Improving Student Numeracy Skills through a Combined MIS/DS Course via Traditional and Online Teaching Methods

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Abstract

This paper describes the process taken to develop a quantitative based and Excel™-driven course that combines *BOTH* Management Information Systems (MIS) and Decision Science (DS) modeling outcomes and lays the foundation for upper level quantitative courses such as operations management, finance and strategic management.

Keywords: course development, online teaching methods, Excel, management information systems, management/decision science.

1. "I'M IN BUSINESS, BUT I DON'T DO NUMBERS."

Hearing this statement one day in a Production and Operations Management course set forth a departmental quest to help our students "do numbers." Combined with growing acceptance of online learning technology and general familiarity of student's Microsoft Office™ skills (i.e. Davis, Kovacs, Scarpino & Turchek, 2010), the Department of Business Administration and Accounting (DBAA) recognized an opportunity: Develop a quantitative based and Excel™-driven course that would combine *BOTH* Management Information Systems (MIS) and Decision Science (DS) modeling outcomes and lay the foundation for upper level quantitative courses such as production and operations management, finance and strategic management. An additional benefit of offering a confluence course so early in the academic career was to emphasize the possibility of students' selecting a second major in Computer Science or Information Systems or a minor in Computer Science (McKenzie, 2005).

2. RATIONALE FOR AN EXCEL-BASED QUANTITATIVE COURSE

The DBAA faculty recognized that Information Systems is a field that involves both technology and people and is constantly changing (Battig, 2010). Given student reluctance to embrace quantitative concepts, focusing on the practical value of computer science or information systems may pique interest in the field.

The Bureau of Labor Statistics National Employment Matrix shows employment growth of at least 20% and a median salary of greater than $60,000 for both computer systems design and management analysts by 2018 (Sauter, 2011). Kizior & Hidding (2010) refer to the International Institute of Business Analysis (IIBA) to define the requirements of a business analyst. A quick search on Monster.com resulted in hundreds of career possibilities in the College's regional area. IIBA indicates that a business analyst understands business problems and opportunities and works as a liaison to analyze, communicate and validate changes to business processes. The

Chief Information Officer at the College expects a business analyst to have a solid understanding of basic statistics, Total Quality Management (TQM) tools, process mapping tools and accounting. In addition, expectations include strong written and oral communication skills, and an attitude that includes patience, curiosity, and listening.

In order to relate to an example of a business analyst, the concept of a "TUI" was explained. "GUI" or graphical user interface has long been a familiar word in the computer sciences discipline. Either by definition or even consumer experience, such as the prevalent use of the iPhone, even the non-computer science student understands the notion of graphical user interfaces. "TUI", or Translator User-Interface, is a phrase coined by Incisive Analytics' Chief Architect, Christina Rouse[i]. The concept summarizes the requirements of a business analyst: one who can translate business needs into technical requirements to effect change in business processes.

Higher Education stakeholders have raised concerns over college student quantitative skills for years (i.e. U.S Department of Education, NCEE, 1983; Arum, A. & Roksa, J. 2010). In late 2007, a curricular initiative was taken to address the numeracy skills of the college's business (BU) majors. DBAA faculty had anecdotally reported for many years that students often arrived in their courses with weak enumerative skills and a low comfort level using quantitative techniques to support decision making. Many of these skills should have been acquired in pre-requisite courses.

Prior to the quest, a mathematics course, either finite mathematics or one of several calculus options, was a pre-requisite for Business and Accounting majors. DBAA faculty questioned whether students took the "easy way out" and registered for a lower level math, even if the student's academic record suggested a more advanced course.

A study of high school and college math courses revealed some interesting patterns. Most notably, 50% the students enrolled in a College math course that was "lower" (that is, covering less sophisticated concepts) than what they completed in high school, with the majority of these students enrolling in college Finite Mathematics. Topics covered in finite mathematics included matrices, sets, probability, difference equations and game theory.

Discussions with our colleagues in the Department of Mathematics regarding Finite Mathematics helped us to identify that finite math was no longer meeting the needs of our majors, as determined by upper level course needs, nor was it increasing their numeracy skills beyond what they had already achieved in high school. It was decided that the DBAA would develop a rigorous course that would develop the foundation for critical skills needed in upper level courses.

