Effectiveness of an Integrated Pre-capstone Project in Learning Information Systems Concepts

James W. Denton
College of Business and Economics
West Virginia University
Morgantown, West Virginia 26506

and

William E. Spangler
A. J. Palumbo School of Business Administration
Duquesne University
Pittsburgh, Pennsylvania 15282

ABSTRACT

The inherently interdisciplinary nature of electronic commerce makes it an ideal basis for an integrative course in information systems. This paper describes the initial design and implementation of a project-based "pre-capstone" course for undergraduate MIS majors, and assesses the impact of the course on student perceptions of their MIS skills. As defined here, a pre-capstone course integrates the major technologies and operational issues underlying electronic commerce for a class of students of varying skills and classroom experiences, with the intention of providing the students with a more meaningful experience earlier in the MIS program.

We discuss the specific issues and lessons learned from our initial implementation of this type of course, which provided the students with a creative learning experience that allowed them to discover deficiencies in their knowledge and address those deficiencies through communicating and learning within student teams. We also present survey results indicating how the more realistic context of the course impacted students' perceptions of their knowledge and abilities compared to the perceptions of students who learn MIS concepts and skills in isolation. We found that through the use of student teams containing a variety of students with somewhat different backgrounds, the learning experience can become more meaningful. This allowed students to become more aware of gaps in their knowledge, and should make them better realize the significance of their future courses.

Keywords: Electronic Commerce, MIS Curriculum, Capstone Course

1. INTRODUCTION

Teaching Management Information Systems concepts is a difficult task. Many important concepts are abstract, especially to undergraduate students who typically have little or no business work experience. Therefore, we must find ways to provide a realistic frame of reference so that the concepts that we wish to teach may be understood and appreciated fully. A full appreciation of MIS concepts requires that we simulate many of the tools, mechanisms, experiences, relationships, and hazards of the business world in our classrooms (Shah and Martin 1997). Some of these concepts can be relatively easily defined as technical procedures or processes involving the use of the tools of MIS. Other concepts are more complex, involving human relations issues or the information strategy of an organization (Becker, Gibson & McGuire 1994). An additional challenge is to maintain an up-to-date course in the face of a rapidly changing environment (Srinivasan, Guan, and Wright 1999).

Most MIS curriculum developers have identified key MIS topics to be taught separately, for the most part, in individual courses. For example, in IS'97 (Davis, Gorgone, Couger, Feinstein & Longenecker 1997) several MIS organizations have issued model curriculum guidelines delineating a series of courses beginning with courses in IS fundamentals and personal productivity tools; then progressing through

courses in IS theory, IT hardware and software, programming, database, telecommunications and systems analysis; and finally culminating with physical design and project management courses. The result is a sequence of courses, with each course presenting an MIS concept in relative isolation until the senior year, when project oriented courses provides a capstone experience. Capstone courses provide a means for students to apply knowledge gained in previous courses and integrate those experiences in a more realistic setting, where concepts are applied simultaneously, rather than sequentially and in isolation. Furthermore, capstone courses can address a number of important business issues that are often missing or under-emphasized in traditional IS courses, including the critical analysis of business problems, the pragmatic use of technology, the role of systems integration, and the impact of current and emerging trends in information systems (Gupta and Wachter 1998).

Our paper extends the idea of a capstone experience to earlier courses in the curriculum, where students may not have yet been exposed to all of the tools and knowledge required to complete a comprehensive project successfully on their own. By using groups of students with different skills, an integrative experience can be provided to students at an earlier stage in the MIS program. More specifically, our goal is to sensitize students a priori to the real-world complexities and challenges of information systems, and thus to motivate their learning in subsequent core technology courses.

2. SELECTING AN INTEGRATIVE TOPIC

The decision to offer a new course in electronic commerce evolved somewhat slowly. When we initially considered offering a new elective to our undergraduate MIS students, we employed what might be termed a traditional 'top-down' approach to planning such a course. That is, we began with the desired goals and objectives of a new course – primarily with regard to the type of knowledge our students would gain from the course – and then began to consider candidate courses that would most effectively achieve those goals. In designing the course, we were guided by a number of interested stakeholders and knowledge sources, including potential employers in private industry, students, and various references in IS academia (including the IS-97 specification).

