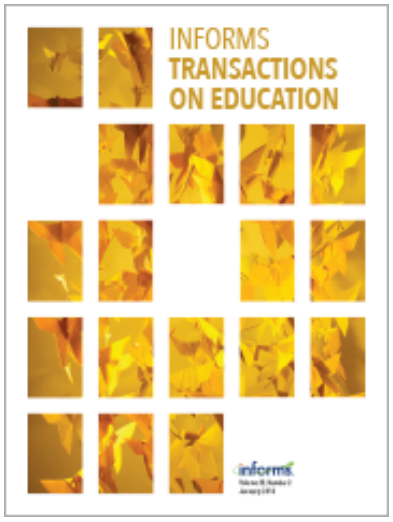

INFORMS Transactions on Education

Publication details, including instructions for authors and subscription information:
http://pubsonline.informs.org

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To cite this article:
Roger B. Grinde, Jill A. Kammermeyer, (2003) Experiences Using Thematic Assignments in an Undergraduate Management Science Course. INFORMS Transactions on Education 4(1):23-36. https://doi.org/10.1287/ited.4.1.23

Experiences Using Thematic Assignments in an Undergraduate Management Science Course

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Abstract

This paper presents a theme-based approach for individual and group assignments in an undergraduate Management Science course. We have been using this approach since Fall 2001, with three different themes. In Fall 2001 we used a "generic" entertainment venue theme. For Spring 2002 we focused the "venue" theme, took advantage of current events, using the Winter Olympics as a basis for the assignments. In Fall 2002 we switched to Socially Responsible Investing as the theme throughout the term. The use of a theme to link assignments throughout the term is a middle ground between cases (instructor-specified) and student-defined projects. The aim was to combine some of the best features of both approaches to the active learning component in the course. This paper discusses our approach, outlines the assignments, and provides student feedback regarding their perceptions as to the effectiveness of the assignments.

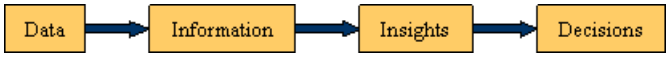
Editor's note: This is a pdf copy of an html document which resides at http://ite.pubs.informs.org/Vol4No1/GrindeKammermeyer/

1. Background

This paper discusses the implementation of a series of "thematic" assignments in an undergraduate Quantitative Methods (a.k.a. Management Science) course at the University of New Hampshire. This has been a required course in the undergraduate business curriculum. In preparation, students have one college-level mathematics course (usually Finite Math) and one Business Statistics course. Quantitative Methods is one of six junior-level courses, which can be taken in any order. The other courses are Organizational Behavior, Finance, Marketing, Operations Management, and Management Information Systems.

Teaching a required undergraduate Management Science course is a multi-objective and highly constrained opportunity. We have worked together teaching this course since 1994; the course has evolved over the years from a methodological focus to an end user modeling and analysis focus. Accompanying this shift was the move to spreadsheets in Fall, 1995 as the computing platform for the course. One of the ways we endeavor to meet the learning goals remains having students realize, and ideally, "own", the idea that the Management Science way of thinking is very powerful in the business world as well as in everyday life.

The course emphasizes decision making within the context of business in the information age. Managers can easily be "buried" with data; the main premise of the course is that quantitative analysis is needed to convert the data into information. Managers need to then translate information into business insights, from which decisions can be made. The diagram below summarizes the paradigm:



Learning goals of the course are as follows:

- Develop modeling skills to structure and represent business problems at an appropriate level of detail for the decision(s) at hand.

  ISSN: 1532-0545

- Become proficient using the spreadsheet as a decision tool, including
  1. developing correct, flexible, and documented spreadsheets,
  2. performing appropriate analyses, including sensitivity analysis,
  3. converting the quantitative results into information and managerial insights.
- Use tools bundled with Microsoft Excel as well as Excel Add-Ins to apply proven quantitative techniques to practical problems and correctly interpret the results.
- Communicate findings in terms meaningful and useful to management.
- Become a critical consumer of quantitative information.
- Recognize how businesses and organizations successfully use quantitative analysis in the real world.

Course content comprises five inter-related modules: General Spreadsheet Modeling & Analysis, Decision Analysis, Forecasting, Simulation, and Optimization. Coverage of the traditional Management Science topics focuses on model development, implementation, and interpretation. The General Spreadsheet Modeling & Analysis module is intended to immediately provide students tools they can use in other courses and in their everyday life. It also serves to set the modeling and analysis focus for the course, helps students begin to apply structure to the decision making process, and sets the stage for the use of spreadsheets in the remainder of the course. We provide further description of this module, as the concepts gained there are reinforced throughout the course.

The main concepts of the General Modeling & Analysis module are

1. the development of correct, flexible, and documented spreadsheet models,
2. the importance of developing a "base case" model,
3. basic data management & analysis skills.