A course, *Management Decision-Making Tools* (MDMT) was designed under a two-phase approach. It was first run as a special topics course in Spring 2008 for seniors, with great success and then again in Fall 2009 for first year students. The rationale for initially teaching seniors was to identify the topics and skill levels that would most benefit first and second year students.

For the second phase, prior to the start of Fall 2009, the Registrar identified a number of incoming declared BU majors who had originally opted for finite mathematics and placed them into the special topics course. An important outcome of this semester was realizing that students would perform better with statistics as a pre-requisite. Table 1 in the appendix briefly outlines the original objectives of this course. The course was accepted by the college's Curriculum and Education Policy Committee as an *alternative* to Finite Mathematics in the Business and Accounting major, effective Fall 2010.

With an upcoming college-wide curriculum change, effective Fall 2011, we decided to "wait and see" how the Mathematics department as well as our Business and Accounting major courses would be revised before establishing MDMT as a requirement for the major. The Mathematics department ultimately terminated Finite Mathematics and developed a new entry-level college math course available for all college students. The new curriculum required a "quantitative reasoning" component. Business and Accounting majors satisfied this required by taking a Statistics course, which now also served as a pre-requisite to *Management Decision-Making Tools*.

The DBAA program also undertook modifications to the Business and Accounting majors, as well as minors in Business and Accounting (see one

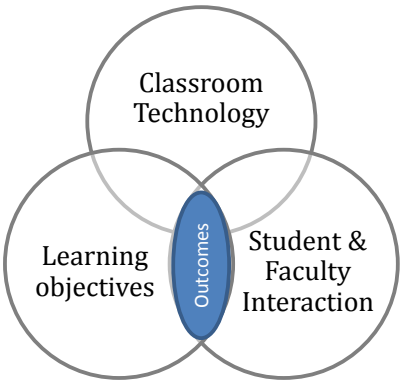
of five DBAA Learning Goals in the table below). A focus of our curriculum was to improve analytical and math abilities as students opt for a business major because it does not require calculus (although it is *strongly recommended*). Students selecting majors based on perceptions of lower-level quantitative skills as well as the impact after college has been well documented in the research (i.e. Ganesh, Sun & Barat, 2010; McClure & Sircar, 2008, Holtzman & Kraft, 2010 among others).

The new curriculum, identified college-wide as "4-4," effectively required all courses to become 4 credit hours and students would take 4 courses each semester, requiring 128 credits for graduation. "4-4" triggered a significant change throughout campus as majors had to be limited to 15 total courses, including pre-requisites. The Business major, for example was 18 courses. Our Faculty was expected to design courses to meet college and departmental learning goals of increasing academic challenge and student engagement across the curriculum, with a goal of 10 hours of outside class time work per week per course.

***DBAA Learning Goal*:**
Possess basic competencies necessary to operate and lead in an organizational environment. This includes the areas of group dynamics and operations, financial and quantitative applications and analysis, technology, and problem solving.

Our *Management Information Systems* course in the existing curriculum was a 100-level introductory course often taken in the first or second year of college. The course introduced students to the role of information technology and information systems in formal organizations. It included the study of the use of information technology to build efficient and effective information systems. A particular focus was on development of information systems that provided meaningful information for management decision making. This was accomplished primarily through the Microsoft Office™ suite of applications.

The DBAA faculty, after great debate and significant collaboration, decided to combine *Management Information Systems with Management Decision-Making Tools*. Our objective was to integrate faculty and student interaction, technology and learning objectives to achieve outcomes. Refer to the exhibit below.



The combined "*Management Decision Tools*" (MDT) was offered for the first time as a 4-credit course in Fall 2011 and is now a requirement for both Business and Accounting majors, with a statistics (either elementary or business) course as a pre-requisite.

The following sections identify available campus technology, the course as taught under the 3-credit system, lessons learned and suggestions for improvement in the "4-4" curriculum. The paper concludes with recommendations for future research.

3. CLASSROOM TECHNOLOGY

Similar to Davis et al., (2010) this paper uses online learning (rather than a myriad of terms such as eLearning, Distance Learning, Technology-Supported Learning, Web-based Learning, and computer-based learning) to describe any higher educational course that uses technology to deliver all or part of the course content.

