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IMPROVING LEARNING OUTCOMES IN A FLIPPED SPREADSHEET-BASED GRADUATE DECISION MODELING COURSE

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ABSTRACT

This paper discusses the challenges related to flipping the classroom in a spreadsheet-based graduate decision modeling course. The purpose of this paper is to extend the conversation on flipped classrooms to the thorny world of teaching spreadsheet decision modeling at the graduate level. After reviewing the literature, we report on our experience in a MBA supply chain management course and a similar master's course for security management executives. Initial course structure, learning outcomes assessment, student feedback, subjective observations, and data-driven course modifications are discussed. Based on our experience, we recommend that instructors provide in-class scaffolding before the classroom activity begins.

KEYWORDS: Flipped classroom, course inversion, spreadsheet decision modeling, continuous improvement, active learning, problem-based learning

INTRODUCTION

This paper discusses our experiences with flipped classrooms in similar graduate decision modeling courses. The bulk of the paper focuses on a graduate supply chain management decision modeling course, which emphasizes computer spreadsheets. After a brief look at the relevant literature, we describe the course structure, report on results of both direct and indirect measures of course efficacy, and discuss changes that we have made to improve learning outcomes and student feedback in subsequent semesters.

In our experience, we have found that student learning outcomes are higher when the course includes a large number of problem-based applications. The use of problem based learning approaches has been studied extensively in the educational literature (see, for example, Hmelo-Silver, 2004), and active learning, in general, has been known to have a positive relationship to higher-order learning for many years (Chickering & Gamson, 1987). Experiential classroom exercises designed to challenge students to apply course concepts are particularly effective (Paul & Mukhopadhyay, 2005). Furthermore, when students work with teammates on these exercises, learning can be even more effective (Trigwell & Sleet, 1990). Learning is enhanced in these cases through synergy and what Topping & Ehly (2001) call “peer-assisted learning.” Thus, the combination of problem-based learning with experiential classroom exercises provides a promising approach for improving student learning. Other educational research also emphasizes student-centered classrooms in which students become actively engaged in their own learning and take part in more higher-order tasks (Shea et al., 2012). One way to provide these opportunities during class time is to push the content out of the class and require students to conduct pre-class work.

Given the importance and success of active learning in college classrooms and the coincident rise in popularity of blended (hybrid online) course formats; it is not surprising that interest in flipped classrooms is increasing. In one of the earliest articles on flipped classrooms, Lage, Platt, and Treglia (2000) define course inversion (now commonly known as flipped classroom) as replacing traditional classroom activities (e.g. lectures) with activities that were typically conducted outside of the classroom (e.g., team exercises). Flipped classroom instructional models typically use videos for students to view prior to class, thus preparing them to engage in higher-order interactive activities (Davies et al 2013).

By using a flipped classroom, university faculty have the time to create more in-class student-centered and active learning strategies such as targeted remedial assistance, practice activities, group discussions, small-group problem-solving, group presentations, using group evaluation tools (Zappe, S., Leicht, R. et al 2009 & Khan 2012). In the past 16 years, the growth of online education and blended learning formats have made this process much easier to manage (Sahin, Cavlazoglu & Zeytuncu, 2015).

Even with the increasing popularity of flipped classrooms, it is unlikely that all approaches work well nor that the use of flipped classrooms is appropriate for all courses. For example, research by Kirschner, Sweller, & Clark (2006) suggests that problem-based approaches that rely on “minimum guidance” do not work well because students must have a sufficient foundation in the particular area before they can effectively guide themselves. Hence, it is up to the instructor to design activities that provide the necessary scaffolding to promote learning rather than simply casting their students adrift (for more on scaffolding, see the seminal paper by Wood, Bruner, & Ross, 1976).

Furthermore, according to Davies et al (2013), “Much of the research regarding the specific pedagogical approach of flipping the classroom is only beginning to be published” and Davies points to Lage et al (2000), Moravec et al (2010) and Strayer (2012) in which these approaches are based on “contextually situated learning circumstances.” Thus, understanding the costs and the benefits of each approach is essential before integrating these technology-based tools (Bergmann and Sams 2013 & Davies, 2011).

The use of flipped classrooms in introductory spreadsheet courses shows considerable promise as evidenced by a number of studies. Frydenberg (2013), for example, used a student survey to investigate whether the flipped classroom approach in an introductory information systems course was helpful. Students reported that the classroom exercises were motivating and improved their learning. Davies, Dean & Ball (2013) designed an experiment for testing the efficacy of the flipped classroom for teaching spreadsheet analysis in an undergraduate information systems course. They found that the flipped approach led to improved learning outcomes. Evidence of the effectiveness of flipped classrooms in advanced spreadsheet decision modeling courses, however, appears to be scant. In this paper, we contribute to this niche in the flipped classroom literature.

