Using Scaffolding to Improve Learning Outcomes in a Flipped Supply Chain Management Decision Modeling Course

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This paper discusses the challenges related to flipping the classroom in a spreadsheet-based graduate supply chain management 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. The paper highlights a number of non-traditional approaches for improving student learning in an MBA-level course, and it reports the results of two semesters of classroom experience across multiple sections. In particular, in-class, conceptual scaffolding was added to the flipped course format in the second semester to improve glaring problems identified in learning outcomes assessment from the first semester. This modification significantly improved student performance on two of the four learning objectives.

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

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I. INTRODUCTION

In quantitative business courses, student learning outcomes improve when the course includes a significant number of problem-based applications that require students to apply course concepts to real-world situations. This statement is well-supported by the educational literature. The use of problem based learning (PBL) approaches has been studied extensively (see, for example, Hmelo-Silver, 2004). PBL has also been defined as providing students with baseline knowledge in order for them to learn how to think (Edens, 2000).

It has long been understood that in general, active learning has a positive relationship to higher-order learning (Chickering and Gamson, 1987). Active learning exercises that are designed to challenge students to apply course concepts are particularly effective (Paul and Mukhopadhyay, 2005). Furthermore, when students work with teammates on these exercises, learning can be even more effective

(Trigwell and Sleet, 1990). Learning is enhanced in these cases through synergy and what Topping and Ehly (2001) call "peer-assisted learning." Thus, the combination of PBL 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). However, classroom time is limited. Requiring students to learn foundational concepts and techniques during pre-class work allows time for the instructors to use more in-class active learning techniques.

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 a 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, which prepares them to engage in higher-order interactive activities in the classroom (Davies et al 2013). Given time limitations, the use of blending is critical to the success of the flipped classroom approach. Assigning pre-recorded lectures as homework activities opens up classroom time for active learning activities (Bishop and Verleger, 2013). Bergmann and Sams (2012) argue that blended learning using the flipped classroom model provides an "ideal merger of online and face-to-face instruction (p. 25)."

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, Leicht, et al 2009 and Khan 2012). In the past 16 years, the growth of online education and blended learning formats has made this process much easier to manage (Sahin, Cavlazoglu and Zeytuncu, 2015). Furthermore, the flipped classroom provides more opportunities for student-to-student collaboration. This collaboration may take the form of small group learning activities whereby the students engage with each other in various ways (Volet, Vauras, and Salonen, 2009). This allows students to influence each other's metacognitions and may influence new cognitive growth (Salmon, 1993). However, in order to prepare students for collaborative learning techniques, structured scaffolding appears to positively influence interactions within the group by providing the students with the support they need to interact and share ideas (King, 1998 and 2002).

Thus, empowering students to take a more active role in their learning, in turn, takes them away from the more traditional teacher-centered approach. Mayer, Moeller, Kaliwata et al (2012) argue that in PBL environments with student-centered approaches (with scaffolding) are more effective predictors of student success than the more traditional teacher-centered approach. Schmidt, Rotgans and Yew (2011) conclude that

> PBL works because it encourages the activation of prior knowledge in the small-group setting and provides opportunities for elaboration on that knowledge. These activities facilitate the comprehension of new information related to the problem and enhance its long-term memorability (p. 792).

To think of it another way, the flipped classroom provides an environment similar to engineering and science classes in which students apply the newly learned content by working together, solving problems in a laboratory under the guidance of the instructor (Mayer, Moeller, Kaliwata, Stone, Frank, 2012).

1.1. A Case for Scaffolding and Problem-Based Learning

Even with the increasing popularity of flipped classrooms, it is unlikely that all approaches work well or that flipped classrooms are appropriate for all courses. For example, Kirschner, Sweller, and 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.

Scaffolding was first conceptualized as a social-cultural theory by Vygotsky. In Vygotsky's *Mind in Society* (1976), the zone of proximal development is defined as, "the distance between the actual development level as determined by independent problem-solving and the level of potential development through problem solving under adult guidance or in collaboration with more capable peers" (p. 86). Wood, Bruner, and Ross (1976) describe scaffolding as a process that enables a "…novice to solve a problem, carryout a task or achieve a goal, which would be beyond his [or her] unassisted efforts" (p. 90). This process consists of a more experienced person "controlling" the more challenging task elements and allowing for students to focus on finishing the tasks they have the ability to complete. Wood et al (1976, p. 90) "contend that the learner cannot benefit from such assistance unless one paramount condition is fulfilled… comprehension of the solutions must precede production".