The College is a residential liberal arts institution where nearly all 1900 undergraduate students reside on-campus. Students are mainly from the regional area. In total, 38 states and 13 countries are represented in the student body.

Campus-supported technology tools are not new to the Campus. eCollege (similar to Blackboard or webCT) was introduced in 2000 to several graduate classes and piloted to undergraduates during the 2004-05 academic year. Effective Fall 2009, faculty were required by the college to minimally post their syllabus and book list to eCollege. It should be noted that many faculty

members had an extensive eCollege page and made use of the many available online learning tools.

In addition to eCollege, most classrooms are connected wirelessly and are equipped with an instructor podium, SmartBoard or SmartPodium and an LCD projector as well as connections for laptops, video and document cameras. Faculty members can reserve classroom laptop carts for students that do not have laptops. Beginning Spring 2009, the campus began to experiment with lecture-capture software, Tegrity.

Davis *et al.*, (2010), in an exploratory study on IT/IS courses, determined that students preferred "on-ground" (i.e. face-to-face) and "on-ground" with online supplement formats to be more effective in the learning process, with an exception for Office™/Productivity software. Their study also revealed that students in quantitatively oriented courses would have difficulty in completely online courses. Finally, they found that those students preferring online courses were generally non-traditional (in terms of age and work experience) and lived 6-10 miles from campus.

Previous experience in quantitative courses demonstrated the benefits and struggles of using technology in class. MDT in Spring 2011 was held in a computer lab, equipped with classroom management software, and was limited to 25, comprised mostly of first and second year students with a handful of seniors taking the course as a special elective. The classroom management software was demonstrated with a "planted" student who was instant messaging on Facebook.™ Their screen was displayed on the two LCD projectors at the front of the lab. Taking control of the keyboard, the Instructor offered to buy the online friend dinner at Leunig's, a very popular, up-scale restaurant in the downtown area. Throughout the semester, the Instructor would randomly, and positively, comment on student work; just so they remained cognizant that their work was being monitored. It was impressive to note that there were only a few exceptions to staying focused on classwork.

4. COURSE STRUCTURE AND DELIVERY

Class was held twice a week, on Monday and Wednesday, and the Instructor offered staggered office hours Monday-Friday, with several Saturday or Sunday afternoons for additional help. Email was responded to quickly and always within 24 hours. The impact on student outcomes based on personal and electronic interaction between faculty and student, even in large classes, has been documented in the research, most recently by Conn, Boyer, Hu & Wilkinson (2010).

In attempt to capture student interest, as well as to meet the course objectives, while recognizing different learning styles (i.e. Prosperpio & Gioia, 2007), especially given the various quantitative and technological skills of students, cases and projects were built into the MDT course from the beginning. Baugh (2010) recommends designing a semester project that is relevant to the student. Students in his qualitative study were proud of their results and often exceeded project requirements. Furthermore, students applied technology tools that interested them.

After reviewing the syllabus through eCollege on the first day of class, a brief non-graded Excel™ assessment was distributed. The assessment asked basic questions regarding formulas, functions, charts, formatting, and cell references. Students scoring 80% or higher were then identified as Excel™ "Geeks" and students scoring below 80% were identified as Excel™ "newbies." The terminology was the class choice.

Newbies and Geeks were then paired (about 8 Geeks and 17 newbies) and time was given to allow for introductions and exchange of contact information. Students were not required to sit with their Geek, but they now had access to a peer that would also be able to assist or mentor with course concepts and Excel™. Geeks were asked to respond to newbie questions within 24 hours. Students commented that they did not often email their "geek" but they knew they had a resource, especially if they missed a day of class.[ii]

The course was split into the following units: basic Excel™ review (break-even analysis, financial statements, if-statements, VLOOKUPs, Pivot Tables and charting), Linear Programming (graphically and then solved via Excel's™ Solver and What's Best™ add-in), Nonlinear Programming, Project Management (Gantt Charts, CPM and PERT) Regression Analysis, Forecasting, Simulation, and Decision Analysis.

Each unit was from 1-2 weeks in length, depending on class progress. Students were assigned homework problems: there were "geek" problem sets and "newbie" problem sets. Both

problems covered the same material, but the "geek" homework was enhanced with more challenging material. All students had access to all homework problems, and newbies were welcome to also attempt "geek" assignments.