COURSE STRUCTURE

The primary subject course in this study is entitled Decision Modeling for Supply Chain Managers. It is a three-hour graduate course, which is part of the new Supply Chain Management concentration for our MBA and is also required for graduate students seeking a Supply Chain Management certificate. All courses in this concentration are team taught by a faculty member and a corporate partner. The course is hybrid online and meets once per week for two hours and forty-five minutes over an eight-week session.

Learning Objectives (LOs) of the course are shown below. These LOs were developed by Supply Chain Management faculty members in partnership with a large industry panel in order to match curriculum with industry needs.

After completing this course, a student will be able to:

1. Generate forecasts, cost/volume analyses, Monte Carlo simulations, and linear programming models using computer spreadsheets;
2. Analyze real-world business problems in supply chain management and identify the appropriate decision modeling approach;
3. Design effective spreadsheet models to solve complex problems; and
4. Analyze decision model results and related qualitative contextual factors, and recommend specific actions based on this analysis.

The course was divided into eight learning modules. One module was covered each week with online lectures and a team exercise completed in class. With the exception of the introductory module covered in week one, students were expected to complete the assigned reading and practice homework and review all online lecture videos before arriving in class. Each class session was entirely devoted to working on an in-class team exercise. The exercises were designed to be practical applications of the material presented in the reading assignment and online videos. They were intended to reinforce and extend course concepts and skills and build student confidence.

The first module consisted of two team exercises. The first exercise was intended to act as an icebreaker, and the second was used to model how the remaining classes would operate. Since students had already taken classes together over the previous year as part of a graduate cohort, they had developed extensive working relationships with several class members. Consequently, we randomly assigned students to teams to break self-formed groups and to simulate a cross-functional team project in a work environment. We then reshuffled the groups in the fifth week to ensure that students were not saddled with less productive team members for the entire session.

After the introductory session, the remaining class sessions followed a similar pattern. Students completed the various assignments, and reviewed the exercise or case assignment, which was posted online at the beginning of the week. This provided students with an idea of what the requirements of the exercise would be before class, but they were unable to begin the exercise until class started because the data used in the exercise was not revealed until the beginning of the class.

At the beginning of each class, we reviewed the case objectives, and we discussed any concepts or techniques that we believed students would have difficulty with once the exercise began. This review typically took 15-20 minutes to complete, which left students with nearly 2.5 hours to complete the exercise and submit their team's findings.

To simulate real business communication, a team's final work product was submitted in email format with the spreadsheet file included as an attachment. We required students to write emails that were clear, concise and complete. We believe that it is important to teach students how to communicate their analysis and recommendations without resorting to voluminous emails or reports that managers are unlikely to read.

The weekly course modules covered the following topics:

Module 1: Course introduction
Module 2: Excel fundamentals, data visualization, and pivot tables
Module 3: Elementary data analysis and descriptive statistics
Module 4: Regression analysis
Module 5: Time series forecasting
Module 6: Decision making concepts
Module 7: Linear optimization
Module 8: Monte Carlo simulation

DIRECT MEASURES: COURSE ASSESSMENT RESULTS

Students were given an extensive online exam at the end of the course that required them to answer a number of analytical and conceptual questions as well as solve several spreadsheet problems. This exam was worth 40% of the students' grade and was a primary instrument for evaluating individual performance in the course. The exam was also used to evaluate aggregate student performance on the four learning objectives discussed earlier. The results of this assessment are given below.

The assessment results indicate that students struggled on three of the four LOs. Nearly half of the class had significant difficulty generating one or more of the spreadsheet problem types covered in the course (LO1); and about the same proportion of students had significant difficulty with spreadsheet model development (LO3). Most troubling was the class performance on problem recognition (LO2). In this series of questions, students were given a series of problem statements and asked to identify the correct solution approach. Nearly two-thirds of the students were deficient in this area.

INDIRECT MEASURES: STUDENT COURSE EVALUATIONS

At the end of the course, students were asked to complete student course evaluations using a standardized and validated instrument, which contained a number of Likert scale questions and space for written comments. Although the scale questions and student feedback in the course were respectable, three issues emerged from the student comments that caused us some concern. These issues are summarized below.

Table 1: DIRECT MEASURES			
Learning Objective	**Does Not Meet Expectations**	**Meets Expectations**	**Exceeds Expectations**
LO#1. Generate forecasts, cost/volume analyses, Monte Carlo simulations, and linear programming models using computer spreadsheets.	44.9%	28.2%	26.9%
LO#2. Analyze real-world business problems in supply chain management and identify the appropriate decision modeling approach.	62.8%	33.3%	3.8%
LO#3. Design effective spreadsheet models to solve complex problems.	47.1%	35.3%	17.6%
LO#4. Analyze decision model results and related qualitative contextual factors, and recommend specific actions based on this analysis.	34.0%	35.8%	30.2%

1. Groups of four or five students are too large for a linear classroom (rows of computer tables).
2. Several students complained that members of their teams were seemingly unprepared for the class assignments.
3. Students noted that there was a wide degree of Excel skill in their groups, which caused some students to become spectators on the assignment analysis.

