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C. Christopher Lee
Editor
Central Washington University

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As has been the case with the previous issues of the journals supported by the Allied Academies, the articles contained in this volume have been double blind refereed. The acceptance rate for manuscripts in this issue, 25%, conforms to our editorial policies.

The Editor of this Journal will continue to welcome different viewpoints because in differences we find learning; in differences we develop understanding; in differences we gain knowledge and in differences we develop the discipline into a more comprehensive, less esoteric, and dynamic metier.

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Manuscripts

THE IMPACT OF COMPUTER LITERACY ON STUDENT ACADEMIC PERFORMANCE IN THE INTRODUCTORY MANAGEMENT INFORMATION SYSTEMS COURSE

L. Richard Ye, California State University, Northridge

ABSTRACT

During the last decade, business school students have seen information technology being integrated into all aspects of their curricula at an ever-accelerating pace. Virtually all business schools now ask that their students meet certain computer literacy requirements before graduation, and these requirements are often part of the prerequisites for students enrolled in advanced courses of their majors, such as accounting, marketing, management science, and of course, information systems. There appears to be a strong belief, shared among the instructional faculty and prospective employers, that a higher level of computer literacy can lead to enhanced student academic performance, increased employment opportunities, and perhaps future success on the job (Jaderstrom, 1995; Tanyel, Mitchell, & McAlum, 1999; Trauth, Farwell, & Lee, 1993; Zhao, Ray, Dye, & David, 1998). Anecdotal evidence also seems to support such conventional wisdom: better computer skills should lead to more productive use of the technology, which in turn should lead to improved academic and job performance.

In this study, we examine empirically the correlation between students' level of computer literacy and their performance in an introductory information systems course. The research is seen as a first step in a series of studies designed to explore the predictive validity of the computer literacy requirement.

INTRODUCTION

During the last decade, business school students have seen information technology being integrated into all aspects of their curricula at an ever-accelerating pace. Virtually all business schools now ask that their students meet certain computer literacy requirements before graduation, and these requirements are often part of the prerequisites for students enrolled in advanced courses of their majors, such as accounting, marketing, management science, and of course, information systems. There appears to be a strong belief, shared among the instructional faculty and prospective employers, that a higher level of computer literacy can lead to enhanced student academic performance, increased employment opportunities, and perhaps future success on the job (Jaderstrom, 1995; Tanyel, Mitchell, & McAlum, 1999; Trauth, Farwell, & Lee, 1993; Zhao, Ray, Dye, & David, 1998). Anecdotal evidence also seems to support such conventional wisdom: better computer skills should lead to more productive use of the technology, which in turn should lead to improved academic and job performance.

Surprisingly, there has been little formal research effort aimed at evaluating the effectiveness of the computer literacy requirement within academic settings. We do not know, for example, if students who have satisfied the requirement necessarily perform better than those who do not yet meet the requirement. Students may also question the validity of the requirement as a prerequisite for other courses. The problem appears to be twofold. First, there is no universal definition of what constitutes computer literacy (Jones & Pearson, 1996). As a result, we design our evaluative criteria based largely on individual judgments and group consensus. Second, we do not fully understand the process by which students' technology skills influence their academic performance and, ultimately, their job performance. Consequently, it is difficult to determine what specific performance indicators are most closely linked to an individual student's level of technology skills.

In this study, we examine empirically the correlation between students' level of computer literacy and their performance in an introductory information systems course. The research is seen as a first step in a series of studies designed to explore the predictive validity of the computer literacy requirement.

COMPUTER LITERACY AND PERFORMANCE

"Computer literacy" is a commonly used term in the business world, but it is not precisely defined. Computer literacy, in general, is being knowledgeable about the computer and its applications (Rochester & Rochester, 1991). Such knowledge appears to have two dimensions: conceptual, and operational (Winter, Chudoba, & Gutek,1997). The conceptual dimension includes an understanding of the inner workings of a computer or general computer terminology. Without such knowledge a user would find it difficult to figure out any system problems, or to learn to adapt quickly to new systems or software. The operational dimension refers to the necessary skills a user acquires, through training and practice, in order to operate specific systems to complete specific tasks.

While prior research did not evaluate the performance impact of computer literacy empirically, there is evidence that such a performance impact is likely to be task-dependent (Goodhue & Thompson, 1995; Lonstreet & Sorant, 1985; Rhodes, 1985; Thompson, Higgins, & Howell, 1994). For example, if we considered a student to be highly computer literate because s/he demonstrated a high level of proficiency in using a word processor or a spreadsheet program, we would also expect the student to perform well on tasks involving the use of a word processor or a spreadsheet program. We could not predict, however, how the student would perform on tasks involving the use of a database program, if s/he had not received training in database software. This leads us to the following hypothesis:

H1: Students' task performance will be positively correlated with their level of computer literacy, if the same type of software is involved in assessing their level of computer literacy and their task performance.

Winter, Chudoba, and Gutek (1997) use the notion of "functional computer literacy" to argue that a user needs both the conceptual and operational knowledge to perform effectively and productively in various white-collar work settings. A truly "computer fluent" user, they contend, does not simply memorize the correct sequence of keystrokes or mouse clicks. Rather, the user must form an internal representation of the system's structure and functions. Indeed, there is consistent research evidence that links a user's valid mental models of a system to better task performance (Foss & DeRidder, 1988; Booth, 1989; Sein & Bostrom, 1990; Weller, Repman, Lan, & Rooze, 1995). Within the context of computer literacy training, we would therefore expect students to form useful mental models of a computer system based on their conceptual knowledge of the system, and to be able to transfer that knowledge to tasks in an unfamiliar hardware/software environment. This leads us to a second hypothesis:

H2: Students' task performance will be positively correlated with their level of computer literacy, even if the task involves the use of unfamiliar software.

The foregoing arguments suggest that the performance impact of students' computer literacy depends on the nature of the task. More specifically, it depends on whether the task involves the transfer and application of the conceptual and operational knowledge obtained from their computer literacy training and practice. This gives rise to a third hypothesis:

H3: Students' task performance will have no correlation with their level of computer literacy, if the task does not require the use of their conceptual or operational knowledge of the computer hardware/software.

METHOD

A multiple regression analysis was applied to assess the significance of students' level of computer literacy in predicting their task performance. In addition to the primary independent variable, level of computer literacy, the analysis also included two other independent variables: gender, and grade point average.

A number of prior studies have investigated the impact of student gender as a predictor of academic performance, but the results appear inconclusive. Two earlier studies found that female students performed better than males in accounting (Mulchler, Turner, & Williams, 1987; Lipe, 1989), while others found males outperforming females in finance (Borde, Byrd, & Modani, 1996) and Economics (Heath, 1989), but no gender effect in marketing (Borde, 1998).

Extensive research also exists on gender-related computer attitudes and aptitude, with more consistent results. Several studies found that, compared to men, women tend to display lower computer aptitude (Rozell & Gardner, 1999; Smith & Necessary, 1996; Williams, Ogletree, Woodburn, & Raffeld, 1993) and higher levels of computer anxiety (Anderson, 1996; Bozionelos 1996; Igbaria and Chakrabarti 1990). Because the present study focuses on students' performance in an information systems course, we include gender in the research model so its effect can also be explored.

Grade Point Average (GPA) as a predictor of academic performance is widely reported. Numerous studies have found GPA to be significantly correlated with student performance in accounting (Doran, Bouillon, & Smith, 1991; Eskew & Faley, 1988; Jenkins, 1998), marketing (Borde, 1998), and economics (Bellico, 1974; Cohn, 1972). However, because the predictive impact of GPA in an information system course is unknown, we believe it should also be included in the present research model.