Langer & Applebee (1986) identify the five requirements for scaffolding: 1) Student ownership of the learning event; 2) Appropriateness of instructional task; 3) Structured learning environment; 4) Shared responsibility; and 5) Transfer of control. These requirements are implemented as part of a flipped classroom whereby the students individually contribute during the in-class activities, the structured in-class activities are based upon the knowledge they received in the videos, and the students apply this knowledge by completing challenging problems. Finally, as the students increase their competence, they take on greater responsibility during the in-class group work.

1.2. Flipped Classrooms in Quantitative Courses

Researchers have experimented with flipped classrooms in many different quantitative disciplines. Baepler, Walker, and Driessen (2013), for example, used flipped classrooms to compensate for lost seat time in an undergraduate chemistry course. They found that the flipped classroom approach fully compensated for the loss of face-to-face instruction from the blended approach; and in one of their two test cases, student learning outcomes were superior using this strategy. Mason, Shuman, and Cook (2013) compared the outcomes of two upper-level mechanical engineering course sections. One of the sections was taught using traditional techniques and the other was taught using flipped classroom techniques. They found that student learning outcomes were as good or better using the flipped approach and student satisfaction was as good or higher after they adapted to the less structured format. Swart and Wuensch (2016) implemented a flipped approach in an undergraduate course in business decision modeling. They concluded that the flipped classroom increased student and instructor satisfaction, and they deduced that this finding will lead to improved student retention in years to come. Prashar (2015) conducted a pilot study on flipped classrooms in an undergraduate operations management course. She concluded that although the method has promise, it is important that instructors provide adequate foundation before the active learning activities and they carefully structure the activities to avoid overwhelming students. Consistent with these findings, Asef-Vaziri (2015) showed in a multi-year study of an undergraduate operations management course that a flipped classroom format can lead to significantly improved learning outcomes over the traditional classroom format.

The use of flipped classrooms in 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 and 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. Furthermore, the authors of this paper have found no evidence of published research on the efficacy of scaffolding in these courses. This paper contributes to this niche in the flipped classroom literature.

The remainder of this paper proceeds as follows: In section II, the nature of the subject course is defined; in section III, results of Semester 1 are discussed; in section IV, changes made and learning outcomes from Semester 2 are discussed, and in Section V, the results are placed in context and practical implications of this research are discussed.

II. COURSE STRUCTURE

The subject course in this study is entitled Decision Modeling for Supply Chain Managers. It is a three-hour graduate course, which is part of a new Supply Chain Management concentration for the college's 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 and meets once per week for two hours and forty-five minutes over an eight-week session. Enrollment in each section varies from 20-35 students depending on the size of the cohort. Learning Objectives (LOs) for 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. Learning modules and classroom activities are shown in Table 1. All activities and cases discussed in this table were written by the professor teaching the course. Each classroom exercise required from two hours to two and one half hours to complete. To help students prepare for the class exercises, the assignments were provided in advance; but the data for each assignment was withheld to prevent students from performing data analysis before class.

At the beginning of each class, the professor and corporate partner reviewed the case objectives, and they discussed any concepts or techniques that they believed students would have difficulty with once the exercise began. This review typically took 15 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. Students were required to write emails that were clear, concise and complete. This format was adopted in response to the industry panel's request that graduates be able to accurately communicate their analysis and recommendations without resorting to voluminous emails or reports that managers are unlikely to read.

III. FIRST SEMESTER

3.1. 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 assess student performance on the four learning objectives discussed earlier. The results of this assessment are given in Table 2.