Our initial investigation led to two major needs: 1) to link MIS concepts more closely with business (and accounting) processes, and 2) to update our curriculum, which suffered from a rather limited scope. In particular, we desired to expose our students to broad MIS concepts and provide some experience with project management. Other courses could address these issues to varying extents, such as an Enterprise Resource Requirements Planning (ERP) course utilizing a specialized system from a company such as Oracle, SAP or PeopleSoft. During this time, however, the popularity of electronic commerce began to rise dramatically, and our business school, like many others, began an e-commerce initiative. With students also beginning to ask about potential offerings in e-commerce, we began to explore an e-commerce course that 1) addressed the needs mentioned above, and 2) appealed to the demands of the internal and external marketplaces. Thus the original approach became a combined 'top-down' and 'bottom-up' (i.e., e-commerce driven) approach to course analysis and design.

Electronic commerce is an ideal vehicle for an integrative course because it mirrors the interdisciplinary nature of the MIS area. It readily provides a rich environment where issues from the areas of Accounting, Marketing, and Business Law can be considered along with technical concepts such as systems analysis, database design, Common Gateway Interface (CGI) programming, interface design, and HTML programming. A project in electronic commerce will provide an experiential opportunity for actively solving ill-structured problems in MIS as well as business in general.

A pleasant side effect is that the platform for electronic commerce is the Internet, which is readily available to educational institutions. This helps to alleviate a common problem faced in project-oriented courses: providing the students with a technical platform that adequately simulates the enterprise systems found in business. By using the Internet as the technical platform of our system, it is not necessary to simulate the workings of a large enterprise system to provide a realistic experience for the students. Hosting student electronic commerce projects on a small, dedicated server can provide realism without utilizing a large institutional system. It has been has demonstrated that a simple personal computer and personal web server software can be used effectively to host student teams in a capstone project-oriented course (Denton 2000).

3. COURSE DESIGN ISSUES

The broad nature of electronic commerce allowed us to select a textbook and an approach to the course that would address our needs as well as satisfy the desire to offer a course in an exceptionally popular area. Specifically, we could use the concepts and technologies of e-commerce, together with an encompassing web site development project, to provide an integrative – and compensating – experience for our undergraduate MIS students. At the same time, however, we were required to consider the diverse technical backgrounds of the students in establishing a framework for the development project. The key objective was a project that would challenge students by facilitating cooperation and peer mentoring in a novel – and somewhat uncertain – development environment. Each of these primary design issues – i.e., topic, project, and learning environment – is discussed below.

Considering our needs, we chose a textbook (Greenstein & Feinman 2000) that ostensibly is targeted to accounting students, but which offers important benefits for MIS students. From an MIS perspective, the text discusses the technical aspects of security, cryptography, and networking principles. In addition, since the authors have both information systems and accounting expertise, the text also takes an operational/accounting approach to e-commerce. This allowed us in part to address critically important business process issues that heretofore had been omitted or discounted in our standard MIS curriculum – including risk management and control, regulation, business transaction processing, electronic payment mechanisms and EDI. On a more pragmatic level, this integration of IS and accounting knowledge is critically important to MIS students, particularly those who wish to pursue careers in consulting.

We chose to supplement the operational and technical issues in the text via an interactive web site development project – also proposed by the textbook authors – that would provide students with experience in the technical aspects of web design and implementation, as well as in the practical issues of project management and coordination. Students learned and/or revisited a number of specific technologies during the project, including:

- web page design and development (including HTML, Forms, Javascript, and the use of a web development tool such as FrontPage)
- database design and implementation (using Microsoft Access), and
- Common Gateway Interface (CGI) programming using Visual Basic (VB), which provided interactivity to student web sites – i.e., allowing their sites to receive and respond to customer information and inquiries.