This study was conducted among 92 business school students enrolled in four sections of an introductory information systems (IS) course at a public university. All sections were taught by the same instructor, under the same set of conditions. The use of information technology was an integral part of the course requirement. To complete the course successfully, students must complete two hands-on course projects, one hands-on mid-term examination, and a traditional paper-and-pencil final examination.

At the beginning of the course, we measured the students' level of business computer literacy with an existing examination instrument. This provided an individual numeric computer literacy score (CLS), data for the primary independent variable of the study. The instrument had been in use twice a year to determine if a student had met the business school's computer literacy requirement. The exam consisted of three parts: hardware and software concepts, word processing, and spreadsheet modeling. The concepts part was administered on paper in multiple-choices format, while the remaining two parts involved hands-on word-processing and spreadsheet problems to be completed on a computer. Over the course of five years since its first use, the exam had produced a consistent passing rate of 30 to 35 percent. This suggests that the instrument is fairly reliable.

A student information database was used to collect data for the other independent variables: gender, and student GPA prior to taking the IS course. A multiple regression model was run on four performance measures: project 1, project 2, mid-term exam, and final exam. Project 1 involved the development of a database application using a database management system (DBMS), to which the students had no prior exposure. This performance measure was designed to test Hypothesis 2. Project 2 involved the development of a production plan using spreadsheet modeling. The measure was used to test Hypothesis 1. Students completed the two projects individually, outside the classroom. The hands-on mid-term exam consisted of three parts: IS concept questions answered with a word processor, a database problem, and a spreadsheet problem. This measure was designed to test Hypotheses 1 and 2. The final exam consisted of entirely conceptual IS questions, conducted in paper-and-pencil format. The exam questions focused on traditional IS theories such as transaction processing, decision support, and systems development, which can be considered hardware/software-independent. The measure was used to test Hypothesis 3.

The general regression model was formulated as follows:

$$Ps_i = \beta_0 + \beta_1 CLS + \beta_2 GEN + \beta_3 GPA + \varepsilon_i$$

Where:

Ps_i = numeric score on the two projects and the two exams (100 possible on each),
CLS = numeric score on the computer literacy exam (100 possible),
GEN = subject's gender, coded 1 for male and 2 for female,
GPA = subject's cumulative grade point average prior to taking the course (4.0 scale),
β_0 = intercept,
β_{1-3} = slope coefficient, and
ε_i = error term.

RESULTS

Descriptive statistics for the various measures of independent and dependent variables are presented in Table 1. The relatively large standard deviation value for CLS suggests that there was a great degree of variation among students' computer literacy levels.

TABLE 1. Descriptive Statistics

Variable	*M*	*SD*	*N*
Dependent Variables			
Project 1 score	67.40	23.68	92
Project 2 score	80.67	15.11	92
Mid-term Exam score	56.43	11.25	92
Final Exam score	55.49	11.31	92
Independent Variables			
CLS	62.15	21.16	92
Gender	1.51	0.50	92*
GPA	2.67	0.48	92

* 45 males and 47 females

Shown in Table 2 are simple pair-wise correlation coefficients among the independent variables. We found that gender and CLS were negatively correlated at the .05 probability level. This is not surprising. As discussed earlier, prior studies suggest that males tend to demonstrate a higher level of computer aptitude than females. We also found GPA and CLS to be positively correlated; this is consistent with the expectation that high-achieving students make greater efforts in acquiring the necessary knowledge and skills, including computer literacy.

The correlations found in Table 2 do not pose a serious multicollinearity problem. The correlation coefficients were relatively small. We also calculated the variance inflation factors (VIF) for each of the variables. While a VIF considerably larger than 1 would be indicative of serious multicollinearity problems, none of the VIF values calculated for this study was greater than 1.10.

TABLE 2: Correlation Coefficients

Variable	CLS	Gender	GPA
CLS	1.00	-.24*	.24*
Gender		1.00	.10
GPA			1.00

* $p < 0.05$.

In Table 3, we report the results of the regression analysis. The proposed model appeared to fit well in predicting performance for three of the four performance measures: Project 2, the Mid-term Exam, and the Final Exam. Reported coefficients of determination (R^2) were 0.21, 0.36, and 0.27, while F values were 9.33, 18.30, and 12.18, respectively, all at a significant 0.01 probability level.

Students' level of computer literacy, represented by CLS, proved to be significant in predicting student performance on Project 2 ($t = 2.79$, $p < 0.01$) and the Mid-term Exam ($t = 2.38$, $p < 0.05$). These results lend support to the hypothesis (H1) that students' level of computer literacy may influence their task performance, if the task involves the use of software familiar to them. We did not find CLS to be predictive of student performance on Project 1. Therefore there was no evidence to support the hypothesis (H2) that students might be able to transfer their computer literacy knowledge to tasks involving the use of an unfamiliar type of software. This also seems to explain the difference between the *t* statistic for Project 2 and the *t* statistic for the Mid-term Exam, since one part of the exam involved the use of database software. Finally, we found no CLS impact on student performance on the Final Exam. This result provides support for H3, that students' level of computer literacy will have no effect on their task performance, if the task requires neither conceptual nor operational knowledge of a computer system.

TABLE 3. Results for Regression Models for Various Performance Scores: Standardized Beta Coefficients (*t* Statistics) for Independent Variables

Variable	Project 1	Project 2	Mid-term Exam	Final Exam

CLS	-0.12 (-1.05)	0.28 (2.79)**	0.24 (2.38)*	0.12 (-1.23)
Gender	0.05 (0.42)	0.27 (2.66)**	-0.09 (-1.04)	-0.04 (-0.47)
GPA	0.32 (2.96)**	0.20 (2.07)*	0.53 (6.03)**	0.50 (5.36)**
Intercept	30.92 (1.88)	34.83 (3.71)**	19.50 (3.13)**	21.52 (3.20)**
Model statistics Adj. R^2 *F* value	 0.07 3.33*	 0.21 9.33**	 0.36 18.30**	 0.27 12.18**
* $p < 0.05$. ** $p < 0.01$.				

Of the other two independent variables, we found GPA to be a significant predictor of performance across all four dependent measures. This is consistent with prior research asserting the validity of using students' past GPA as a strong predictor of future academic performance. To high academic achievers, an IS course, despite its heavy technological content, does not appear more difficult than courses in other subject areas.

Overall, gender was not a statistically significant performance predictor for an IS course. Gender's significant effect on Project 2 performance is worth further exploration, however. Because Project 2 involved the use of a spreadsheet program, the result seems to raise an interesting question: are females better at using a spreadsheet program than males? More research is needed to confirm and explain this observation.

DISCUSSION AND CONCLUSION

In this study we examined the performance impact of students' computer literacy in an information systems course. Results of multiple regression analysis found the predictive power of computer literacy to be task-dependent. As expected, if a task requires substantial uses of computers and a specific type of software, students with a higher level of computer literacy, as measured by their proficiency in using that specific combination of hardware/software, achieved significantly better performance. Conversely, if the task requires the use of unfamiliar software, or if the task requires neither the use of computers nor conceptual knowledge of computer hardware/software, students' level of computer literacy had no significant impact on their performance. Instead, students' GPA appeared to have far more predictive power for such tasks.