For example, in a break-even analysis problem, "newbies" would find the break-even point and manually chart the graph of revenues and fixed and variable costs and then respond to questions. "Geeks" had the added challenge of building the chart in Excel by solving equations via Goal Seek. A second assignment covered importing web query data from the Bureau of Labor Statistics website (www.bls.gov). Students then created charts in Excel™ to show the trending of various employment fields and salaries. The "Geek" portion included Pivot Tables with descriptive statistics of salaries by industry.

At the completion of each unit, an assessment was delivered. Assessments were two-part: qualitative concepts (written, short-answer or fill-in-the-blank) and a small case study to complete in Excel (or by hand graphing, in the case of the introductory linear programming unit).

It did not take long to feels the effects of trying to help 25 students with different learning styles and paces without a teaching assistant. Even with the peer mentoring groups, students would become frustrated and/or bored which can impact class group dynamics (Billson, 1986).

Lecture-capture software, in this case, Tegrity™, provided an interactive solution. Class sessions were pre-recorded (static image of the Instructor downhill skiing, recorded voice and step-by-step Excel™-based quantitative modeling shown) and were available for students via a link from eCollege. Dey, Burn & Gerdes (2009) suggest that online presentations were helpful for "equation heavy" courses.

Students referred to the class recordings as "mini-me sessions." One student commented,

> *The online step-by-step helped me to practice the formulas in Excel™ and were really helpful once I understood the formula by hand. I would pause the video and work through the homework at my own pace.*

When asked, students indicated that they did not use the index or searching functions. The lecture-capture software was easy to use, required just a few minutes of training, and uploaded to eCollege without issue. The instructor spent little time in the production process of editing – it was not deemed necessary for this course. As with results from the literature (i.e. White, 2009), class attendance did not diminish with the availability of course recordings. It is possible that the students considered this a "small class" and that their absence would be noticed. Attendance was taken daily.

The log results of viewings at the end of the semester showed that 24 of the 25 students viewed the 10 lecture recordings and there were a variety of viewings of homework hints, for a total of 255 viewings. Individual viewings lasted from a few minutes to nearly two hours.

Tegrity™ recorded lectures were not the only resource for demonstrating new topics. Traditional lectures covered each topic thoroughly and step-by-step with demonstration on the LCD projectors during the first 40 to 45 minutes of class. The remaining time, 30 to 35 minutes, was used for students to work in small groups, often with their "geek" on assigned homework problems. One student commented:

> *There was a lot of work but we were given sufficient time to ask questions in class, either to our mentor or to the professor. I think the combination of teaching methods was effective because of all the example problems she [the professor] walked us through before trying to do the problems on our own.*

The final project, a semester-based project (Baugh, 2010), was to develop a decision model for "everyday use." Students were given the opportunity to be creative, to think "outside the box" and to transfer their learning into a topic they found interesting. The guidelines included: working in a team of two if desired, use as many quantitative concepts as possible and prepare an executive summary that explained the model. Students then presented their models on the last day of the course. The rubric included points for accuracy, complexity, usability, feasibility, and formatting. A few examples are described in Table 2 in the appendix.

5. LESSONS LEARNED

The six seniors in the course, in addition to their course evaluations, were asked to consider how this course should be taught under the new cur-

riculum. Each student wrote a two-to-four page reflection that offered some positive insights as well as constructive feedback on their experience. The information in this section is based upon the Instructor's notes, student evaluations, and the senior reflections. Main concepts garnered identified that online tools, such as lecture-capture, improved the learning environment for both students and Instructor; assessment tools were well received, and the seniors also made suggestions to institute a personal portfolio and class-based journal.

At the beginning of the semester, before the implementation of the lecture-capture software, the experience could be summarized in one word: exhausting. Even though the Instructor had already incorporated eCollege for the syllabus, daily agendas, helpful links, handouts, and grading, it really was the online lecture-capture software that turned the course from a potential failure. Prosperio & Goia (2007) suggest that teachers are responsible for circumventing disconnects between current teaching methods and the technology rich "virtual generation" learning methods.