All of the students had some experience in web page development in their introductory IS class. In that class, they used a tool of some type – most likely MS Word or Netscape Composer – to develop their web pages, and were exposed to minimal information about HTML and related concepts. Similarly, all of the students were exposed to fundamental database concepts, and had used a personal database (Access) to create simple tables, queries, forms, and reports. Some of the students had taken a more advanced course in database design, exposing them to more advanced modeling issues such as normalization. Many – but not all – of the students had taken an introductory course in Visual Basic, but were unfamiliar with the nature of CGI and the notion of retrieving and sending data without the use of a VB form. Therefore, HTML and CGI/VB programming were covered in a series of lectures prior to students attempting to implement them in their web sites.

Notably, ambiguity and uncertainty within the learning environment were an important aspect of course design. Given the incomplete and diverse backgrounds of the students, an integrative electronic commerce project was expected to impose a certain level of uncertainty on all of the class members. For example, the project required them to engage in systems analysis in order to set appropriate goals and objectives, evaluate their product(s) and potential customers, and determine how their web site should be implemented. To some students, this required the application of principles learned in a previous systems analysis class. To others, this resulted in confronting the issues of analysis for the first time, and — if our hopes were to be realized — relying on more knowledgeable students for guidance.

The class, therefore, became a vehicle for implementing a creative learning process (Isaksen & Parnes 1985) where students

- become aware of deficiencies in their knowledge

- define missing information that is critical to the task
- seek out new information to solve problems
- formulate hypotheses in their search for a solution
- test and perfect their hypotheses
- communicate their results

In addition, considerable uncertainty resulted from the task of developing interactive web sites, which required students to synthesize their knowledge of individual technologies and to apply that knowledge to the construction of a seamless system. This can be very challenging and somewhat stressful for students. For example, a number of students with previous experience in an introductory VB programming class – where the emphasis is on developing simple applications constrained to a single PC – are locked into the idea of developing VB programs exclusively around the concept of a Visual Basic form. Consequently, they have difficulty understanding how a VB program can send and receive data from a web server via a CGI interface. "We don't even know where to start" was a common refrain.

This type of conceptual disconnect between old and new paradigms is common in programming – a standard example is the difficulty at times in training traditional programmers in more modern 'visual' and object-oriented techniques (Nelson, Armstrong & Ghods 2001). In our course, simply lecturing on the nature of CGI – even when it is specifically targeted to Visual Basic – would be woefully insufficient. However, after students have struggled with the concept and attempted to implement CGI on their own – with various degrees of success – subsequent explanations of the process, using their own efforts as context, would be much more relevant, and effective.

The electronic commerce project was, therefore, an attempt to use uncertainty and doubts as a means of initiating a process of discovery for the students (Lee 1999). Students are accustomed to viewing a college course as presenting a series of facts to be memorized and reproduced on exams. The electronic commerce project triggers a different type of learning process – one that requires the student to perform an intellectual exploration and utilize higher-level cognitive skills. By interacting with the environment presented by the project, students live through new experiences, which build and modify their conceptual models of how the world of information systems works.

4. COURSE AND PROJECT IMPLEMENTATION

The implementation of the course proceeded from the design issues described above, with much, if not most, of the organizing effort directed to the term projects. The project introduced a number of project management experiences, which served as a type of 'pre-capstone' experience. Groups had to be constructed so that they included students with a sufficient range of skills to produce a viable product while maintaining a group size that was small enough to be managed effectively. Because of the large number of requirements for each web site, we used large groups (8 to 10 students each), each of which were decomposed into certain functional sub-groups and led by a project manager.[1] The instructor, in turn, assumed the role of CEO and Technology Consultant – interacting primarily with project managers, and with other students on an as-needed basis.

Students were presented with some overall constraints on group composition. It was necessary to have a project manager, as well as a minimum of two students assigned to each function: i.e., web page design, site content, CGI programming, and database design and implementation (CGI and database responsibilities could be combined). Within these constraints, however, students essentially were permitted to self-organize into groups, using an approach somewhat similar to a commodities exchange. This somewhat chaotic approach allowed students with leadership abilities and inclinations to gain project management experience, while allowing other students to work in (possibly multiple) areas that were of interest to them, thus engendering a degree of intellectual curiosity. It also allowed students with little experience in an area to work side-by-side with more experienced students (i.e., those students who had taken the Intro to Visual Basic, or database management course). As such, this approach allowed inexperienced students to 'preview' their future courses, while simultaneously providing retrospection for students who had taken the VB and/or database course previously. Finally, although the size of the groups and large number of requirements allowed a certain level of knowledge cross-pollination between students, students (and particularly the project

[1] Thanks to Joseph Williams at Colorado State University for his suggestions regarding group structures.

managers) learned that delegation and coordination were essential. One or two students simply could not attend to all requirements, and the sheer size of a group precluded them from working as a single unit.