The rubrics used for each of the learning objectives had three columns, which included Does Not Meet Expectations, Meets Expectations, and Exceeds Expectations. In general, a student whose work met expectations had a good model and spreadsheet implementation that worked fairly well. Students in this category typically made minor theoretical or spreadsheet implementation errors, or they may have made minor errors in post hoc analysis of the results. A student whose model and spreadsheet implementation were error-free and who had made an exemplary post hoc analysis of the model results was categorized as exceeding expectations. If a student's model, spreadsheet implementation, and/or post hoc analysis was fundamentally flawed, then this student was categorized as having not met expectations. LO2 was assessed somewhat differently. This learning objective was assessed using scenario-driven objective questions. Students who answered all questions correctly exceeded expectations, students who answered 80% of the questions correctly met expectations, and students who answered less than 80% correctly did not meet expectations. The results of this assessment are given in Table 2. Note that the overall N for the assessment was 78. LO4 had a lower N because it was impossible to evaluate the post hoc analysis of the assigned problem if the student was unable to complete the modeling task. This problem was corrected in the subsequent semester as discussed in the next section. The assessment results suggest 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 modeling approach. Nearly two-thirds of the students were deficient in this area.

TABLE 1. COURSE LEARNING MODULES.

Week	Module	Case/Activity
1	Course introduction	Icebreaking exercises
2	Excel fundamentals, data visualization, and pivot tables	In this case, students were given forecast data for a complex maintenance organization and asked to predict future cash outflows for purchased parts.
3	Elementary data analysis and descriptive statistics	In this activity, students were given commodity price data to analyze pricing behavior using Excel's descriptive statistics function, histograms and pivot tables/charts.
4	Regression analysis	In this case, students were given shipping cost data for a logistics firm. After completing a preliminary statistical analysis, they were asked to build regression models containing a number of independent variables. Iteration was required to identify a best model. Students were then asked to make point and interval estimates and to make and defend their recommended course of action based on model results and post hoc analysis.
5	Time series forecasting	In this activity, students were asked to bring in real word time series data from their work and then create several time series forecasts using Excel. They were then asked to choose the best model after calculating the MAE, compute a forecast, and make a recommendation regarding forecast utility based on their results.
6	Linear optimization	In this case, students were asked to build an integer programming model using Solver to schedule purchases and in-house production. After building their models, students were required to perform sensitivity analysis on the LP relaxation, make recommendations based on their analysis, and identify organizational problems that led to lost profits in the case.
7	Decision making concepts	In this case, students are given a make or buy problem. To complete the problem, students must forecast demand using time series techniques, compute break even points and NPVs of the various alternatives, and recommend the best course of action based on model results and problem context.
8	Monte Carlo simulation	In this case, students are asked to build a Monte Carlo model in Excel to predict equipment failure for multiple production machines to determine the appropriate level of repair kits to order.

TABLE 2. ASSESSMENT RESULTS FOR SEMESTER 1.

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. (N=78)	44.87%	28.21%	26.92%
LO#2. Analyze real-world business problems in supply chain management and identify the appropriate decision modeling approach. (N=78)	62.82%	33.33%	3.85%
LO#3. Design effective spreadsheet models to solve complex problems. (N=78)	46.15%	35.90%	17.95%
LO#4. Analyze decision model results and related qualitative contextual factors, and recommend specific actions based on this analysis. (N=53)	33.96%	35.85%	30.19%

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 (overall rating = 4.3/5, N = 69), three issues emerged from the student comments that caused some concern. These issues are summarized below.

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 unprepared for the class assignments.
3) Students noted that there was a wide range 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 that a fully-flipped classroom was not entirely effective in this course.

3.2. Reflections on the Classroom Experience

Although there was certainly room for improvement, many aspects of the course worked well. Since this was a new course in a new MBA concentration using fundamentally new teaching techniques, it came as no surprise that some aspects of the course were not as effective as had been hoped. For instance, the instructors quickly became aware that some students were not prepared to handle various aspects of group dynamics, which led to their disengagement. The disengaged students deferred to the high-performing students and let them do all the work. Thus, the instructors had to motivate and challenge disengaged students to start contributing. In later semesters, the professor was able to correct this issue by emphasizing personal responsibility for out-of-class preparation in the course syllabus and establishing a mechanism that enabled groups to "fire" unprepared or disengaged students.

A major advantage of this new, flipped classroom technique was that it provided opportunities for immediate instructor intervention. By walking around the classroom and observing students' progress on the in-class assignments, the instructors were not only able to identify and resolve the problems associated with group dynamics, they were also able to intervene when the students were off-task, did not understand the assignment, and/or were not completing the assignment correctly.