The study's failure to find support for H2 requires further explanation. Project 1, designed to test H2, required students to develop simple database applications. While the database software was unfamiliar to the students, we had expected them to use their mental models of a computer system to transfer existing knowledge to a new, novel task. What affected their performance, however, did not appear to be their operational knowledge of the software, but rather their understanding of the database concepts. A closer look at their submitted work revealed that many students had difficulty grasping fundamental concepts such as relationships and Boolean logic in complex database queries. While the graphical user interfaces in today's software environment provide great operational consistency across different applications, what seems to dictate task performance, as implied by this study, is an understanding of the task itself. Computers are only tools. A poor understanding of the task will lead to an ineffective use of tools.

The research reported here is limited by several factors. The participants were all from courses taught by one instructor at one university. In the absence of a standard test instrument, the computer literacy examination used in the study was a choice of convenience. While extraneous factors such as instructor styles and task designs were controlled, the results of the study may not be generalizable to different institutions. Further research is needed to overcome these limitations. First, a standard evaluation instrument for computer literacy must be developed and validated. Second, the current study needs to be replicated under different settings.

The findings from this study have important implications on teaching and learning. Despite the universal requirements for computer literacy among academic institutions, the performance impact of such requirements is far from clear-cut. The relationship between a technology-induced increase in students' personal productivity and their academic performance appears, at best, indirect. The predictive power of computer literacy on performance does not depend on whether and how much information technology is *used* in the completion of a course. Rather, it depends on how much that technology is integrated into the *evaluation* of student performance. Unless we can demonstrate a clear relationship between computer literacy and performance, many students will continue to perceive the requirement as an unnecessary roadblock to their progress in their chosen academic programs.

Future research also needs to explore the linkage between computer literacy and personal productivity, and the linkage between productivity and academic performance. Establishing the predictive validity of computer literacy requirement is paramount. As information technology is further integrated into the educational process, we need evidence of such predictive validity to help influence students' attitude and behavior toward fulfilling the requirement. Meanwhile, this would also heighten the need for adequate student training in the uses of information technology, if we expect them to be successful.

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A DO-IT-YOURSELF FACULTY INFORMATION SYSTEM

Lynn R. Heinrichs, Western Carolina University

ABSTRACT

University administrators, like corporate managers, need information systems to support decision-making. Building internal systems for organizing, maintaining, and sharing information is a vital part of managing any organization. In an academic environment, faculty planning and reporting activities require access to timely, accurate information by deans and department heads.

This paper describes a project undertaken by one business school to implement a "do-it-yourself" faculty information system (FIS) to support the College's day-to-day operations, longer-term planning activities, and AACSB reaffirmation efforts. A data model was developed using a semantic object modeling approach. The data model was translated to a relational design for implementation. Three different sources were used to extract data for populating the database tables. The final system was implemented in a local area network environment to provide shared access.

INTRODUCTION

Management information systems (MIS) serve the management level of an organization by summarizing and reporting on the basic operations of an organization (Laudon and Laudon, 1999). MIS are characterized by:

- Support for structured decisions at the operational and management control levels, but are also useful for planning purposes,
- Reporting and control orientation,
- Use of existing corporate data and data flows,
- Use of past and present data,
- Internal orientation,
- Minimal flexibility and analytical ability.

University administrators, like corporate managers, need information systems to support decision-making. Building internal systems for organizing, maintaining, and sharing information is a vital part of managing any organization. In an academic environment, faculty planning and reporting activities require access to timely, accurate information by deans and department heads. Although universities maintain human resource information systems, these systems typically provide institutional-level reports that do not address the managerial needs of mid-level administrators.

Like any IS problem, implementing a system for faculty planning and reporting can be accomplished using either a "build it" or "buy it" approach. For example, Vinsonhaler, Vinsonhaler, Bartholome, Stephens, and Wagner (1996) developed a knowledge-based system for tracking academic productivity called PERIS – Productivity Evaluation, Reward, and Improvement System. The system tracked activities for the components of teaching, research, and service. Using IF-THEN rules, point values were assigned to activities. Activity points were accumulated to calculate a productivity total for each component as well as for a faculty member overall. The traditional advantage to this "do-it-yourself' approach is that an application is developed that meets the specific information needs of its users. However, the approach can suffer from long implementation times and substantial development costs.

Off-the-shelf software packages, such as the Dean's Associate from Octagram, allow an institution to quickly implement a faculty information system solution. The Dean's Associate is specifically designed to meet the needs of schools seeking AACSB accreditation or reaffirmation through two types of reports: business school management and accreditation-related. Cost of the software is based upon the size of the faculty.

This paper describes a project undertaken by one business school to implement a "do-it-yourself" faculty information system to support management decision-making and AACSB reaffirmation efforts. Specific objectives of the system were to:

- eliminate duplication of records,
- improve organization of and access to data,
- enhance decision-making with relevant and timely information,
- increase faculty awareness of business school performance and productivity,
- generate AACSB reports.

Information provided by the system is used in the business school's day-to-day operations, longer-term planning activities, and AACSB reaffirmation efforts.

BACKGROUND OF THE PROBLEM

A combination of factors initiated the faculty information system (FIS) project in Fall 1997. The business school underwent a change in leadership the previous year followed by a change in office support personnel. Many of the paper and electronic record systems previously used were unavailable. Uncoordinated efforts among staff to recreate information were leading to redundant record systems. Addtionally, the school was two years away from the self-evaluation period of its AACSB reaffirmation.

Some information the business school required for decision-making and reaffirmation was available from institutional systems. However, reports were not timely and did not contain the appropriate level of detail needed for some types of decisions. Much of the data needed for AACSB reaffirmation surrounded faculty composition and intellectual activities. The personnel system maintained by the university did not capture this type of information.

The lack of appropriate information from university systems combined with the need for new internal record systems to support decision-making and AACSB reaffirmation triggered the FIS project in Fall 1997. Business school administrators examined the build versus buy options. The buy option was considered preferable, but funds could not be obtained to purchase an off-the-shelf solution. Since sufficient time and in-house expertise were available to implement a “do-it-yourself” solution, the school opted to build the faculty information system.

INFORMATION REQUIREMENTS

A subset of information requirements for the FIS is summarized in Table 1. The complete set of information requirements is too extensive to discuss comfortably in this paper. The requirements represent what information the FIS needed to generate for decision-making and external reporting activities.

Table 1
Sample Information Requirements for the FIS

Purpose	Type of Decision, Problem or Question	Type of FIS Output
Faculty Activity Tracking	Do faculty have appropriate course loads to achieve the school’s mission?	Semester credit hours generated No. of course preparations
	Are faculty members intellectually active and are activities consistent with the mission?	No. of intellectual contributions Profile of intellectual contributions by type of outlet (journal, proceedings, etc.) and type of scholarship (basic, applied, instructional development)
Faculty Planning	Should the school request additional faculty positions?	No. of teaching positions generated by faculty
AACSB Reporting	Is the full-time faculty adequate?	Minimum full-time equivalent
	Is the faculty sufficiently diverse?	Ethnic origin, gender, rank
	Are faculty members academically qualified?	Terminal degree and year Profile of intellectual contributions

Faculty Activity Tracking. Since the school's mission should guide all activity, information is needed to verify that faculty teaching and scholarly activity is consistent with the mission. Information in this area is used for internal decision-making as well as AACSB reporting.

Faculty Planning. Each year, the school's dean must justify requests for new faculty positions. " Positions generated" is a key figure used to justify these requests. If a faculty of 50 is generating credit-hour production equivalent to 55 positions, then new faculty lines can be justified.