This module attempts to correct bad modeling habits many students have acquired. The objective is for students to begin to think of the spreadsheet as a modeling and analysis tool. This tends to differ from their past use, which could best be characterized "spreadsheet as a calculator." Their initial focus is usually aiming for a single numerical answer. Consequently, their models often include numbers buried within formulas and other modeling "sins." Therefore, this module emphasizes the importance of structure in problem solving, general modeling principles, and the advantages obtained from a correct, flexible, and documented model. We seek to erase past spreadsheet misconceptions and attempt to bring all students to a defined, similar level of spreadsheet proficiency.

This module also includes a refresher of descriptive statistics (using native Excel functions and the Data Analysis add-in), exploratory data analysis (using the filtering and PivotTable features of Excel), types of charts and their applicability to the communication of various information, sensitivity analysis (using Data Tables), Scenario Analysis (using Scenario Manager), basic root-finding (using Goal Seek), and spreadsheet model documentation (using text boxes and cell comments). During this module we also impose the formatting and documentation requirements[1] for spreadsheets; we attempt to lessen the documentation burden by providing some simple macros[2] written by one of the authors, as well as two obtained from The Spreadsheet Page[3] (Walkenbach, 2003). This module is essentially our adaptation of the first two categories of modeling skills described by Powell (2001): "numeracy and logical skills" and "basic modeling skills."

2. Active Learning Component

Given the course learning goals, it is essential that active learning be a significant part of the course and the assessment structure. We have used a variety of means to hopefully better engage students and allow them to develop some ownership of the concepts and thought processes.

Initially we used fairly traditional Management Science cases. Strengths of cases include having the students

(1) http://ite.pubs.informs.org/Vol4No1/GrindeKammermeyer/SS_Guidelines.pdf
(2) http://ite.pubs.informs.org/Vol4No1/ GrindeKammermeyer/RBG_macros.xls
(3) http://www.j-walk.com/ss

engage a real (or at least realistic) problem situation, and the requirement that students exercise the modeling and analysis aspects of the problem solving process. However, our undergraduate students generally have very little real-world experience, and they had trouble relating with many of the issues in the cases. Cases often were not close enough to the students' experience base for them to be relevant. Instead of an exploratory, analytical view, students tended to approach cases from an "Is this the right answer?" mentality. Many of the cases encouraged this mentality because they were essentially technique-driven. Some textbooks have improved on the usefulness of cases by having them continue through the text. This deemphasizes the mindset that each problem is best handled with a specific methodology. While cases that run through a text can have varying levels of success, it is still difficult to bridge the gap of real-world experience for undergraduates.

When we moved to a project orientation, each student would prepare a project "proposal," and then groups of students (3-4 students each), using a simple multiple-criteria decision model as a guide, would select one of the topics as the official project of the group. The groups were formed in different manners over the semesters, in an attempt to engage more students. The main strength of the project approach was that students generally had a high level of "ownership" of the topic and of the project responsibility itself, because it was something with which they were familiar. Students also gained experience in both defining the problem and in garnering data, which did not usually occur with the cases. Some of the benefits described by Grossman (2002) regarding student consulting projects were also attained. The downside of projects for our students was that some projects tended to "swallow" students, while other projects were not "deep" enough to add much value for students. Another downside was that the student whose proposal was selected for the term project tended to have much more "ownership" than the others. Sometimes other group members perceived this student as the one ultimately responsible for the project. This was counter to our intent to have the project teams trigger interdependence among the team members so that they would come up with solutions faster and perform better (Thompson, 2000). The projects presented an instructional dilemma. If students were essentially left to their own devices after the proposal stage, a sizeable percentage of the projects and/or groups did not meet either student or faculty expectations when the projects were "done" at the end of the semester. On the other hand, it was extremely time consuming from an instructional standpoint to have multiple, staged deliverables and/or meetings throughout the semester, given the numerous topics, data sources, and group dynamics.

To provide some focus and structure while retaining flexibility, we have begun using a series of thematic assignments. The series essentially becomes a live case stretching throughout the semester. We have found that by providing a theme with varying levels of guidance (for different assignments), students have the flexibility to choose something they enjoy (the "ownership" issue). At the same time, since all students are using the same theme (but different specific topics within the theme), the faculty member can write assignments to develop knowledge and skills in several of the methodological areas of Management Science.

Both the theme approach and cases that continue through a text have the potential to carry a common application thread through different problem solving methodologies. They can help to engage students, as well as foster the realization that no methodology is necessarily ideality suited to a particular situation. However, we believe themes provide more "hands on" experience for students. Students have some degree of choice in the specifics of the topic and, most importantly, students are responsible for finding data sources, a useful real word skill.

The development and implementation of thematic assignments represents a middle ground of the active learning component continuum. The theme-based assignments retain two satisfying characteristics of projects:

1. each group does something a bit different from other groups, and
2. the groups have some degree of choice in the specific topic.

On the other hand, the topics still have enough similarity between groups to allow the instructor to orchestrate the process; to ensure that all students become involved with the modeling and management science methodologies.