Classroom discussions also provided important background information for the projects – covering topics such as HTML, development and implementation of web forms, CGI programming (and implementation using Visual Basic/Access), and the use of cookies (again implemented via Visual Basic). We supplemented the standard classroom meetings with several ad hoc, informal sessions, which addressed issues and questions that arose as students struggled with the realities of implementing new technologies. These classroom sessions in part attended to the need to monitor and manage the inevitable frustrations felt by students when they encounter ambiguous situations and unstructured problems for the first time in their course work.

5. RESULTS AND DISCUSSION

In order to gauge the effectiveness of the course, we sought to answer three essential research questions related to student perceptions of learning. The three questions were:

1. Did participation in the EC course impact students' perceived knowledge of specific IS subject areas?
2. Did students' perceived learning vary across those subject areas?
3. Was perceived learning of the subject areas contingent on other courses taken prior to or concurrent with the EC course?

Toward this end, a brief survey was given to all of the participants at the conclusion of the course. To provide a comparison, the survey was also given to students in a parallel Visual Basic programming class. The courses surveyed consisted primarily of second-semester Juniors and first-semester Seniors in College of Business and Economics at West Virginia University. Eighty-five percent of those surveyed were MIS majors, and seventy-five percent were male. Four groups were represented in the survey:

Group 1. Students taking the Electronic Commerce class with no Visual Basic experience.

Group 2. Students taking the Electronic Commerce class while concurrently taking Visual Basic.

Group 3. Students taking the Electronic Commerce class who had previously taken Visual Basic.

Group 4. Students taking Visual Basic, but who were not enrolled in the Electronic Commerce class.

The survey asked the students to rate their own knowledge in five areas: general computer knowledge, general information systems knowledge, knowledge of databases, knowledge of programming languages, and knowledge of and ability to analyze information systems in organizations. The survey asked them to assess, on a five-point scale, their perceived knowledge both at beginning of the class (pre-class) and at the conclusion (post-class). The five-point scale allowed students to assess their knowledge along a continuum from one through five, where one was identified as "none", three was identified as "moderate", and five was identified as "very high".

We calculated an average pre-class and post-class knowledge score for the intersection of each group and area (see Table 1, below). Since the survey relied only on the students' individual perceptions of their knowledge, the results cannot be expected to provide definitive conclusions about the effectiveness of the course, per se. As shown in Table 1, the students uniformly rated their knowledge in all areas higher at the end of the course than at the beginning, which could indicate that many of the students simply were attending to their own – or to their professors' – expectations of learning.

TABLE 1
Student Self-assessment of Computer and Information System Skills

	Group 1 (EC Only) Before/After	**Group 2** (EC + Conc VB) Before/After	**Group 3** (EC + Prior VB) Before/After	**Group 4** (VB Only) Before/After
General computer knowledge	3.00/4.00	2.83/3.78	3.00/3.91	2.87/3.76
1.1.1 General IS knowledge	2.60/4.20	2.43/3.78	2.87/3.87	2.03/3.10
1.1.2 Knowledge of databases	2.80/3.60	2.43/3.61	3.00/3.93	2.03/3.21
Knowledge of programming languages	1.60/3.00	1.96/3.13	2.74/3.65	1.56/3.18

1.1.3 Ability to analyze IS in organizations	2.40/3.60	2.39/3.61	2.74/3.87	1.79/3.00
1.1.4 Number of Observations	5	23	23	39

Notably, however, the survey findings suggest that the integrative (and contextual) nature of the course does impact student perceptions of learning under certain circumstances. Specifically, although knowledge increased in each group and topic area, the *relative* increase in knowledge varied between certain groups. To compare the impact of the course on the different groups, we began by computing a difference, **δ**, which measures the increase in the students' perceived knowledge level for each of the four groups (see Table 2).

