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CRACKING THE SHELL TO STUDENT LEARNING: AN INNOVATIVE INSTRUCTIONAL APPROACH

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ABSTRACT

A common problem faced by those who teach Operations Management and Industrial Engineering courses is motivating students to learn and apply the quantitative and managerial aspects of the material. The aim of our educational methodology is to not only teach and reinforce the core principles of the disciplines, but to have students develop a set of skills that will make them competitive in the classroom and the workforce. *Teaching is why a university exists.* As a result, the objective of our instructional approach is to attract and retain dedicated students to the fields of Operations Management and Industrial Engineering and to keep those students competitive and in focus with industry's needs.

INTRODUCTION

Common belief says that students seek to minimize the challenge of their education. This is not true. Rather, students seek to maximize the learning that they can achieve given scarce resources of time and energy. It is therefore crucial to communicate the overall picture into which a course's content (and, indeed, a given lecture's content) fits. The emphasis of our instructional approach seeks to develop the following attributes desirable for a newly graduated (operations management or industrial engineering) student: (1) an ability to identify and define a problem, develop and evaluate alternative solutions, and effect one or more designs to solve the problem; (2) a breadth and depth of technical knowledge; (3) a fundamental understanding of mathematics; (4) an effectiveness in communicating ideas; (5) a high and professional ethical standard; (6) an ability to skillfully use computers for computational, analysis and design; (7) a motivation and capability to continue the learning process, and (8) a knowledge of business strategies and management practices.

We use three techniques for facilitating student learning. First, we provide students with a typed "shell" of class notes that integrate the classroom topics and examples. During a class session, students complete the notes ("fill in the shell") based on the instructor's presentation and/or group discussions. Such an approach offers the advantage that a greater depth and breath of course material can be covered in a limited time. Students appreciate the approach since by the end of a class period, they have a complete set of notes which is superior to any textbook. Second, we integrate training exercises or learning games into the class. These exercises reinforce ideas developed in the lecture and excite students about the material. Finally, we require students to complete computer-intensive homework modules. The goal for each is to expand the critical thinking skill of the students by requiring them to apply the following general problem solving steps: (1) define the problem, (2) analyze the problem, (3) synthesize the concept, (4) develop alternatives and select one, (5) implement the solution, and (6) follow-up. Software programs used in the homework modules include a variety of simulation, spreadsheets, and optimization packages.

INNOVATIVE AND UNIQUE FEATURES

While the content in the courses we teach is fairly standard (and defined), our method for delivering and reinforcing the material is innovative in the following ways:

(1) students are provided with a typed "shell" of class notes that integrate the classroom topics and examples. During a class session, students complete the notes ("fill in the shell") based on the instructor's presentation and/or group discussions;
(2) training exercises or learning games are used to reinforce the concepts; and
(3) homework modules are given to the students to actively apply the topics while also developing their computer skills.

EFFECTIVENESS AND BENEFITS

"To hear is to forget, to see is to remember, to do is to understand"

The best way to learn is to do. The second best way to learn is to watch an expert do. The worst way to learn is to talk about doing. Our methodology emphasizes active student participation and learning. Other benefits include:

(1) The "shell" note format can be used in virtually any classroom setting (small class, large class, distance education). Adapting our instructional approach to different classroom setting is easy.
(2) Lecture materials are reinforced by use of training exercises which enable the students to visualize concepts and understand practical challenges.

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(3) Homework modules aid in student understanding and developing of computer skills.

STUDENT LEVEL

Our instructional approach has been used for undergraduate (freshman, junior, senior) and graduate (master and doctoral) courses in Operations Management and Industrial Engineering. Instruction has occurred in small classroom settings (fewer than 20 students), auditoriums (up to 100 students), and through interactive television (to distance learning students).

NUMBER OF STUDENTS

Approximately 800 students (in 29 classes) have been taught using our approach.

ORGANIZATION

The hardest part with creating a "shell" of notes for the students is that one needs to know what they are going to say ahead of the class period - potentially one, two, or even three weeks ahead of time. This requires one to be very organized and dedicated. We would estimate that we each average *200 hours* in note preparation time per new course.

While 200 hours is a huge time commitment for developing a note set, the potential payoff to the instructor is large. In our experience, the first version of a note set for a course usually has numerous grammatical and formatting errors. After the second iteration (second time one has used the notes), most of these problems will be corrected. Thus, the notes become fairly "bullet proof". Given the static nature of the material we teach, these notes will be useful for numerous future class sessions. Updates that do occur can easily be done by changing the examples to keep them current and relevant. One of us has used a set of simulation notes for 5 semesters in a row. Thus, the initial preparation was intensive, but course preparation for subsequent semesters has been minimal. In fact, both of us have required students to purchase the complete note packet for a course at the beginning of the semester. Based on our experiences, a typical packet is 200 to 250 pages long. As an aside, each of us envision that the note sets we have developed will potentially be developed into a textbook(s).

In addition to developing the "shell" of the course note is the process of creating training exercise for these students. This is usually the hardest component in a course's development since exercises have to be relatively self-explanatory, be interesting to the student, and demonstrate the concept. The purpose of the games is to reinforce ideas presented in the lecture. In general, after each of us has covered a topic area, a game or training exercise is conducted to quickly reinforce the topics developed through the lecture, thus further ensuring student learning. This approach enables students to visualize concepts and gain insight to the practical difficulties associated with each topic. Our experience has shown that, many times, students are unable to grasp the overall thrust of an idea presented in the lecture until they can see/feel/experience the concept in action.