In our experience, undergraduate students need some of this structure to gain confidence in problem structuring, model building, and analysis. However, in order to have the student be the "active constructor, discoverer, transformer of their own knowledge" (Fellers, 1996) they need to have "ownership" of their assignment. Since the individuals and groups have some degree of choice regarding the specifics of their subject matter within the theme, we have observed a higher level of engagement over the entire term with the thematic assignments than we had with either the cases or projects. Cases tended to result in brief, disconnected bursts of activity, while the projects tended to result in a major burst of activity toward the end of the term.

3. Themes and Assignments

We began using theme-based assignments in Fall 2001. Centering on the theme of an "entertainment venue," four assignments were developed. All of these assignments were group-based, but some required individual-specific components that were submitted as part of an appendix. In Assignment 1, for example, each student was to select an entertainment venue (e.g., theater, arena, auditorium). The group then used a simple multiple criteria decision model to help determine which venue would be the group's focus throughout the term. Not surprisingly, the dominant factors were often data availability and general interest level in the group. Although not measurable, individual personalities within the group also came to play in the selection process.

In retrospect, the methodologies to be employed in the assignments were driven by how we had used cases in past semesters. The first assignment focused on developing a base case model and developing good modeling habits. The second and third assignments dealt with the impact of uncertainty on the decision; Assignment 2 focused on sensitivity & scenario analysis, while Assignment 3 focused on simulation. Finally, Assignment 4 introduced the area of optimization. The assignment process was similar to the projects of the past: teams were expected to assign roles to team members and to keep a journal as a record of group/individual activities. Each group member was required to complete a peer evaluation of all members in their group, which was used in some instances to make grade adjustments.

After the Fall 2001 trial, alterations were made in the assignment framework. Specifically, the number of assignments was increased to six, with three being individual assignments and three being collaborative assignments. The first assignment was individual and was meant to encourage all students to choose a topic and become engaged in the theme prior to becoming part of a group. In this way, some of the individual contributions that might tend to get lost in the team assignments get recognized and rewarded. The initial individual assignment also allows the faculty member to get an initial assessment of student abilities and problem-solving processes.

One of the individual assignments (Assignment 4) was a writing assignment. This writing assignment related to the theme, and was aimed at addressing one of our primary learning objectives which we didn't feel was getting enough attention, that of recognizing and describing situations that could benefit from a more structured decision-making process. The creation of a written assignment was an outgrowth of a "Writing Across the Curriculum" workshop the authors attended in Fall 2001. Fulwiler (1997) states "the more you write, the more you learn," and "critical thinking comes from critical writing." This convinced us to try a short, but formal, written assignment. An in class writing assignment (counted toward class participation) was tested in Fall 2001. It was met with enthusiasm by the students and frankly surprised the faculty member. This writing assignment was intended to encourage students to develop skills in more technical writing than is usually required in other business courses. It also allowed students who are not spreadsheet "whizzes" to excel in another aspect of the course.

The series of thematic assignments follows a concept termed "focused revision," a central idea in writing pedagogy (Fulwiler and Hayakawa, 1997). In effect, students revise and build upon the same model throughout the course, much as one might revise and build upon a writing assignment throughout a writing course.

Table 1 provides a brief description of the assignments given in Spring 2002 and Fall 2002. Links are provided for the Spring 2002 assignments. In Spring 2002 we applied the "entertainment venue" theme to the Winter Olympics which were concurrently being held in Salt Lake City. In Fall 2002 we used Socially Responsible Investing (SRI) as the theme. This is very much related

to business ethics and corporate responsibility, topics that have been extremely visible in the recent past.

Assignment		Spring 2002	Fall 2002
1	(Individual) General Modeling & Analysis, Base Case Modeling, Data Collection	Chose specific Olympic venue/event[4] Develop newsvendor-type model for event profit with multiple seating classes[5].	Select three stocks from Domini Social Index stock universe www.domini.com and develop basic portfolio tracking model.
2	(Group) Sensitivity and scenario analysis	Investigate impact of uncertainty (groups formed based primarily on venue/event chosen for Assignment 1). Perform sensitivity analysis and scenario analysis on key parameters[6].	Investigate impact of uncertainty (groups formed randomly). Perform sensitivity analysis and scenario analysis.
3	(Group) Simulation and risk analysis	Investigate impact of uncertainty (continued). Define probability distributions for model inputs and develop a simulation model[7].	Investigate impact of uncertainty (continued). Define probability distributions for model inputs (using past return data) and develop a simulation model.
4	(Individual) Writing assignment, synthesis & application	Written proposal for security planning at Torino 2006 winter games[8]	Written memo to "Stock Research and Selection Committee to propose a quantitative screening model in a SRI impact area.
5	(Individual) Optimization	Diet planning for Olympic journalists[9].	Bond portfolio optimization.
6	(Group) Integrative	Security Budget Planning Model for specific venue/event for Torino 2006 games. Identify equipment & staffing needed, develop cost estimates[10].	Portfolio Tracking Model: Revisiting of Assignment #3 (comparison of simulated values to actual value) and suggestions for simulation model revision. SRI Area Screening Model: Revisiting of Assignment #4. Utilize individual assignment #4 and develop collaborative SRI Screening Model.