Consistent with student course evaluations, the instructors observed a wide disparity of Excel skills on each team, which depended to a great extent on each student's educational and professional background. The video lectures and examples and practice problems were designed to narrow this gap. However, it was clear from classroom observation that the gap was still too wide. After informally interviewing some members of the class, it became clear that some students who struggled with Excel chose not to complete all of their out-of-class practice problems (or were unable to do so) and relied, instead, on the stronger members of their teams to carry them through the classroom exercises. This choice appeared to directly impact aggregate student performance on the final exam and subsequent learning outcomes assessment.

During the setup of each assignment, the instructors 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 being asked repeatedly. Furthermore, since this course was team taught by a faculty member and corporate partner, they would often offer students different approaches for resolving specific issues, which were occasionally contradictory. These issues led to class stoppages to answer frequently asked questions or to clarify techniques. This was distracting to students and an inefficient use of class time.

The PBL-approach executed in a flipped classroom created a significant amount of performance pressure that students had to overcome. Classroom exercises were much more difficult than the homework assignments and presented several challenges to students. The first challenge students had to overcome was framing the problem. Unlike simple homework problems, class exercises were less structured. Most of the exercises were presented to the student via a simulated email from their supervisor and accompanied with a MS Excel data file which would be used to solve the problem. Student teams often had difficulty getting started with this format.

The final questions in each exercise focused on application of the analysis. Earning full credit on these questions required students to make strategic business decisions for industries in which they did not work. This was another significant challenge for students to overcome. As the classes were held in a computer lab, the instructors encouraged students to research the industry on the Internet to ensure that their answers were realistic. In addition, students required frequent reminders that defending their recommendations and evaluating the quality of their decisions were nearly as important as their spreadsheet analysis.

Last, students had difficulty writing business reports in the required email format. Early in the semester, responses tended to be incomplete or excessively long. To mitigate this problem, the professor found that it was necessary to consistently emphasize concise, thorough reporting in team assignment evaluations.

IV. SECOND SEMESTER

4.1. Providing Scaffolding: A Modest Unflip

It was clear from classroom experience and assessment results that even after completing a battery of reading assignments, video assignments, and practice problems, many students were unprepared to take on less structured assignments presented in the classroom portion of the course. It is not surprising that they were overwhelmed. In a compressed, eight-week period, part-time, professionally-employed MBA students must dramatically improve their spreadsheet analysis skills, they must acquire a working knowledge of the theory and modeling approaches to a number of different classical statistics and management science techniques, and they must develop the acumen to distinguish between trustworthy and untrustworthy model results before they make their recommendations. Clearly, students needed more support than was available in the fully-flipped format.

So, after reviewing the assessment results, speaking at length to students, and reviewing the pedagogical literature on PBL, the instructors decided to pivot from a fully-flipped classroom to a partially-flipped classroom. The modified structure included an interactive, mini-lecture of about 30 minutes at the beginning of each session. Topics and examples for these mini-lectures were targeted at issues in each area that the instructors had seen students struggle with in the past. This mini-lecture was intended to provide students with the necessary scaffolding to successfully complete the classroom activity. During these sessions, students were encouraged to follow along on the example and to ask questions as they arose.

To increase the impact of these scaffolding sessions, the corporate partner presented the mini-lecture to the class using data from his or her work when appropriate. This allowed students to review the concepts and techniques using real-world data from a practitioner who explained difficult concepts somewhat differently from the professor's video lectures. This approach was based on the belief that students would benefit from a different perspective rather than simply rehashing the professor's examples using new data.

In practice, these scaffolding sessions allowed the corporate partner and professor to achieve instructional synergy in the classroom. When a student had difficulty understanding the explanation provided by one of them, the other member of the team would try a different approach. On more practical aspects of the problems, the corporate partner was able to bring real-world perspective; and on more theoretical issues, the professor was able to quickly identify a way to resolve the conceptual difficulty.