The "production" of the audio recordings and the step-by-step procedure did take time for preparation. However, it was also an effective preparation tool for class. Once the process was practiced several times it was actually very easy; even though the decision models being covered were increasing in complexity. The pre-recorded sessions allowed the Instructor to focus on the STUDENTS during class time and cover more examples and application of models:

> *I felt that during this class I was learning valuable information about Excel; however at times I felt like it was a little tough to keep up to pace. With the videos in front of me it was not so hard to keep up with how Excel worked and more class time was spent being able to understand WHY Excel worked.*
>
> *The videos allowed us to focus more on class time to ask questions and learn from those answers and to work with other people.*
>
> *Because we had the online videos, I feel as though a worthwhile assignment could be adding a mini project at the end of each topic on top of the assessment so we can apply these models to a business scenario.*

Students generally viewed assessments as a better evaluative tool then exams; although, in a sense, they were essentially one in the same. The main difference, though, was that the assessments were unit based rather than time based throughout the semester. Only one unit was assessed at a time. Several students felt that for concepts such as nonlinear programming, simulation, and forecasting, they needed more time to absorb the material. With the change from three to four credits, it will be possible to spend more time on each topical area. Surprisingly, students recommended quizzes. Students felt that quizzes would ensure that everyone was caught up on the chapter and supplemental reading material.

An interesting mention was made for both online discussion threads and building project portfolios. The discussion thread would:

> *offer the students and you* [instructor] *the ability to share thoughts and opinions on subjects in class. For example, the section on simulation models. Many businesses employ these types of models into their operations. Through discussion threads each person could find a real life situation where simulations are used. You [instructor] could also ask more in-depth questions that we would be able to have an even better understanding of the models we learned. I believe this would be key to understanding new material and retaining the information.*

Samkin & Francis (2008) suggest that, for those students who engage with them, learning portfolios can contribute by facilitating a deep approach to learning. The authors applied both a learning portfolio and personal journal entries to a third year accounting course.

A student recommended a semester portfolio as being beneficial for students to refer to in other courses. "We could even be "hired out" as consultants to the Introduction to Business course as they develop their business plans." One student stated, "I've been asked by my friends to help with Excel for their Finance course. It was fun to teach them something new." Another commented that "I have learned how useful and important Excel™ can be and it is just as important to know how to do the decision models

and be able to teach someone else how to use modeling."

Students appreciated the chance to create their own decision model at the end of the semester, as shown by the examples above. Many students felt that each unit should have a small decision model that would "help a real company and we could have informal presentations a few times during the semester. This would also help us improve our presentation skills and show how many possibilities there are to use these models."

Beginning with Spring 2012 registration, it will be important to assess whether students pursue further courses in computer science or information systems. Furthermore, how students apply these concepts to their upper level business courses must be evaluated.

6. CONSIDERATIONS

As in any teaching method, there are a number of issues that need to be considered.

1. The relatively small class size, due to lab seating limitations, was actually helpful in many ways. There were a variety of skill sets within the class and it would have been difficult to give each person equal assistance if the class was much larger than 25. The inclusion of peer mentors was also helpful; although their work was often checked to make sure it was correct. Students were able to get to know one another more in this class by helping each other resulting in a close sense of a learning community.

2. Business students are quite used to a combination of online and "traditional" teaching methods. They were very comfortable accessing information from eCollege and downloading videos to their laptops or mp3 players. What was new was the ability to learn quantitative models using Excel. In addition to learning the decision model under study, they had to develop their own skill set. Another recommendation by a student was to keep a journal that worked as an Excel™ "how-to" guide.

3. Zhu (2010) suggests that in a virtual classroom community, students demonstrate active participation, especially when experiences are linked academic and social settings together. Several students recommended the importance of online discussion groups and one student stated, "keeping a journal and seeing what other students are doing would be useful to help me reproduce concepts to other classes."

4. Dey *et al.,* (2009) in their exploratory research found significant differences in transferring concepts between live lecture and multimedia and video presentation. Students watching the multimedia presentation scored higher than their counterparts that just listened to the lecture. It will be valuable to study whether other DBAA faculty feel that students quantitative and Excel skills improve over time. It will not be for several semesters before these students will be "tested" on their retention. DBAA faculty presume that students will be prepared for upper level course work. Miller & Brooks (2010) suggest a deviation of SERVQUAL (Parasuraman, Zeithaml, & Berry, 1988) called ClassQual to evaluate overall "service" quality in the education setting, especially in regards to course content, faculty concern, and student satisfaction.