Table 2 summarizes the management science knowledge and skills developed through the assignments, as well as the spreadsheet skills developed and/or enhanced.

Assignment		Knowledge and Skills	Spreadsheet Tools
1	(Individual)	• Basic model construction • Base case analysis • Identification of assumptions • Expectations for assignments • Influence diagrams • Use of secondary data sources • Communication of results: PowerPoint presentation with script	• Native Excel • Printing options to meet course requirements • Documentation: formulas, cell comments, text boxes, use of instructor-supplied macros for formatting and documentation • Drawing tools • Auditing tools • Simple charts
2	(Group)	• Changing input values • Sensitivity Analysis	• Data Tables • Goal Seek

(4) http://www.saltlake2002.com/
(5) http://ite.pubs.informs.org/Vol4No1/GrindeKammermeyer/A1_S2002.pdf
(6) http://ite.pubs.informs.org/Vol4No1/GrindeKammermeyer/A2_S2002.pdf
(7) http://ite.pubs.informs.org/Vol4No1/GrindeKammermeyer/A3_S2002.pdf
(8) http://ite.pubs.informs.org/Vol4No1/GrindeKammermeyer/A4_S2002.pdf
(9) http://ite.pubs.informs.org/Vol4No1/GrindeKammermeyer/A5_S2002.pdf
(10) http://ite.pubs.informs.org/Vol4No1/GrindeKammermeyer/A6_S2002.pdf

Assignment		Knowledge and Skills	Spreadsheet Tools
		• Scenario Analysis • Effective displays of results • Continued use of model over time • Communication of results: PowerPoint presentation with script	• Scenario Manager • Charts • Sorting • Filtering • Pivot Tables
3	(Group)	• Monte-Carlo Simulation • Review of probability and statistics • Data and distribution "fitting" • Interpretation of results • Communication of results: PowerPoint presentation with script	• Crystal Ball • Data Analysis Add-In • Charts
4	(Individual)	• Synthesis of course material • Communication of the benefits of using a Management Science approach to address a concern • Students given background information/article	• None
5	(Individual)	• Optimization (linear programming) • Sometimes an "optimal" solution is just a beginning point.	• Solver
6	(Group)	• Integrative assignment • Given loose definition, students develop a model to aid in decision-making • Identification of assumptions • Identification and acquisition of needed data • Realization that a model is usually an evolving tool • Assess the quality of the model; explain how it could be improved • Explain how different Management Science tools could be used to enhance the analysis • Communication of the model assumptions, structure, and usefulness to management (PowerPoint slides with script).	• Mostly native Excel • Explanation of how advanced tools could aid in the analysis • Group determined

Assignment 1 is designed to engage students in the theme, help them develop some basic modeling skills in the spreadsheet environment, and set the stage for the other assignments. Throughout all assignments, we impose formatting requirements for the spreadsheets themselves as well as the overall assignment. One purpose is certainly to allow assessment and grading to be more consistent, but another purpose is to begin to develop some modeling and documentation discipline in students. Assignment 1 also lays the foundation in terms of expectations for model flexibility, documentation, and communicative quality of the submitted assignment. We provide specific guidelines for spreadsheets[(11)], which apply to all spreadsheets developed during the course.

The first assignment is less intense than the others from a modeling and analysis standpoint. The main product is a base case model, from which further analysis can be performed. However, it does introduce the concept of data quality along with the use of secondary data sources. Almost immediately, students are faced with a common problem all managers face. They realize the information they really need probably isn't available! For example, for the Spring 2002 Olympic theme, students were able to obtain total seating capacities for a venue, but did not necessarily know how many seats were allocated to each seating class. Likewise, there was no real way for students to know what the fixed and variable costs were for running an event. This helped to reinforce the importance of stating and explaining one's assumptions explicitly. This also provided a teaching point that sometimes

[(11)] http://ite.pubs.informs.org/Vol4No1/GrindeKammermeyer/ SS_Guidelines.pdf

assumptions for real decisions are made on the basis of very little "real" data. We also try to convey that a model is rarely something that is built, used once, and discarded. By having students include some of the unknown quantities in the model (or, at least in the assumptions), this helps them to understand that models are usually evolving abstractions of reality.

Peer feedback is used with Assignment 1. On the stated due date, students exchange submissions with a classmate and critique the other's work. We provide a detailed checklist[12] of items for this purpose, but have students provide written comments on the spreadsheets first before we distribute the checklist. The checklist contains routine items relating to the formatting requirements. It also contains more substantive items dealing with model organization and model flexibility. We have 2-3 students present their models, so the class can discuss the advantages of good modeling practice. This gives students a clearer picture of our expectations; they have had to evaluate someone else's work, and have seen the faculty member make comments about students' work. One rather mundane, but very important realization is that it helps students realize that evaluating a printed spreadsheet without row/column headings and gridlines is nearly impossible. One copy of each student's work is collected on this day, and students submit their revised versions during the next class period. The critique exercise helps the student become a critical consumer of quantitative information, introduces the idea of revision, and emphasizes the concept of a correct, flexible and documented base case.