AACSB Reporting. Two AACSB standards, "Faculty Composition and Development" as well as "Intellectual Contributions," require substantial information about the size, make up, qualifications, and intellectual activity of faculty members (AACSB, 1999). The faculty information system should generate information that documents compliance with these standards.

A key concern in defining the initial information requirements was the level of detail required for tracking and reporting intellectual contributions (IC) activity. Recording IC activity can involve substantial data entry if complete citations for all contributions are maintained. A simple prototype was developed to test the feasibility of entering complete citations. The additional work required for data entry was impractical given the staff available. The primary objective was to establish an IC profile at the faculty member, department, and college levels that documented the quality of scholarship and the consistency of activity with the mission. Generating this information did not require capturing complete citations. Only a simple transaction representing each citation that could be tied back to a faculty member's vita was needed.

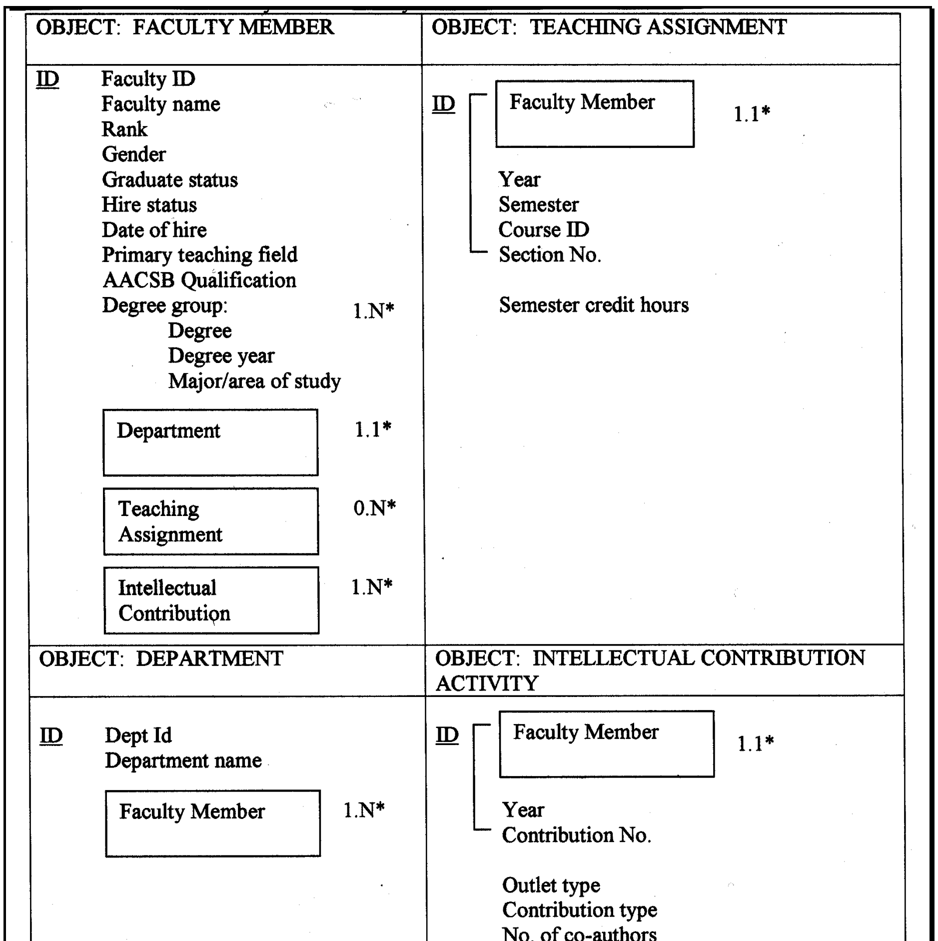
THE DATA MODEL

The data model was developed using a semantic object modeling approach. According to Kroenke (1998), "a semantic object is a named collection of attributes that sufficiently describes a distinct identity." Attributes can be simple (single-valued) or group (multiple attributes). Object`s can be simple, composite, compound or hybrid. Simple objects contain only single-valued , nonobject attributes. Composite objects contain one or more multi-valued, non-object attributes. Compound objects are made up of at least one object attribute. And hybrid, as the name suggests, are combinations of two different types. A completed semantic object model translates easily to a relational database design.

Four of the objects included in the data model are presented here: FACULTY MEMBER, DEPARTMENT, INTELLECTUAL CONTRIBUTION ACTIVITY, and TEACHING ASSIGNMENT. The data model assumed that faculty members belong to one department, but a department can have many faculty. A faculty member will have many teaching assignments and IC activities, but a teaching assignment or intellectual contribution activity belongs to only one faculty member. Figure 1 shows the semantic object diagram for the limited FIS.

Faculty Member Object. The FACULTY MEMBER object contains all attributes of a faculty member that are needed for satisfying the information requirements of the FIS. A faculty ID attribute uniquely identifies each member. FACULTY MEMBER has three object attributes that represent relationships with the objects. One group attribute, DEGREE GROUP, describes the attributes of the academic degrees earned by a faculty member. Since a faculty member can earn multiple degrees, the group is considered multi-valued.

Department Object. The DEPARTMENT object contains simple attributes department ID and name. The FACULTY MEMBER object attribute represents the multiple faculty members that are associated with a DEPARTMENT.



*Note: The N.M notation indicates the minimum and maximum cardinalities. For example, "1.1" notation indicates that the FACULTY MEMBER will belong to at least one DEPARTMENT and at most one DEPARTMENT. The INTELLECTUAL CONTRIBUTION object has a 0.N relationship with FACULTY MEMBER. A faculty member might not have any contributions, but could have many.

Teaching Assignment Object. TEACHING ASSIGNMENT contains attributes that describe a course taught by a faculty member during a specific term. If two faculty teach the same course, each is considered to have a unique TEACHING ASSIGNMENT. The semester credit hours represent the credit hours applied to the faculty member's teaching load.

Intellectual Contributions Activity Object. For the purpose of the faculty information system, the INTELLECTUAL CONTRIBUTIONS ACTIVITY of a FACULTY MEMBER must describe when (the year) the activity occurred, the type of outlet for the activity, and the type of scholarship. A contribution number is used to associate the activity with the corresponding citation on the faculty member's vita. If an intellectual contribution is authored by more than one faculty member, each individual will have an entry in the database. The attribute "number of co-authors" is used to designate whether or not more than one FACULTY MEMBER contributed to the output. Availability of this attribute allows the FIS to produce a profile of activity that summarizes contributions with or without duplicate counts for co-authors.

THE DATA DESIGN

A semantic object model easily translates to a relational database design. The relational approach organizes all data in two-dimensional tables (or relations). Relationships between tables are created through common columns. Table 2 shows the table design for the FIS. Five tables are used to implement the four objects from Figure 1.