Although the amount of this perceived increase is not significantly different in most respects between the four groups of students analyzed (see Table 3), a major exception occurs in the perception of the knowledge of programming languages. In this area, there is a significant difference (i.e., greater than 90% confidence) in the **δ** values between Group 2 and Group 4, and a significant difference in the **δ** values between Group 3 and Group 4. Group 2 students and Group 3 students were enrolled in the Electronic Commerce class and either concurrently enrolled in the Visual Basic class (Group 2) or completed Visual Basic in a prior semester (Group 3). Group 4 consisted of students in the Visual Basic class who were not part of the Electronic Commerce class.

TABLE 2

Values of δ, the difference between students' assessment of their knowledge levels before taking the course, and after completing the course

	Group 1 (EC Only)	Group 2 (EC + Conc VB)	Group 3 (EC + Prior VB)	Group 4 (VB Only)
General computer knowledge	1.00	0.95	0.91	0.89
1.1.5 General IS knowledge	1.60	1.35	1.00	1.07
1.1.6 Knowledge of databases	0.80	1.18	0.93	1.18
Knowledge of programming languages	1.40	1.17	0.91	1.62
1.1.7 Ability to analyze IS in organizations	1.20	1.22	1.13	1.21
1.1.8 General IS knowledge	1.00	0.95	0.91	0.89
1.1.9 Knowledge of databases	1.60	1.35	1.00	1.07
1.1.10 Ability to analyze IS in organizations	0.80	1.18	0.93	1.18

TABLE 3

Values of Alpha for t-test results for pairwise comparisons (H_0: $\delta_1 = \delta_2$)

	Groups					
	1 vs 2	**1 vs 3**	**1 vs 4**	**2 vs 3**	**2 vs 4**	**3 vs 4**
General computer knowledge	0.883	0.806	0.730	0.839	0.708	0.890
1.1.8 General IS knowledg	0.708	0.135	0.206	0.141	0.200	0.684
1.1.9 Knowledge of databases	0.502	0.835	0.409	0.444	0.983	0.334
Knowledge of programming languages	0.761	0.401	0.501	0.328	**0.051**	**0.002**
1.1.10 Ability to analyze IS in organizations	0.918	0.942	0.925	0.760	0.958	0.749

It makes sense that the students in Group 3 rated their knowledge increase to be less than that of the students in Group 4. Group 3 students had already been exposed to Visual Basic, while Group 4 students had just completed their initial Visual Basic course. The students in Group 4 were starting from a lower position on the learning curve, and therefore stood to make a larger incremental gain in knowledge. It is most interesting, from the perspective of this study, to consider why the students in Group 2 should rate their increase in knowledge level to be significantly less than the students in Group 4. Group 2 consisted of students who, like the students in Group 4, were being exposed to Visual Basic for the first time, and were both starting from the bottom of the learning curve. The difference is that Group 2 students also participated in the Electronic Commerce class.

Since the Electronic Commerce class exposed the students in Group 2 to more advanced Visual Basic concepts than were presented to the students in Group 4, why did Group 2 students rate their knowledge gain

to be significantly less than did Group 4? The answer in part could be that students in Group 4 were exposed to the integrative aspects of the electronic commerce course, which provided them with a more realistic frame of reference for their programming activities. These students were exposed to more than the usual textbook exercises and simplistic projects required of an introductory Visual Basic student. Essentially, in the more encompassing and uncertain context of an e-commerce programming project, students begin to understand the limitations of their own knowledge subset, and to gain an appreciation for the complexities of the technology.

6. SUMMARY AND CONCLUSION

In this paper, we have described the process of designing and implementing an integrative course at an earlier point in the MIS curriculum – i.e., a 'pre-capstone' course. Motivation for the course came primarily from the need to infuse a more realistic and meaningful experience into the MIS curriculum, prior to the traditional capstone course. Design and implementation of the course required consideration of a number of issues, particularly the mutually constraining tasks of choosing an appropriate topical context for the course and determining which technologies were most relevant and capable of integration under the topic. After consideration of several alternatives, we chose electronic commerce, primarily because of its myriad technical and business components, as well as the natural integration of those elements. We subsequently designed the course to incorporate the appropriate technical, project management and business elements, and then implemented the first offering over the course of a semester. At the end of the semester, we surveyed the students to assess the impact of the course and the perceived effect on learning.