5. How will the students "carry" learned concepts to other classes? Additional research on retention and confidence in numeracy skills needs to be studied as students take advanced quantitative courses. A difficulty with this course is that it is placed early in the student's academic career. It is possible that an entire year could go by before a higher level business quantitative course is taken. The DBAA plans on studying the impact of this course as students continue in their academic program.

7. CONCLUSION

Millennial students are inundated with technology bells and whistles that encourage simultaneous multi-tasking on a habitual basis: texting, updating Facebook and Twitter statuses, listening to music via their iPod or Pandora, occasionally taking a phone call, checking (several) email accounts and possibly writing a term paper, using online resources. Embraced, the virtual environment can actually create different opportunities for learning (Prosperio & Gioia, 2007).

Dey *et al.,* (2009) reminds us that the digital generation would demand more interactive instruction. As faculty, we develop curricula based on our practices, attitudes, beliefs and technolo-

gy skill sets. At the College, our faculty benefit from the strong resources of an effective team in Instructional Technology Services. In the end, our students ability "to do numbers" and apply information system concepts may well depend on the efficient integration of student and faculty interaction in a virtual world.

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Table 1: Management Decision-Making Tools Special TOPICS (original) Course Description:

Course Description:

This course provides an introduction to the concepts and methods of Management (also known as Decision) Science, which involves the application of mathematical modeling and analysis to management problems. It also provides a foundation in modeling with spreadsheets. The primary goals of the course are to help you develop logic to build business models and analyze diverse decision-making scenarios utilizing computer software. Another important goal is to encourage a disciplined process to approach management situations.

More specifically, the course will:

- Introduce you to the basic principles and techniques of applied mathematical modeling for managerial decision-making. These methods will be applied to problems arising in a variety of functional areas of business, including economics, accounting, finance, marketing, and operations. Sample topics include linear & nonlinear programming, project management, simulation, decision analysis, forecasting, and queuing.

- Show you how to use Excel spreadsheets effectively for business analysis. You will learn a comprehensive set of spreadsheet skills and tools, including how to design, build, test, and implement a spreadsheet.

- Sharpen your ability to structure problems and to perform logical analyses. You will practice translating descriptions of business situations into formal models, and you will investigate those models in an organized fashion.

- Expose you to settings in which models can be used effectively. You will apply modeling concepts in practical situations. You will learn to extract insight from models, and to use those insights to communicate, persuade and motivate change.

Textbook: ***Managerial Decision Modeling with Spreadsheets***, by Balakrishnan, Render & Stair. 2nd Edition

Table 2: Final Project Descriptions

Project Title	***Description***
Take me to the ballpark	Two students designed a network flow diagram for a trip to Boston for a Red Sox game, including rest areas, eating options, parking, and overnight accommodations. To apply the critical path concept, they used a random number generator to apply "happiness" scores. The critical path determined the "happiest" way through the network. As the random numbers would re-calculate, the critical path would adjust, and with the use of conditional formatting, would "light up" in Red Sox colors.
Stats, Stats, and More Stats	A varsity baseball player collected statistics from the College division competitors. Using a series of regression analyses, pivot tables, and charting, he was able to provide a working model of key players as well as find statistically significant results on batting averages.
Scarves, anyone?	A two student team developed a business model, including forecasting and simulation, to determine net profit for their first year business course which required a business plan.
Is it Tax Season?	An Accounting student developed a simulation model that would identify the profit of his tax preparation service for international firms. Firms with higher revenues were charged a higher preparation fee. The model included complex if-statements, VLOOKUPS, and charting.
Leaving on a Jet Plane	A student from New York City developed a linear programming model that analyzed the optimal way home for various school vacations: bus, train, or plane. Constraints included an overall budget, travel times, and a minimum number of flights needed to receive the maximum possible frequent flier points. There was also a constraint for "parental demand" for trips. The model was easily adapted to several other students in class.

[i] Personal Communication with Christina Rouse, June 15, 2011, Incisive Analytics, www.incisiveanalytics.com

[ii] Support for peer mentors in higher education has been well researched for retention, academic success, and educational experience; see for example, Kram, 1983; Pagan & Edwards-Wilson, 2002; Topping, 1996, and recently Terrion & Leonard, 2010.