Table 2
The Data Design

Table Name	**Table Columns**
Faculty Member	Faculty ID, Faculty name, Rank, Gender, Graduate status, Date of hire, Hire status, Primary teaching field, Qualification
Degrees	Faculty ID, Degree, Degree Year, Major
Department	Dept ID, Name
Teaching Assignment	Faculty ID, Year, Semester, Course ID, Section No., Level, SCH
Intellectual Contribution	Faculty ID, Year, Contribution No., Outlet type, Contribution type, % of Contribution

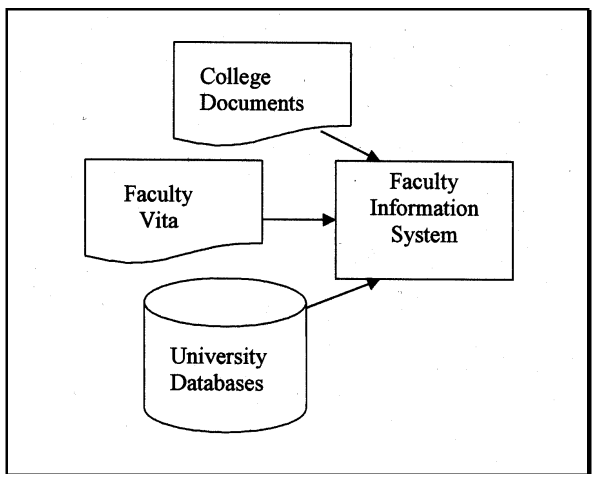
IMPLEMENTATION

According to Watson, Houdeshel, and Rainer (1997), two types of information are "generated and managed internally in the organization: information based on data records . . . and document-based information such as reports, opinions, memos, and estimates. (p. 272)" Both types of internal information were used to populate the FIS database. As shown in Figure

2, university information systems were used to extract data regarding instructional activity. College of Business documents provided faculty composition information (origin, status, and rank) while faculty vita were used to capture terminal degree and intellectual contributions input.

The database was implemented using Microsoft Access. Data captured from internal documents were entered manually into database tables while data extracted from university information systems were imported. Once the tables were in place, queries were developed to extract information for generating reports.

The database tables, queries, and reports were installed on the local area network (LAN) to allow for shared access. The LAN implementation allows multiple staff to use the information system, thus avoiding the redundancy problems that existed with former systems of record keeping.



FUTURE DIRECTION

A Web-based version of the system has already been tested. However, because of concerns regarding confidentiality of some data, the Web-based FIS is still in test mode. Eventually, all faculty and staff should be able to view FIS reports using a Web browser. For now, the LAN version continues to meet the current needs of the business school.

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ONLINE TRADING: PROBLEMS AND CHALLENGES

Balasundram Maniam, Sam Houston State University
Sanjay S. Mehta, Sam Houston State University
Mark R. Leipnik, Sam Houston State University

ABSTRACT

Despite the explosive growth and popularity of trading securities through the multitude of Internet brokerage firms, there are a number of problems and challenges associated with this venture. This study discusses and analyzes many of the problems and challenges plaguing the Internet trading sector. The main objective of this paper is to bring light to the "dark-side" of online trading as well as provide insight toward solving these dilemmas in an accurate and well-supported manner. Some of the items discussed include: hidden costs and deceptive advertising, independence, reliability, execution of trades, security issues, and the long-term outcome of online trading.

INTRODUCTION

Online trading is a practice that has exploded in growth and popularity. Currently, there are approximately 150 brokerage firms offering online trading (Future Banker, 2000). Societies use of the Internet has changed the entire concept of securities trading. In fact, Minkoff (2000) termed society=s use of online trading as "mainstream". In further support of this notion, he went on to add that by the year 2005, it is predicted that 81 percent of the households that own stocks will have an online account. Currently, 25 percent of the households that own stocks have an online account. Another study estimated that by the year 2003 approximately 9.7 million American households will manage more than $3 trillion in assets spread among some 20.4 million online accounts (Drummer, 1999). These are mind-boggling statistics compared to just three years ago when electronic trading was regarded a fad (Carroll, Lux, and Schack, 2000). Presently, in the U.S. one out of every six stock trades occurs over the Internet (Kassenaar, 1999). In 1999 online brokerage firms raised $1.76 billion in capital markets due to approximately five million online investors (*Economist*, 1999, and *Registered Representative*, 1999). Despite all of its growth and popularity, online investing possesses a host of problems and challenges for everyone involved. "You can make money fast and lose it faster," concluded Drummer's (1999, p.1).

LITERATURE REVIEW

There are several studies in the literature that attempt to discuss some of the problems and challenges associated with online trading. The first problem discussed in the literature is hidden costs and deceptive advertising associated with online trading. Atkinson (2000) supported this contention that buried in all the online trading hype resides the fine print. This obscure data translates into a venture that is more costly than one was lead to believe. Another topic of discussion was that of the independence one comes to face when it comes to online trading. The fact that one must solely bear the overwhelming duties of research and investment decisions was supported through the studies conducted by Opdyke (2000) and Brackey (2000). Reliability was yet another area of concern discussed in these studies. The studies conducted by Patel (1999) and Opdyke (2000) confirmed that factors such as Internet congestion and erroneous data sites could prove costly to investors.

Delayed and varied execution speeds and self serving market makers were among the items responsible for this pitfall of online trading as was collaborated in the studies by McNamee (2000) and Patel (1999). Internet security is also a major concern to investors. Computer hackers and viruses plague every sector of the computer community and with certainty will continue to do so.

Finally, the long-term ill effect of online trading in regards to earnings was also discussed in the literature. McMillan's (1999) study found investors who outperformed the market by three percentage points before they began online trading, typically lag it by two points afterwards.

PROBLEMS AND CHALLENGES

Internet applications are endless and e-commerce companies are developing innovative business models and making advancements everyday. One of the fastest growing internet ventures is online trading. The first internet securities trading occurred in 1994. By 1997, it has been estimated that 17 percent of all trades occurred online via the internet (Goldberg, 1998). Online brokerage firms emerged and the wealth of information available to many investors have promoted the practice of investing through the internet. The opportunity that online investing present to investors is intriguing and returns often seem very promising. Within these opportunities lie many problems and challenges that are potential obstacles for the online investor. There are a variety of issues that online investors will face today and continue to do so in the future.

Hidden Costs and Deceptive Advertising

Since the mid 1990s, investors have been seeing advertisements by a multitudes of online brokerage firms bidding for customers. There are the endless stories and portrayals of the average person making thousands at the click of a mouse. Teaser advertisements boast of inexpensive or even free trades -"teaser rates"- in relation to the high dollar commissions one would pay a broker at a traditional full service firm (Atkinson, 2000). Now, even the traditional firms are offering online trading at discounted rates, whereas in 1998, none offered online trading (Bielski, 2000; Orr, 1999; *Economist*. 1999). So, why would anyone want to spend an exorbitant amount of money to trade securities using traditional off-line full service brokers when they can start an online account and do it themselves for a fraction of the cost (Brackey, 2000)? The choice appears clear-cut, or does it? For example, compare a trade costing $104 through a traditional full service firm versus $5 through an online brokerage. How can one go wrong? Well, buried in all this online trading hype is the fine print that Atkinson(2000) discussed in his study.