The focus of Assignments 2 and 3 is the impact of uncertainty on decision-making. Assignment 2 approaches this from a sensitivity and scenario analysis framework, while Assignment 3 employs Monte-Carlo simulation. Students usually need to enhance their model developed for Assignment 1 in order to complete these assignments. Sometimes they have searched for and found data to support their assumptions. Also, since Assignment 1 is an individual assignment while Assignments 2 and 3 are group-based, students must determine the advantages and disadvantages of each group member's base case, in order to arrive at a collaborative base case model for the group. Through this activity they are seeing different modeling approaches to the same or similar problems.

Assignment 4 is an individual writing assignment. In Spring 2002, we provided students with an article published in IIE Solutions (Elliot, 2002) discussing how simulation was used in the planning process for the Salt Lake games. Since security was such a large issue in the wake of the September 11, 2001 attacks, the assignment asked the students to write a "proposal" as to how simulation could be used as a tool for security planning for the Torino, Italy 2006 Winter Olympic Games. This provided a good transition since the Salt Lake Olympics were over at this point. Students needed to visit the Torino Olympic web site[13] to obtain information about the different venues, the transportation system, etc. During Fall 2002, students were provided with a background on Socially Responsible Investing (SRI)[14] along with some of the more informative SRI-oriented web sites[15] Students were asked to consider the "triple bottom line" of SRI: financial, social and environmental, and then choose one of the four main SRI impact areas: environment, community relations, employee relations, and customer relations. They were then asked to write a proposal for a model, specifically for their chosen impact area that could be used to quantitatively screen stocks, using the stocks that they had been following in Assignments 1-3 as examples. The idea of this writing assignment is to have students synthesize the course material, and extend their technical skills into thinking about modeling and other applications of Management Science.

Assignment 5 deals with optimization. This methodology can be difficult to adapt to the theme. Small models tend to be fairly artificial, and large models tend to be beyond the scope of many undergraduate courses. If more class time is devoted to optimization, students could address larger, more complex, and more realistic situations. For the Spring 2002 Olympic theme, we used a diet planning application based on an assignment by Dworman & Piramuthu (1998), which is in turn related to Bosch (1993) and to Erkut (1994). For the Fall 2002 theme, we used a bond portfolio optimization application inspired from a problem

[12] http://ite.pubs.informs.org/Vol4No1/GrindeKammermeyer/A1_GradeSheet.pdf
[13] http://www.torino2006.org/eng/index.asp
[14] http://www.socialinvest.org/
[15] http://www.business-ethics.com/

in Winston & Albright (2000), as some of their group assets were in a bond fund by this time. It could easily have been a more general asset-allocation application. By this time in the course we are trying to emphasize to students that many methodological tools can be applied to similar problems, and it is rare that a management problem calls out for one specific methodology. For example, with the bond portfolio application, one could approach it from either an optimization standpoint or a simulation standpoint. Interestingly, sometimes more inquisitive students see this and try to actually combine the methodologies, which is what some of the latest analytical tools provide (e.g., OptQuest and RiskOptimizer).

Assignment 6 is an integrative assignment, essentially representing a focused mini-project. Students are given more leeway in data collection, model definition, and analysis. Using the proposal from Assignment 4 as a starting point, they are required to consider appropriate assumptions, filter and sort through references for data, and develop a new model. In Spring 2002 we instructed students to develop a "Security Budget Planning Model" for the Torino 2006 Olympic Games. We provided background information on the organizing committee and some of the planning that had already been done (found via web searches), and asked students to develop a model that could be used to aid in the planning for security for a particular venue that would be used in Torino. Students had to research the venue and various types of security equipment and procedures. Some groups became quite engaged in this activity, and it helped to reinforce the reality of Management Science that much of one's time is spent in the data collection and filtering phase. One of the interesting anecdotal comments from students was that they seemed to think that four years in advance was a very long time to be starting to plan for security at the Olympics. This provided a good teaching point that there is always planning going on for events far into the future, and much of this required planning is never seen in a direct way by the public.

In Fall 2002, Assignment 6 also stressed integration of the methods, with two parts. Since Assignment 3 simulated end-of-month change in portfolio values, and the end of that month had now occurred, groups were able to compare their simulated results with actual results for their Portfolio Tracking Model. This provided an opportunity to think about and propose model revisions and to make suggestions to have their model better represent reality. The main focus of this assignment, however, was the development of a collaborative "SRI Screening Model." The groups reviewed each student proposal from Assignment 4, and became critics of each individual proposal. They were then asked to realistically determine the best and most usable of all the research and modeling completed for Assignment 4, be critical consumers and then produce a collaborative "SRI Screening Model".