The first item was easy enough to fix without changing the pedagogy. But the latter two items confirmed to us that a fully flipped classroom was not entirely effective in this course.

CLASSROOM EXPERIENCE

Although there was certainly room for improvement, many aspects of the course worked well. But since this was a new course in a new MBA concentration using new techniques, we were not surprised to learn that some aspects of the course were not as effective as we had hoped they would be. In this section, we identify some of the aspects of the course that did not work well.

First, we believe the decision to assign groups in week one and then again in week five did not produce the results we expected. Students were very challenged with the amount of course content that they were expected to assimilate each week. Expecting students to successfully process the course material while dealing with the challenges of normalizing a working group, not once but twice, was a bridge too far. Because groups were randomly formed in week one and week five, the chance that all the team members had worked together previously was much less than if the students had selected their groups themselves. The strangers in the groups did not feel the peer pressure to perform in order to support the entire team. Also, because the teams were only together for four weeks, it was often easier for the performers in the first group to tolerate freeloading instead of addressing it because the chance the freeloader would be in their new group was minimal.

We encountered a disparity of MS Excel skills on each team, which depended to a great extent on each student’s educational and professional background. We believed that this gap would narrow as the students completed the lectures and more importantly, the homework assignments during the semester. This was not the case. In fact, it was clear that some students who struggled with Excel did not complete all of their out-of-class practice problems and relied, instead, on the stronger members of their teams to carry them through the classroom exercises. This choice did not serve them well during the final exam.

During the setup of each assignment, we attempted to address issues that students would encounter as they attempted to solve the problem. Although some questions were asked during this review, most of the student questions were asked and answered while the teams were working on the assignment. This resulted in the same question often being asked over and over. Furthermore, since this course was team taught by a faculty member and corporate partner, sometimes we would offer students different approaches for resolving specific issues, which could be contradictory. These issues led to frequent class stoppages to answer frequently asked questions or to clarify techniques. We found this process to be an inefficient use of class time.

PROVIDING SCAFFOLDING: A MODEST UNFLIP

In the next semester, one of authors used a similar course structure in a graduate decision modeling course for security executives. Although the context and many of the decision models used in the course were different, the course shared many of the basic characteristics of the supply chain management course: the course was hybrid-online, the course had eight, two hour and forty-five minute scheduled sessions over the semester, and the in-class portion of the course was devoted entirely to spreadsheet exercises. Although this course was not a new offering, it was recently revised.

In general, students in the security management course had less analytical preparation than their MBA counterparts. We found that the majority of the class had poorly defined Excel skills. The disparity between the most prepared and least prepared students was greater than we had observed in the supply chain course. Furthermore, the many tutorials and primers that we provided on the course website were insufficient to bridge the gap. It quickly became apparent that the planned pedagogy did not match well with student skills. As a result, we decided to pivot from a fully-flipped classroom to a partially-flipped classroom. The modified structure included a mini-lecture of about 30 minutes at the beginning of each session. Topics and examples for these mini-lectures were targeted to issues in each area that the instructor had seen students struggle with in the past. This mini-lecture is intended to provide students with the necessary scaffolding to successfully complete the classroom activity.

The modest unflip of the security management course appears to be effective. Although course-level assessment data was not available for this course, final exam performance was satisfactory and student feedback was very favorable. The success of this revision along with our analysis of the indirect and direct measures from the MBA course suggested that similar revisions in the MBA course were warranted. At the time of the writing of this paper, we are currently teaching the supply chain course with the modest unflip. Thus far, this approach has led to improvements in several areas. Although learning outcomes assessment data is not yet available for this course, we believe that there will be substantial improvement.

CONCLUSION

In our experience with the supply chain management course, we identified several areas in which we could improve. Some of these improvements came directly from the student evaluations while others were based on students' performance on the learning objectives. In particular, we found that pushing all of the conceptual content to pre-class work is impractical. Although most students appear to have studied the material, their level of comprehension was inadequate for the task at hand. We have found that a short interactive session at the beginning of the workshop is a particularly useful device for providing the scaffolding that students will need to complete the problem-based activity. This observation is consistent with observations that we cited earlier by Kirschner et al. (2006). Although, in our original model, students were provided videos and practice problems to learn the concepts and tools, this approach is probably closer to the "minimum guidance" identified by Kirschner et al. than we had envisioned. Even so, this does not mean that the flipped format should be discarded. With a modest unflip, we believe that students can benefit from the classroom activity. Therefore, we recommend that instructors who are contemplating designing a flipped classroom for teaching spreadsheet decision modeling should schedule a mini-lecture to review the more important concepts and techniques in class before the activity begins.

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