Unfortunately, the advertisements leave out a great deal of very important information regarding what all is involved in these accounts. As Morgenson (2000, p.1) stated, "Online investing is far costlier than most investors think." Nothing is ever mentioned about the large minimum balance one must maintain or initially deposit in order to qualify for these low advertised trading commissions (Kassenaar, 1999, and Financial Service Online, 1999). For example, Merrill Lynch, a traditional full service firm that recently began offering the online trading option through its Merrill Lynch Direct Account, offers trades for $29.95. However, the account requires a minimum account balance of $20,000 or $250 if the funds are applied to an Individual Retirement Account. American Express Brokerage, an Internet discount brokerage, has the following pricing guidelines: Investors who have account balances less than $25,000 must pay $14.95 for each buy and sell. Online buys cost nothing and sells cost $14.95 if investors have a minimum account balance of $25,000. Investors with account balances over $100,000 are entitled to free buys and sells. Brown and Co., a deep-discount online brokerage firm, offers trades for $5 each. It has the following guidelines: An investor must have at least five years= investment experience and have a minimum of $15,000 to open an account. Atkinson (2000) further warns that some firms even require that an investor make a certain amount of trades in order to qualify for the discounted trading fees. There are also the added costs of placing particular types of orders, such as limit, stop, or telephone orders (Atkinson, 2000). For example, Schwab, who requires an initial deposit of $5000, charges $29.95 if the trade is placed over the Internet, $49.50 if placed over the telephone using an automated service, and $55.00 if he or she personally gets a broker to place the trade. As one can see, an investor must possess a sizable sum of cash in order to qualify for some of the low trading fees offered by brokerages. In addition there are additional obscure fees that investors are required to pay when trading online.

In order for this area of concern to improve, everyone involved must do his or her part in facilitating change. Brokerages must strive to keep potential customers informed of the costs associated with this venture. Investors need to take it upon themselves to become educated on all the aspects of online trading (Gordon, 2000). They must investigate each brokerage in order to find out which one best suits his or her needs. Lastly, reading the fine print is imperative. As the old adage states, "if it is too good to be true, then it probably is." The Securities and Exchange Commission (SEC) and other pertinent Governmental entities play a role in online trading. Not only must they continue to monitor the industry, but they also need to increase regulation as well as step up enforcement efforts on the brokerages that facilitate inept marketing practices. As one can see there is much room for improvement in this area of concern in regards to online trading. Everyone must, especially the investor, must be cognizant of what he or she is getting into when it comes to trading online.

Independence

The term "do it yourself" is very much applicable in the case of online trading. Many investors who start online trading have no idea what this endeavor requires and the problems and challenges associated with it. The main problem and challenge that one must tackle is that of research. Without a broker to do this task, one is left to rummage through the endless and complicated amounts of data and information. This would include data sources such as financial statements, stock reports, company profiles, and the like. This is a very time consuming, necessary and prudent task. One must possess the knowledge to understand the data and be able to ascertain its reliability and validity. (Research reliability is another topic in and of itself; that will be discussed later in this study).

The second dilemma faced by the "do-it-yourself" investor is that of investment advice. Without a broker, the decision to buy, sell, or hold a security is left up to the investor (Brackey, 2000). Also, investors who possess a portfolio must bear the responsibility of managing it on their own. Diversification issues and the like are matters that must be dealt with. They require extensive research, knowledge, and time. Therefore, one must truly understand the risk and return characteristics of the securities that they are buying and also have sufficient time to handle various issues involved with this task.

Unfortunately, very few people possess the time and knowledge required to handle this task responsibly and wisely, and therefore, it would be in his or her best interest to go through a full service broker. Online brokerages can improve this situation by offering more tools to assist their customers with investment decisions. Many brokerages are doing this and it appears to be a sign of the times (Fraser, 2000). However, one should not expect too many services to be offered because the lack thereof is the reason their trade commissions are low. It stands to reason that the more services available, the higher the trading fees.

Therefore investors get what they pay for. In order to be profitable, they must have ample time and knowledge to fill the gap that would ordinarily be filled by the duties of a full service broker. With the passage of time, hopefully the online brokerage community will provide investors with more account management tools.

Reliability

One is totally dependent on digital technology when it comes to online trading. After all, one cannot trade online if they are unable to establish a "connection" with the firm. There are a number of problems and challenges that can and do arise in association with computers and the Internet. The results can be devastating should a problem arise at the most inopportune moment. As investors are aware.... time is money. Computer crashes are inevitable, on the part of the firm as well as the investor. Heavy internet traffic or volume is another factor that one must eventually deal with (Patel, 1999). Connections and downloads can be delayed or stopped all together due to Internet or web site congestion. Online firms vary in their computer hardware just as investors. One can bet that there are brokerages that do not possess adequate backup servers or properly maintain them. On the same note, there is the potential of brokerages having faulty “backups” or the lack thereof. Some firms may not have an alternate means available for investors to conduct trades. Should investors be unable to conduct an online trade for any reason, he or she should also be able to place the order via the telephone or personally. Online investing requires that firms and the investors possess reliable computer equipment and measures in order to fulfill their intended purpose.

Another aspect of reliability is that of research materials. There are a number of sources available on the Internet that one can obtain free information regarding an array of investment topics. However, Opdyke (2000, p.1) warned in his study, “that the words, ‘good’ and ‘free’ usually don’t go together in the same sentence.” Opdyke further asserted that within this plethora of information resides data that is stale, incorrect, and in some instances fraudulent (Hirschey, Richardson, and Scholz, 2000). Stale information includes out of date material and lagging stock quotes. Chat rooms, bulletin boards, and other like forums cannot be relied on as credible information sources. Opdyke’s study stated that the information one really needs to effectively trade online is restricted largely to brokerage firm customers, institutional investors or those willing to pay handsomely for the research material. Of course this aspect relates back to the issue of “hidden costs”. In short, unreliable data sources can provide devastating consequences.

Everyone involved in the online trading process can help improve reliability. Brokerages and investors must strive to improve their computer capabilities as well as keep their computer systems operating in an efficient manner (*Nikkei Weekly*, 1999). It is imperative that brokerages possess current as well as frequent backups of all data. They too must have a functional backup system available to investors, should the primary system fail or encounter problems. At the very least the firm should have an alternate server. A telephone system is another very beneficial backup alternative, where investors can phone in their orders should they be unable to place their orders via a computer. Investors must also keep up with their brokerages’ computer capabilities as well as their own and make changes accordingly. Technology is constantly changing and it is up to both parties to ensure their systems are operating at optimum performance.

There are also steps that can be taken to improve the acquisition of reliable information. The Internet will always contain information that is inaccurate and sometimes criminal in nature. Sponsors of sites that contain securities data must monitor them frequently to ensure that only accurate and up to date material is provided. Disclaimers should be posted on every site that does not or cannot provide accurate information (Gordon, 2000). Online brokerage firms should provide enough data for investors to make sound decisions or provide a list of sites where one can go to obtain said data. Also, the SEC and other governmental bodies must continue to scan the Internet and step up enforcement efforts on those sites and sponsors who mislead its readers. Investors must educate themselves in regards to obtaining information from sites of this nature and be cognizant of the dangers involved in doing so. Hence, online trading can be very unreliable. Education, monitoring, regulation, and enforcement efforts can help reduce this stigma of online trading.

Execution of Trades

Many people are under the impression that a trade is executed the moment the mouse is "clicked" and at the amount expected. This is far from correct, as illustrated in Table 1. To understand how transactions occur, one must come to understand the online trading process (Hamilton, 1999 and McNamee, 2000). The process begins with the placement of an order. Once that order is placed with a brokerage firm, the firm then forwards the order to a Wall Street "market making" firm that actually executes the order. Brokerages often receive payments from market makers to get their business. This payment system is referred to as "payment for order flow" and is very controversial due to the potential of abuse. For instance, brokers may route orders where he or she is receiving the highest payments as opposed to where investors get the best execution. Routing and rerouting orders is inherently slow and result in poor executions. The market maker will match, but not necessarily beat the market's prevailing rate. A group of market makers may control 30 percent or more of the market's volume. They in turn can use this information for their own gain.