4.2. A Typical Student Week

Figure 1 illustrates a typical week in an eight-week session in which problem scaffolding is used. Activities above the dashed line are completed online prior to the class. Practice problems are homework sets that include basic problem types. These homework problems are not collected, and solutions are provided. Although the homework is not graded, completion of assigned problems is necessary for the students to be successful on the online quizzes. The online quizzes ask students to perform basic spreadsheet modeling tasks to verify that they have a basic understanding of the week's concepts and spreadsheet mechanics. On some of the quiz questions, students are asked to take their completed homework answers and perform additional analysis. Without completing the homework before the beginning the online quiz, it is not possible for students to receive full credit for that week's quiz.

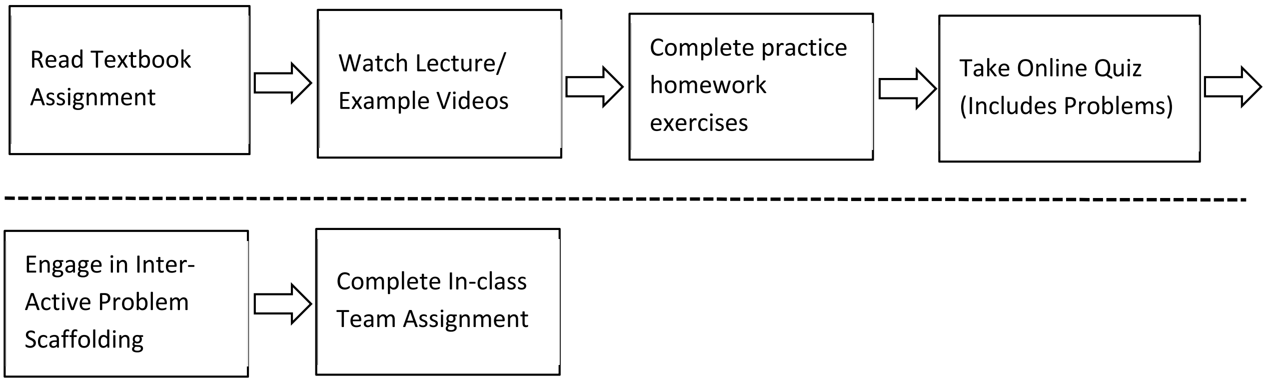

FIGURE 1. A TYPICAL STUDENT WEEK.

Given the escalation in difficulty between the homework exercises and in-class assignments, problem scaffolding became an important element in a student's week. To illustrate the escalation in difficulty, consider the following linear programming (LP) example. In their online preparation, students learn four basic LP problem types: product scheduling, make or buy, transportation, and transshipment. They are then asked to solve relatively small LPs in their online exercises comprising a minimal number of variables and constraints. These problems are of the typical "tables and chairs" level of difficulty common to introductory LPs. After online preparation and problem scaffolding, student teams are asked to solve a case assignment that requires them to formulate, solve, and analyze a make-or-buy integer program with 20 variables and 25 constraints.

4.3. Assessment Results

At the end of the second semester, the four learning outcomes were assessed again. The first three learning objectives were assessed identically in the second semester. However, given problems observed with LO4 assessment in the first semester (see discussion above), the assessment instrument was revised to ensure that all students were able to complete post hoc analysis of model results.

The modest unflip of the course appears to have been effective. Table 3 contains the assessment results from the second semester, and Table 4 compares the difference between the first and second semesters. Learning outcomes improved on all four objectives, but the improvement was much more pronounced on two of the four LOs. More encouragingly, students improved substantially in two of three modeling LOs in the course (LO1 and LO2). Less encouraging is the absolute student performance on LOs 2 and 3, which suggests that there is still quite a bit of room for improvement.

To ascertain whether the observed differences were statistically significant, assessment results from the two semesters were compared using a Chi-square test. Observed differences in LO1 and LO2 were significant with p-values of 0.008 and 0.011 respectively. Although LO3 showed considerable improvement when comparing the percentages by eye (particularly those students that exceeded expectations), the Chi-square test failed at the 0.05 level with a p-value of 0.085. Finally, differences in LO4 were clearly insignificant with a p-value of 0.643.

TABLE 3. ASSESSMENT RESULTS FOR SEMESTER 2.