4. Additional Themes, or, Try It, You Might Like It!

There is an endless supply of possible themes, limited only by the instructor's interests and willingness to experiment. Teaching multiple section and/or large introductory Management Science classes can become routine. Varying the themes to areas of interest and/or expertise keeps the course stimulating and interesting for the faculty member. Collaborative teaching further helps to percolate ideas for the themes, as well as to keep the process going. While the theme approach may add to the total time required, we have found that since the themes were inherently more interesting (to us) than textbook cases, it is easier to keep the course fresh. In addition, to the extent that an instructor chooses themes at least tangentially aligned with one's research interests, this adds a depth of knowledge that can be shared at opportune times in the classroom.

We would recommend that the theme should have some data that is relatively accessible to the students (and verifiable by the faculty member), and that the theme be in an area to which students have at least some exposure. The generic entertainment venue (Fall 2001) and the Olympics (Spring 2002) themes both had plentiful information available via the Internet, but never quite enough information of the right type, which is perfect from the learning experience standpoint. The Olympic theme also had the additional advantage of being in the news at the time. The socially responsible investing theme (Fall 2002) also has plentiful information available, and the area of corporate social responsibility has been prominent for over a year.

Some possible themes and variations on existing themes are listed here:

  ISSN: 1532-0545

- Entertainment venue, building on newsvendor-type problem. Examples are sports venues (e.g., baseball, football, basketball, hockey), arts venues (e.g., opera, ballet, symphony, theater), popular culture (e.g., concerts, theater, coliseums), one-time events with multiple venues (e.g., Olympics, arts festivals such as Spoletto). This theme is relatively easy for an instructor to "tweak" from one semester to the next.
- Investing and Pro-forma financial. Examples include portfolio-type themes such as socially responsible investing, or more general investing themes, which may consider sectors, industries, and/or geography. Pro-forma financial themes might be centered around particular companies within an industry, sector, or geography.
- Industry-specific theme. Several different industries lend themselves to theme-based assignments. The transportation industry (e.g., airlines, rail, bus, personal transportation), health care, and others have potential around which a series of assignments could be built.

The instructor could easily build an international component into any or all of these potential themes. A planned ethical component could also be included (e.g., data source and quality issues, ethical issues in modeling, as well as issues specific to a theme). The focus could also be on different types of problems within the same theme, going into some depth. For example, with a baseball theme, one could address it in a newsvendor-type fashion, security issues, scheduling games/umpires, fans traveling between parks trying to visit each one, replacement of old ballparks, and so on.

5. Student Feedback

At the end of the course, we require students to complete a peer evaluation form, assessing the contributions of their group members. In Spring and Fall 2002 we also asked students to complete a questionnaire about the theme-based assignments regarding their effectiveness as a learning tool.

The first two questions were on a four- point scale, specifically to force a commitment on the part of the student to one side or the other. The third question required a value to be inserted in a blank. The remaining two questions were open-ended and provided the students with an opportunity to provide written comments. The primary purpose of the data collection was not for statistical analysis, but rather for our own use in assessing student perception of the assignments so that we could make improvements in the course. The five questions were:

1. To what extent did the assignments help you to understand the real-world applicability of the topics covered in this course? Possible responses were: "Very Much" (assigned a value of 3), "Quite a Bit" (2), "A Little" (1), and "Not at All" (0).
2. To what extent did the assignments help you to develop your knowledge and skills about the topics covered in this course? Possible responses were: "Very Much" (assigned a value of 3), "Quite a Bit" (2), "A Little" (1), and "Not at All" (0).
3. To be the most effective course, what percentage of the assignments should be individual and what percentage should be group?
4. What was the best aspect of the assignment component of the course?.
5. How would you improve the assignment component of the course?.

A total of 286 usable forms were returned out of total of 288 enrolled students. By semester, Spring 2002 had 122 students (2 forms were not usable) and Fall 2002 had 166 students. Results are summarized in the figures and discussion that follows.

Figure 1 shows the percentage of students responding in each of the categories for question number 1: "To what extent did the assignments help you to understand the real-world applicability of the topics covered in this course?" Overall, 88% answered either "very much" or "quite a bit." There were no responses for the "not at all" selection. There were no real differences by term. In Spring 2002, 86% answered in the "very much" or "quite a bit" categories; in Fall 2002, 90%.