Table 1: Comparison of Transaction Performance and Success Rate

	Week of June 12-16, 2000		Week of July 17-21, 2000	
	Transaction Performance (in seconds)	Transaction Rate (Rank)	Transaction Performance (in seconds)	Transaction Rate (Rank)
Market Index	13.87	91.3%	11.93	97.0%
DLJdirect	4.10	99.4%	4.5	99.9%
E*Trade	15.78	96.1%	NA*	NA*
Charles Schwab	8.29	99.3%	9.24	99.3%
Merrill Lynch	18.69	98.5%	22.24	91.7%

Source: www.keynote.com
Note: NA*: Not available

Online brokerages vary in their trade execution speeds as well as their trade execution success (Patel, 1999). As volatile as the market is, an online brokerage that takes twenty seconds to execute a market order can result in drastic expenses and losses. (*A market order is simply an order to buy or sell a specified amount of a security(s) at the prevailing market rate, whatever that may be at the time the order is 'filled' or executed*). What compounds this dilemma is when an online broker or another source contains lagging stock quotes, as opposed to "real time" stock quotes (Patel, 1999). (*Lagging stock quotes are quotes or prices that are not* *current with the actual market price. Real time quotes are those that follow the market second for second and change accordingly*). For example, an investor places a market order to buy 1000 shares of a “tech” stock. The stock is quoted at $5 a share from a source that has a twenty-second lag time. Unbeknownst to the investor, the actual value of the stock has increased to $6 at the time the order was placed. Now the online brokerage takes an additional thirty seconds to execute the order at which time the stock’s price has escalated to $7 a share. This fifty-second time span - or “slippage” as Patel terms it - has ended up costing the investor an additional $2000. It is the risks and problems such as these that online investors experience everyday, but are seldom mentioned.

In the scenario discussed above, the investor could have placed a limit order on the buy; but there is no guarantee that his or her order would have been executed (McNamee, 2000). Recall that a limit order specifies that the investor will buy or sell shares at the price they specify. If their limit price beats the order offered by the dealer who gets their order, the dealer has to post their order where it will have a chance to be filled/executed. McNamee (2000) addressed this problem through a SEC report. The SEC report found “serious neglect” of these rules by many firms, including three mid-tier NASDAQ market makers that mishandled 46% to 92% of the orders examined. This translated into thousands of customers losing the chance to buy or sell stock at favorable prices. The “execution” issue is a problem and challenge that plagues investors and brokerages with serious negative implications.

There are a number of ways in which everyone involved in the online trading process may address this concern. The SEC must continue to increase and improve regulation and enforcement efforts surrounding this dilemma (*Economist*, 2000). Brokerages must adhere to these various regulations and laws and make certain their affiliates are doing so as well. They must also remember that the customer is the main priority. Their actions must always be in the customers’ best interest. Again, investors must educate themselves on the intricacies of online trading. From the results of time lags to the details of limit orders, investors must be cognizant of the business in order to protect themselves. Everyone involved can improve the process of trade execution if the correct steps are taken.

Security

Another area of major concern is security, which not only plagues online trading but the entire e-commerce industry. But, some argue that online investing is safe and secure. For instance, according to Anderson (1998), president of Ameritrade, online investing is secure mainly due to the fact that the only information being transferred over the internet are orders to buy or sell. Others disagree, because hackers or viruses are infiltrating investors’ accounts. These accounts contain very pertinent as well as private information. However, there are times when very personal information is transferred over the Internet. Many online brokerages allow customers to apply for an account via the Internet. The information called for in these applications is very personal in nature (e.g., social security number, bank account(s) information, and credit card(s) numbers). While many firms have increased their security efforts by implementing complicated encryption techniques and various up to date anti-virus software applications, there are still online firms that are lacking in this area. Should these precautions be overlooked by a brokerage, the ramifications can be devastating to its customers. One can only imagine the damage that could occur should his or her personal information end up in the wrong hands.

Hence internet security is a serious problem that plagues the entire E-commerce community. Computer viruses and hackers are always going to be a threat in our society. It is up to online brokerages to maintain and strive to ensure that their computer systems are up to date in regards to anti-virus software and encryption techniques. It is also up to investors to investigate their brokerage firm to see what measures they are taking against this problem. Additionally, they need to see what can be done on their behalf to guard against breeches of security. This is a topic in which everyone needs to be abreast of and counter measures implemented. Failure to do so can result in devastating consequences.

Long Term Outcome

Over time, aggressive online trading can have a negative impact on investors= earnings. The studies by Minkoff (2000), Future Banker (2000) and Chidley (1999) supported this contention. They found that online investors make close to 10 trades a year, and by the year 2005 it is estimated that each investing household will possess an average of 4.5 accounts. On the same note, it is stated that people with Internet accounts trade more often, as well as, trade more on margin. Furthermore, the Securities Industry Association (SIA) estimates that the average number of online trades per day now exceeds 500,000 (partly because of day-traders).

With all this excessive trades, one must contend with excessive trading fees, and lower earnings. McMillan (1999) and Levinsohn (1999) studies supports that excessive trading have resulted in investors's earnings to decrease. They found that investors increase their trading activity when they open an online account. Through aggressive trading, people get roughly two percentage points below what they would have achieved with a traditional "buy and hold" strategy. Levinsohn (1999) concurred with this argument in by stating that online investors are dismissing the rational strategy of buy-and-hold. McMillan's strongest point in his study was that investors, who outperformed the market by three percentage points before they began online trading, typically lag it by two points afterwards. Atkinson (2000) echoed the sentiments of this argument by stating that poor performance of a portfolio is directly attributed to active trading(i.e., it eats away at its gains). An investor that practices aggressive trading and is unwise to its long-range effects will undoubtedly suffer the financial consequences of such behavior.

Investors must be informed and educated regarding the online trading of securities. Securities trading simulation games which are offered through various sites, are excellent ways for investors to achieve this (Saunders, 1999). When it comes to the volatility of the market or the cumulative fees associated with aggressive trading, the investor must be cognizant of the ramifications of said factors (*Economist*, 1999). Patience and having an investment plan, such as a buy and hold strategy, are key to profitability. In conclusion, the typical investor who practices "buy and hold" stands to make more money than someone who ends up trading aggressively in an uncalculated manner.

SUMMARY AND CONCLUSION

The problems and challenges of online trading are deeply entrenched as discussed. There is no doubt that this practice can be very costly to an uneducated and uninformed investor. However, there are steps that must be taken to improve this dilemma. Investors must strive to better educate themselves through such mediums as investment simulation games in order to fully recognize the intricacies of online trading. To prosper from this endeavor, they must read the fine print in everything and posses the time and other requirements called for in this venture. Maintaining and keeping computers technologically up-to-date is imperative on everyone=s behalf. Brokerages must focus on the customer and keep them fully informed on all aspects of the business. Brokerage firms must ensure that their clients are capable of participating in this form of trading. The SEC and other governmental agencies must continue to increase its efforts in regulating and monitoring this sector of the market to insure that the customer=s best interest are being fulfilled. Online trading presents numerous problems and challenges to everyone involved. Investors must be prepared to work on this if they plan on reaping any benefits. With time, knowledge and continued effort the dangers of online trading can be minimized. Being informed and educated are the best safeguards in this ever-growing field of land mines.