A final component of our teaching methodology is to develop homework sets that require students to explore/consider the real-world applicable of the operation management/industrial engineering techniques. These homework assignments, like the training games, are used to support and reinforce ideas developed in the lecture. While the games are used to visualize the concepts, the homework modules are used to get the students to apply the methodology to practical real-world applications. Both of us have homework modules requiring the students to use software programs such as spreadsheets, simulation and optimization packages

PRESENTATION

Not all individuals learn and retain information in the same manner. Some students learn through active participation, others through visual understanding, and others through detailed explanations and audible recognition (thinkers, watchers, and doers). Our innovative approach ensures that all types of learning styles are addressed in the presentation of the material. Homework and training encourage active participation in learning the material, while the lecture format provides the students with a detailed set of explanations. In addition, the structure of the "shell" note format helps ensure that students attend the lecture to complete and fill out their notes. Obviously face-to-face instruction is far superior to anything the students could gain through a textbook or by copying another student's notes.

One concern both of us have is that once a student takes the course and "fills in the shell" of notes, will s/he not provide the completed notes to future students – especially if the notes do not change. In all the classes we have taught using this approach, this has never occurred. In fact, each of us have nearly perfect student attendance (even though attendance is not a component of the grade). We do not know if this is an indication of student's liking our respective presentation styles or a sign of their unresourcefulness.

As an aside, this teaching approach has worked in several different class settings. The most challenging setting is when a course is broadcast on closed-circuit, interactive television to distance learning students. Distance learning students are very demanding about their education and wish to have the same classroom experience as on-site students. Other than having cameras in the classroom, the only significant change for most televised courses is that use of

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the chalkboard is restricted due to glare. Rather, instructors are encouraged to write all information on a pad of (11 x 8½) paper that a camera looks down on. This camera's signal is broadcast to the offsite and on-site television screens. Using the "shell" note format works perfectly in this circumstance since the amount of information that can be written on the paper is limited and one does not easily have the option of flipping between pieces of paper to tie ideas together. One of the other problems with distance learning students is the logistics involved in providing them with classroom material in a timely manner. If the note set is already developed, distance learning student can be provided with the material once, at the beginning of the semester. In the case where the notes are not developed, one of us has begun posting new note pages to a web site so that the distance learning students can download and print them out before class. In large auditorium settings, we have used presentation software such as PowerPoint to present the material.

EXAMPLE TRAINING MODULE

Operations Management

Training Module 4 - Team Tower

Your team has thirty minutes to construct a tower made out of spaghetti and marshmallows. The criteria for the tower is the tower must be durable, tall and strong (like most modern day skyscrapers). In order to be successful the tower must stand for thirty minutes after being built and be able to support a weight equal to thirty sheets of paper. The team with the best tower based on height, durability and strength will get five points added to their overall score for the course.

You are constrained to the following resources

- miniature marshmallows (one scoop)
- thin spaghetti (half a box)

The purpose of this exercise is to get everyone in your group more familiar with each other, have fun and to highlight some points learned from the strategic planning chapter. Please answer and discuss the following questions within your group.

1. Of the thirty minutes allotted for construction of the tower, how much was spent planning and how much was spent building. (approximate)
2. Do you think your team would have been more successful if more time was used for planning. (explain)
3. What types of information would have enabled your team to be more successful.

3a. How would this exercise differ if the organization wanted your team to build warehouses?

4. We discussed three types of planning for organizations: strategic, tactical, and operational. What types of decisions were made at each of these levels for this exercise?

4a. Crucial to the success of an organization's strategic plan is identifying critical success factors. What might be some of the critical success factors for an organization building skyscrapers and an organization building warehouses.

5. What types of labor structures were used in your group (division of labor)? Did a natural leader arise in the group? Did your team work well together? Did your team work as a team or did each person do their own thing?
6. How did constraining the resources impact your decision on how to build your tower?
7. What did your team learn about planning in general and its overall importance?

EXAMPLE HOMEWORK MODULE

Operations Management

Homework Module 3 - Forecasting Methods

A small manufacturing company that produces steel rods for building construction would like to discover a forecasting method that is effective for their organization. You are given the following data set from which to create the forecasts:

Year	Sales	Year	Sales
1975	**283**	**1985**	**462**
1976	**288**	**1986**	**452**
1977	**36**	**1987**	**474**
1978	**388**	**1988**	**476**
1979	**406**	**1989**	**497**
1980	**412**	**1990**	**487**
1981	**416**	**1991**	**523**
1982	**435**	**1992**	**528**
1983	**428**	**199**	**532**
1984	**435**	**1994**	**552**

1. Use Solver to determine the weights for a 3-period weighted moving average that minimizes the MSE for the data set
   - What are the optimal values for the weights?
   - Prepare a line graph comparing the weighted moving average prediction against the original data
   - What are the forecasts for 1995 and 1996 using this technique?
2. Create an exponential smoothing model that minimizes the MSE for the data set. Use Solver to determine the optimal value of α.
   - What is the optimal value of α?

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- Prepare a line graph comparing the exponential smoothing predictions against the original data.
- What are the forecasts for 1995 and 1996 using this technique?

3. Use regression analysis to fit a linear trend to the data set.
   - What is the estimated regression function?
   - Interpret the r value for this model
   - Prepare a line graph comparing the linear trend prediction against the original data
   - Do you think this is a good model to use for this example, why?

4. Of the above models which is the best overall model?