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. (N=65)	24.62%	24.62%	50.77%
LO#2. Analyze real-world business problems in supply chain management and identify the appropriate decision modeling approach. (N=65)	41.54%	43.08%	15.38%
LO#3. Design effective spreadsheet models to solve complex problems. (N=65)	40.00%	26.15%	33.85%
LO#4. Analyze decision model results and related qualitative contextual factors, and recommend specific actions based on this analysis. (N=65)	26.15%	41.54%	32.31%

TABLE 4. CHANGE FROM SEMESTER 1 TO SEMESTER 2.

Learning Objective	*Does Not Meet Expectations*	*Meets Expectations*	*Exceeds Expectations*	*Chi-square Significance*
LO#1. Generate forecasts, cost/volume analyses, Monte Carlo simulations, and linear programming models using computer spreadsheets.	-20.25%	-3.59%	23.85%	0.008
LO#2. Analyze real-world business problems in supply chain management and identify the appropriate decision modeling approach.	-21.28%	9.75%	11.53%	0.011
LO#3. Design effective spreadsheet models to solve complex problems.	-6.15%	-9.75%	15.90%	0.085
LO#4. Analyze decision model results and related qualitative contextual factors, and recommend specific actions based on this analysis.	-7.81%	5.69%	2.12%	0.643

Results from the student evaluations suggest that students were happier with this version of the class. Quantitative scores were excellent (overall rating = 4.8/5, N = 60), and student comments were positive. In particular, the following patterns emerged in the student comments:

1) Students were more positive about the group aspect of the course. Rather than commenting on problematic group members, students focused on how their groups enhanced their learning.
2) Although there was general agreement that the class exercises were very helpful, several students commented that the video lectures did not provide the interaction and feedback that they benefited from in a traditional lecture.
3) Students appreciated the instructional team synergy that they observed during the scaffolding sessions, and they believed that this helped with their assignments.
4) Students were still somewhat overwhelmed by the pace of the course, but this is more a function of program design than course design.

V. CONCLUSIONS

During the first semester using the flipped classroom format, the instructors identified several areas for improvement. Some of these improvements came directly from the student evaluations while others were based on students' performance on the learning objectives. In particular, the instructors learned 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 conceptual mastery was inadequate for the task at hand. The instructors 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 cited earlier from Kirschner et al. (2006). Although, in the original pedagogical model (Semester 1), 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 had been envisioned. Even so, this does not mean that the flipped format should be discarded. With a modest unflip, students appear to benefit considerably more from the classroom activities.

In the assessment of learning outcomes, student performance improved in all four learning objectives. Improvement in the first two LOs was statistically significant based on Chi-square testing. This suggests that the scaffolding approach does help. Even though more improvement would have been welcomed, particularly in LO2 and LO3, the improvement was substantial enough to continue using the scaffolding approach in subsequent semesters.

Although these results are clearly anecdotal and confined to a single course, they may have significant practical implications. Instructors who are contemplating designing a flipped classroom for teaching spreadsheet decision modeling in a hybrid learning environment using a PBL approach should consider scheduling an interactive mini-lecture to review the more important concepts and techniques in class before the activity begins. For shorter class periods, instructors may choose to schedule the scaffolding session in the class preceding the in-class exercise. The authors of this study believe that many of the attributes of this MBA course design can be applied to advanced undergraduate courses in supply chain management and operations management. Changes would have to be made to timing of the sessions and the material covered in each (undergraduate course sessions tend to be shorter), and the relative difficulty of the assigned cases would have to be aligned with the ability/experience of the students in those courses and the length of the class period.

This study directly contributes to the pedagogical literature in several ways. It presents an innovative PBL course design, which is team taught by a professor and corporate partner in a hybrid learning format. It contributes to the flipped classroom literature by demonstrating that scaffolding via a modest "unflip" may improve learning outcomes. Finally, the learning outcomes assessment, classroom experience, and student course evaluations suggest that scaffolding combined with PBL improves the achievement of learning objectives on spreadsheet-based decision modeling courses.

More generally, the findings in this study provide further support that innovative active learning approaches can improve student learning. It is well known that quantitative business courses challenge students on many levels. Traditional teaching techniques, where students are required to do the difficult application work on their own after the baseline content is presented by the instructor during class time may not be the most effective teaching strategy. Rather, scaffolding and PBL provides the support for various student-centered and active learning techniques, whereby the students develop their own questions, learn from their mistakes and provide assessments to promote learning (Huba and Freed, 2000).

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