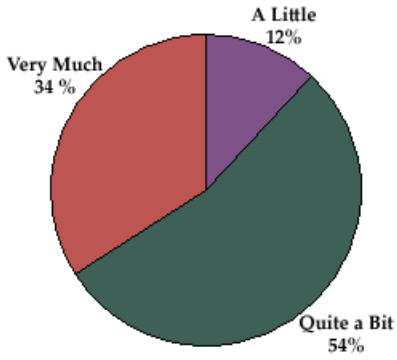


Figure 1: Responses for Assignments Helping Students to Understand Real-World Applicability

Examples follow of student comments that found the real world applicability one of the best aspects of the assignments:

- "To see how you really use this "stuff""
- "Relevant to real world and current events"
- "Applicable to real life situations, made us think!"
- "Seeing real world application of classroom material"
- "We were able to put the skills we learned in class to use and understand how they would be used in real world examples"

Figure 2 shows the percentage of students responding in each of the categories for question number 2: "To what extent did the assignments help you to develop your knowledge and skills about the topics covered in this course?" Overall, 94% felt that the assignments were quite useful in acquiring knowledge and skills. Again, there were no responses for the "Not at all" choice. There was virtually no difference for the Spring 2002 and Fall 2002 terms.

Figure 2: Responses for Assignments Helping Students Develop Knowledge and Skills

Examples follow of student comments that found the knowledge and skills acquisitions one of the best aspects of the assignments:

- "I really feel that they helped me learn, because without them I was really confused"
- "Learning how to use all those add-ins, that I had no idea existed!"
- "Because assignments were focused around real life scenarios they proved to be extremely helpful in understanding how we can apply Crystal Ball, Solver, etc"
- "Being able to apply the things we learned in class. It helped everything make a lot more sense"
- "It had to be done, so you had to learn how to do it"
- "By the end of the assignment I always had a much better idea of the material"
- "What I learned really stuck, as opposed to just studying"

Figure 3 summarizes the responses to Question 3, which asked students to indicate the percentage of assignments that should be individual versus group. Over 60% of students thought the percentage of individual assignments should between 41% and 60% (in both terms, there were three individual and three group assignments). About 24% of students favored no more than 40% individual assignments; slightly over 13% of students would have preferred more than 60% individual assignments.

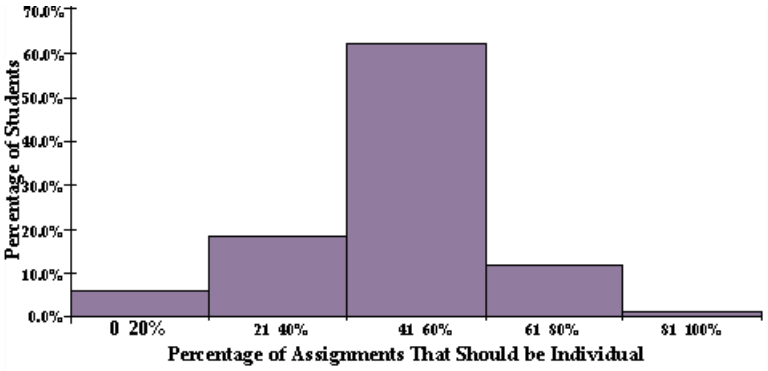


Figure 3: Percentage of Individual Assignments Desired By Students

The response to Question 3 (Figure 3) raised our curiosity regarding factors that might be related to a student's preference. Based on some verbal comments received during the terms, we expected to see a higher percentage of students desiring more individual assignments. Also, student comments for the question "How would you improve the assignment component of the course?" did not always seem consistent with other responses.

Consequently, we looked for possible differences in the responses to the first three questions, as a function of grade earned in the course. This led us to the following hypotheses:

- Hypothesis 1 (Real World Applicability): The ratings on the extent to which the assignments helped the student to understand the real-world applicability of the topics will be significantly different for the different grade groups.
- Hypothesis 2 (Knowledge and Skills): The ratings on the extent the assignments helped to develop knowledge and skills about the topics will be significantly different for the different grade groups.
- Hypothesis 3 (Individual Assignments): The percentage of individual assignments desired will be significantly different for the different grade groups.

Each hypothesis was evaluated using Analysis of Variance. Results of the ANOVA for each question, as well as summary statistics, are shown in Table 3.

	Grade C	Grade B	Grade A
Sample Sizes	68	157	61
Percentage of Total	23.8%	54.9%	21.3%

	Grade C	Grade B	Grade A
Real-World Applicability			
Sample Mean	2.206	2.191	2.328
Sample Std. Deviation	0.682	0.642	0.598
ANOVA Results	F = 1.030, p = 0.3583		
Knowledge/Skills			
Sample Mean	2.294	2.389	2.475
Sample Std. Deviation	0.692	0.585	0.536
ANOVA Results	F = 1.464, p = 0.2329		
Percent Individual Assignments			
Sample Mean	44.926	49.968	51.885
Sample Std. Deviation	16.917	15.091	11.371
ANOVA Results	F = 4.020, p = 0.0190		

For the first hypothesis, the results support no difference in the grade groups for the real world applicability ratings. For knowledge and skills acquisition (hypothesis two), the sample means grow slightly for the students receiving higher grades, but there is no significant difference among the grade groups. Perhaps one should be pleased with the results for these two hypotheses, as long as the means of the ratings are "high enough" for each of the groups. One challenge in teaching quantitative subjects has always been to engage students across all capability levels.