The results of our study – both qualitative, from our observations, and quantitative, from the survey analysis – indicate that the exposure to a pre-capstone experience was beneficial for students in several ways. First, and most directly, the course revealed and addressed gaps in knowledge that are usually left uncovered in typical MIS courses. Within the limitations imposed by our curriculum, the course covered issues – such as interactive web development, security and electronic data interchange – that otherwise would have been addressed marginally, if at all, in the other MIS courses.

In addition, the course exposed students to the uncertain environment that they will experience in business. Technology problems clearly can be difficult in isolation, but they become much more so in combination with other technologies and business imperatives. Students had to recognize – and accept – the contextual limitations of individual technologies, and to formulate strategies for 'getting their product to market.' in spite of them.

The use of teams, consisting of students with different backgrounds and technical skills, provided an opportunity for peer learning. Peer learning, where students learn from each other rather than from a lecturer, is a technique that allows students to develop the communications and collaborative skills that will be so important in their future business careers. It has been shown that peer learning allows students to process information more effectively and efficiently with improved retention (Granger and Lippert 1999).

Finally, and perhaps most importantly, the course provided an integrating experience earlier in the MIS curriculum. This type of experience arguably is important in exposing students a priori to the interdependencies in systems and software, thus providing a context for enhanced understanding of the individual components in later courses. This strategy of presenting students with a problem in context, and then subsequently exposing them to the specific technical knowledge, is a variation of problem-based learning (PBL). PBL has been shown to be effective in motivating student learning behavior (e.g., see Woods 1996), and our experience confirms this.

Each of these experiences helped students to formulate a more realistic picture of the application of IS knowledge and skills in a business environment, and allowed them to come to "know what they don't know". While the students were clearly motivated in the pre-capstone course, we hope – and expect – that their increased self-awareness will serve to motivate them when they confront these topic(s) again in subsequent courses. This somewhat speculative assessment is subject to verification in future research.

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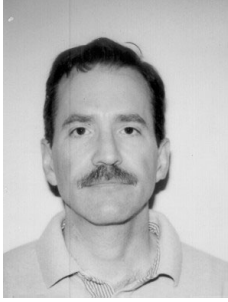

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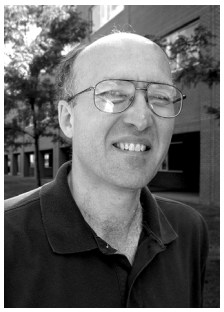

James W. Denton is an Associate Professor in the College of Business and Economics at West Virginia University where he teaches courses in basic information systems, systems design and development, and Visual Basic programming. Prior to receiving his Ph.D. from Kent State University, Dr. Denton worked in engineering and quality assurance in several industrial settings. He has previously published research on neural networks and information systems education in the *Journal of Computer Information Systems;* the *European Journal of Operational Research; Accounting, Management, and Information Technologies; Expert Systems with Applications;* as well as others.

William E. Spangler is an Assistant Professor of Information Technology in the A. J. Palumbo School of Business Administration and J. F. Donohue Graduate School of Business at Duquesne University. After working for several years in private industry, including Unisys (formerly Burroughs) and Westinghouse Corporations, he earned his PhD from the Katz Graduate School of Business, University of Pittsburgh, specializing in Artificial Intelligence. Prior to coming to Duquesne University, Dr. Spangler was on the faculty of the College of Business and Economics at West Virginia University. His current research interests focus on computational modeling for decision support in complex systems, as well as machine learning and data mining. His work has been published in various journals, including the *Journal of Management Information Systems, Decision Support Systems, Information and Management*, *Interfaces*, *Expert Systems with Applications*, and *IEEE Transactions on Knowledge and Data Engineering*. His work has been funded by a number of sources, including NASA, the Nuclear Regulatory Commission, the National Institutes of Health, Blue Cross of Western Pennsylvania, and Thermal Industries, Inc.

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