy, which stresses the importance of enculturation and community of practice. Using this learning approach, this research provides an example of an ISS course, which is made up of lectures, group assignments, security colloquia and the use of an online system. We further investigate the educational potential of such a strategy by carrying out an exploratory case study. The empirical findings have shown support for the model proposed.

However, there are some limitations in this research. Situated learning advocates suggest that effective learning should take place in the context in which a particular knowledge is to be applied. Constrained by teaching regulations, we were not able entirely to replace instruction-oriented lectures with practitioner-oriented learning. Furthermore, we took into consideration some criticisms of situated learning strategy. Opponents of situated learning suggest consideration needs to be given to the extent to which knowledge is context-dependent rather than simply holding that all knowledge is grounded in a situation (Anderson *et al.* 1996; Young 1996). Hence, as a compromise between traditional and situated learning approaches, we used both lectures and security colloquia. We recommend that further research can be carried out to evaluate the educational effectiveness of a full-scale situated learning strategy in delivering ISS education. The second limitation is in the findings of the empirical work. Our case finished at the same time as the course itself. Although students reported positive learning outcomes at the end of the course, the findings are limited in casting any light on whether this effectiveness is preserved after graduation and commencement of employment. Hence, further work should examine the degree to which students can quickly apply knowledge learnt through such a learning

strategy to their eventual work tasks in the real world environment.

We see the contributions of this research in two areas. One is in demonstrating the value of situated learning strategy in ISS education. The other is in providing a practical example of an ISS course design on the basis of this strategy. The situated learning approach allows students to relate abstract knowledge to real world events or practices. The implementation of online discussions and security colloquia, as demonstrated here, offers ISS educators examples of how such a strategy can be applied in practice.

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