For the third hypothesis, percentage of individual assignments, the means are shown to be significantly different, with a p-value of 0.0190. Further exploration

of the pairwise comparisons (using a Bonferroni pairwise comparison test, given the multiple comparisons being made) results in a p-value of 0.0251 for the difference between A and C means, and a p-value of 0.0603 for the B versus C means. The means of the A versus B pair are not significantly different. In summary, the data show that A and B students prefer a greater percentage of individual assignments compared to the C students.

Since during both semesters 50% of the actual assignments were individual, the results of the pairwise comparisons compelled us to examine whether each grade group's mean response differs significantly from 50%. This led to the following hypotheses:

- Hypothesis 4 (Individual Assignment %: A group): The percentage of individual assignments desired for students in the A group will not be significantly different from 50%.
- Hypothesis 5 (Individual Assignment %: B group): The percentage of individual assignments desired for students in the B group will not be significantly different from 50%.
- Hypothesis 6 (Individual Assignment %: C group): The percentage of individual assignments desired for students in the C group will be significantly lower than 50%.

For hypotheses four and five (A and B groups, respectively), one cannot conclude that the mean percentages for individual assignments desired are different from 50%. However, for the C group, the mean percentage individual assignments desired is significantly lower than 50%, with a p-value of 0.0080 (1-tailed). Perhaps these results should not be surprising, as a student earning a C may desire fewer individual assignments (thus relying on group members more), while A and B students are satisfied with an equal blend of individual and group assignments. In any event, these results seem to be supportive of one of the main features of the theme-based assignments, which is a combination of individual and group assignments engaging the students over the term while retaining the linkage to the theme.

6. Summary

This paper has summarized our experience in using a common theme for a series of spreadsheet-related assignments in an undergraduate Management Science course. The approach combines some of the advantages of standard cases with those of student-defined projects, and can be seen as a middle ground between the two. In an attempt to incorporate advantages of both projects and cases, students are given choice in terms of the specifics of their topic (like projects but unlike cases), which seems to enhance the level of engagement in the material. There can also be enough definition of the assignments as well as specific deliverables expected so that inexperienced students do not have the sense of being totally lost.

There are many possible themes one could use as a basis for assignments. We have used three so far ("generic" entertainment venues, the 2002 Winter Olympics, and Socially-Responsible Investing). In general, we have observed that if the theme can be chosen to be something with which the students have some experience and/or interest, combined with being discussed in the media, this adds to the "engagement" of the students.

We have observed several advantages of the thematic assignment approach for the undergraduate Management Science course.

- The assignments give students enough flexibility so they develop some ownership of the topic, similar to a project. Student comment: "I liked working with one major topic for the assignments. It was an effective way to show how many aspects of analysis and business apply At the same time, the assignments have some instructor-imposed limits, making them more manageable than projects.
- Much of the messiness of real-world modeling and problem solving is retained, forcing students to come to grips with missing data and/or data that doesn't suit their needs. This forces students to make and defend quantitative assumptions, something very few students have had to do in other classes. Most Management Science cases also do not force students to do this. Student comment: "Allowed us to use more assumptions, and more challenging because information was not provided and we had to research."
- There is no single correct answer, something most undergraduate students are not used to or comfortable with. This helps to reinforce the reality that

business decision-making is often done when surrounded by ambiguity. This also helps to fight the stereotype of a "quant" class. Student comment: "The ability to allow the students to use creativity and come up with their own model."

- Individual and group assignments can be mixed throughout the term without losing continuity. Student comment: "I liked working with my group, as well as, working on my own: all within the same topic. It worked well!"
- Peer assessment can easily be incorporated into the process.
- Students gain experience presenting their work. Classmates tend to remain more interested in the presentations because they all relate to the same theme, yet each group's specific topic is somewhat different. Student comment: "Forming PowerPoint slides and a script for presentations forced us to find meaning in our models. I thought this was very useful and also gave us a way to explain the rationale behind our work."
- The assignments show that problems can be addressed from several different perspectives. Also, a number of quantitative tools are often needed to address different parts of the same issue.
- A writing assignment can be easily integrated into the theme. Student comment: "I liked the writing assignment, it gave us a perspective on the quantitative."
- Student energy is maintained over the term, unlike cases that have sudden bursts throughout the semester or projects that can have one burst at the end. Student comment: "How the assignments built up as we learned more."
- Structure and discipline in the modeling & analysis process is developed, since students are often starting one assignment with their "finished product" from a previous assignment. Student comment: "One of the best aspects was how each assignment built upon the last."

The real advantages of the theme-based assignments are best summed up by these student comments:

- "It was impressive to see what was actually solved when we were finished!"
- "They get you to think critically about what was taught in class "
- "It was a great help in actually understanding the various aspects of quantitative decision making"

Acknowledgements

The authors appreciate the opportunity to present an earlier version of this paper at the Spreadsheet Mini-conference, preceeding the 2002 Decision Sciences Institute National Meeting. The authors also gratefully acknowledge comments by two anonymous referees, an associate editor, and the editor, which have helped to improve the quality of this paper.

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