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E-COMMERCE SECURITY STANDARDS AND LOOPHOLES

S. Srinivasan, University of Louisville

ABSTRACT

Electronic commerce is enjoying a phenomenal growth at present. Until recently many people did not feel comfortable in using e-commerce. The principal reason for the initial reluctance of many people to accept the Internet transactions was the lack of confidence in the security measures of the Internet. The industry took serious note of people's concerns in this regard and committed to improve the Internet security. Several security standards were developed to facilitate e-commerce. This paper considers several methods available today for secure Internet transactions and addresses some of the loopholes in the system that could jeopardize the trust that needs to be established for the long term success of e-commerce.

INTRODUCTION

The Internet offers tremendous opportunity for merchants around the world to sell their products online. However, the anonymous and open nature of public communication networks has presented serious challenges for securing personal and bankcard information over the Internet. U.S. businesses are seeking opportunities worldwide by using the Internet to open up unreachable foreign markets. According to Internetstats.com, nearly 134 million Americans are online today compared to 118 million last year. Cap Gemini USA estimates that roughly 55,000 new users are going online every day. With this much growth in online use the natural beneficiary is online commerce. Industry’s role in this regard then is to provide confidence for the customers that the transactions online are secure.

Standards play a significant role in securing the transactions on the Internet. Standards provide interoperability, connectivity, consistency of applications, transparent data exchange, distributed open environments, improved information sharing, security, and lower costs to users and software providers. The banking industry estimates that it costs approximately $1.07 per transaction. Surprisingly, without costly branches and human interaction, the cost per transaction using online will be one cent. With such a profound cost differential the businesses are slowly going to gravitate towards electronic transactions, with sufficient incentives to attract customers for online usage. U.S. Internet Council estimates that the capacity of the Internet backbone to carry information is doubling every 100 days in order to meet this added volume. Compared to a growth rate of only 10% in voice communications, the data traffic is rising at the rate of 125%. This phenomenal growth can be directly attributed to the expected $1.3 trillion e-commerce sales by 2003.

EMERGING INTERNET STANDARDS

Some of the newer and popular Internet standards include Secure Electronic Transactions (SET), Enhanced Data Encryption Standard (DES), Secure Sockets Layer (SSL), Secure HyperText Transfer Protocol (S-HTTP), and Secure Multipurpose Internet Mail Extensions (S/MIME).

Secure Electronic Transactions (SET)

Secure Electronic Transactions (SET) is a standardized, industry-wide protocol designed to safely transmit sensitive personal and financial information over public networks. Jointly developed by MasterCard and Visa International, SET uses RSA encryption and authentication technologies to enable secure payment transactions (RSA, 2000). SET uses RSA with 1024 bit keys. The RSA algorithm is the most scrutinized, tested, and trusted public key algorithm. The SET protocol contains state-of-the-art cryptographic technology that provides on-line transaction security that is equivalent or superior to the safeguards in present physical, mail and telephone card transactions.

To meet the security needs of bank card transactions over public networks, the Secure Electronic Transaction (SET) protocol uses cryptography and related technology to provide confidentiality of information about financial data, to ensure payment integrity, and to authenticate merchants, banks, and cardholders during SET transactions. The level of security incorporated into SET is based on RSA's Public-Key Cryptosystem, which has been proven over the last 10 years as the most commercially viable, widely used security technology available. The RSA Cryptosystem is used in over 100 million copies of messaging, groupware, email, and Internet-based applications. In this context it is worth noting the following.

With these many sources for online access around the world, the e-commerce industry has to guarantee security of transactions. Otherwise unscrupulous elements will try to take advantage and bring down the entire e-commerce industry. The stakes are enormous.

The SET protocol defines four main entities involved in a SET transaction: the Cardholder, the Merchant, the payment Gateway, and the Certificate Authority (Keen, 2000). Message integrity and authentication are achieved in the SET protocol through digital signatures. The confidentiality of messages in the SET payment environment is accomplished through encryption of the payment information using a combination of public key and secret key algorithms. The RSA Public Key Cryptosystem is the public-key algorithm used in SET and the symmetric key algorithm is DES (Data Encryption Standard). The SET protocol is also designed to allow for more complex transactions such as returning goods and obtaining a credit, or reversing an authorization for an amount when goods cannot be shipped. **The key aspect of SET is that no physical card is required for processing SET transactions.** Digital signatures help facilitate the transactions.

Data Encryption Standard (DES)

The Data Encryption Standard (DES) was published in 1977 as an encryption standard for U.S. Government applications. It was based on an encryption standard known as Lucifer cipher. When DES was adopted as a federal standard, its expected life was ten years. The DES is an U.S. national standard and de facto international standard. DES security is based on repeated bit permutations within a 64-bit block of text, where the permutations are derived from the specific DES key. Benchmarks have shown that a DES can encrypt about 300 kbps. The fastest DES chips are designed to encrypt data with one key and not to test many keys against the same block of cipher text.

Over the years, there have been several different attempts to crack DES. Although DES can only be cracked through brute force, the increasing speed and sophistication of computer processing power has rendered the standard insecure. Exhaustive key search remains the fastest known attack against the DES. But improvements in technology, leading to the potential for faster key search machines, now pose a greater threat to the use of single-key DES.

Triple-DES

Triple-DES is based on the existing DES, but has been enhanced by tripling the key length. The longer key will make it more difficult to use brute force to crack the code. Triple-DES, a strengthened version of the DES standard, is an alternative favored by banking and financial services industries. The new mode of multiple encryption is the triple-DES external feedback cipher block chaining with output feedback masking. The aim is to provide increased protection against certain attacks like dictionary attacks and matching cipher text attacks, which exploit the short message-block size of DES. The new mode is part of a suite of encryption modes proposed in the ANSI X9.F.1 triple-DES standard (X9.52) (Coppersmith, Johnson, & Matyas, 1996).

The use of triple encryption with multiple keys is generally accepted as the best and most practical method for increasing the strength of the DES against key search attacks. The two major concerns that are addressed when standardizing the triple-DES modes are matching ciphertext attack and dictionary attack. The new method for increasing the strength of triple-DES mode against these attacks, without having to change the 64-bit block size of the DES algorithm, uses secret masking values. It also uses external feedback with Cipher Block Chaining (CBC).

Advanced Encryption Standard (AES)

NIST's Information Technology Laboratory has initiated a process to develop a Federal Information Processing Standard (FIPS) for Advanced Encryption Standard (AES) incorporating an Advanced Encryption Algorithm (AEA). It is initiated that the AES will specify an unclassified, publicly disclosed encryption algorithm capable of protecting sensitive government information well into the next century. The Advanced Encryption Standard will replace DES, which is more than 20 years old. They are looking for a 128-bit block cipher that supports keys of 128, 192, and 256 bits (NIST, 2000). NIST foresees that a multi-year transition period will be necessary to move forward any new encryption standard and that DES will continue to be sufficient strength for many applications.

RSA has delivered a proposal to the U.S. government for a new and more secure algorithm, designed by RSA laboratories team led by Ronald L. Rivest. According to NIST, Advanced Encryption Standard will be publicly defined, a symmetric block cipher designed so that the key length may be increased as needed and be implementable in both hardware and software. Algorithms submitted to NIST will be judged on security, computational efficiency, memory requirements, hardware and software suitability, simplicity, flexibility, and licensing requirements (Corman, 1998). The review process will take several years before the new standard is finally formalized. As the government's business on the public networks like Internet increased, the importance for more security, and higher standards of encryption is necessary.

These three standards together account for majority of the secure transactions online today. We need to keep in mind the rapid and sustained growth of the Internet over the years. The following table shows such a growth: