DECISION SCIENCES
JOURNAL OF INNOVATIVE EDUCATION

Decision Sciences Journal of Innovative Education
Volume 11 Number 2
April 2013
Printed in the U.S.A.

TEACHING BRIEF

Beat the Instructor: An Introductory Forecasting Game

Brent R. Snider† and Janice B. Eliasson
Haskayne School of Business, University of Calgary, 2500 University Drive NW, Calgary, Alberta, Canada T2N 1N4, e-mail: brent.snider@haskayne.ucalgary.ca, janice.eliasson@haskayne.ucalgary.ca

ABSTRACT

This teaching brief describes a 30-minute game where student groups compete in-class in an introductory time-series forecasting exercise. The students are challenged to "beat the instructor" who competes using forecasting techniques that will be subsequently taught. All forecasts are graphed prior to revealing the randomly generated actual demand. Experiential learning and forecasting exercises are reviewed before detailing how the game is administered and debriefed. Student survey results ($n = 247$) provide evidence of teaching effectiveness, including that 78% of students said that playing the game increased their interest in learning the forecasting techniques that were used by the instructor.

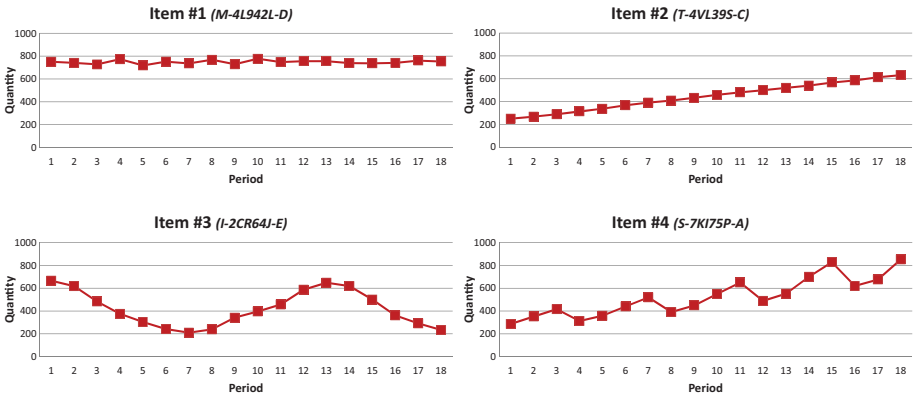
Subject Areas: Experiential Learning, Forecasting, and Management Science/Operations Research.

INTRODUCTION AND INNOVATION

This game enables student groups to compete in-class in an introductory time-series forecasting exercise, even before any lecture content has been covered. In addition to starting the forecasting topic positively via a 30-minute hands-on experiential learning exercise, the game has proven to build strong student interest in learning the forecasting techniques that are covered later in the lecture. Student groups are provided a spreadsheet with historical demand for 12 previous periods for four separate items. Each of the four items represents one of the classical demand patterns of level, trend, cyclical, and cyclical trend (Figure 1). The students are then asked to predict demand for the next six periods for each item, and submit their forecast to the instructor. In addition to competing among themselves, student groups are challenged to outperform the instructor's forecast (who also predicts demand using the techniques that will be subsequently covered). Each group's forecast is graphed in addition to the instructor's, creating anticipation for the actual demand pattern. After actual demand is randomly generated (and revealed

†Corresponding author.

Figure 1: Item demand patterns. P1-P12 "historical" data provided to students. P13-P18 later randomly generated.



on the graph), each group's forecast error is calculated and ranked. Typically the instructor outperforms most if not all groups, generating student interest in learning the techniques that can answer their often posed question: "how did you forecast so well?"

LITERATURE REVIEW

The benefits of experiential learning, where students learn from direct experience as opposed to a case study discussion, within business education are extensively published (e.g., Cotner, Jones, & Kashlak, 2004; Daly, 2001; Paul & Mukhopadhyay, 2004; Williams & Chinn, 2009). Hamer (2000) further separated experiential learning into "semi structured" short classroom activities and "loosely structured" longer more complex activities such as Internet based simulations. Hamer also found that the semistructured approach increased student learning, and that student learning increased when multiple experiential techniques were used. Furthermore, Mehrotra (2007) found that the majority of students will rise to the challenge of experiential learning techniques even if the related concepts were not yet covered in class. More specifically, poor performance during an experiential exercise can increase student interest in subsequent related lecture content as they seek to understand how they could improve their performance (Snider, Balakrishnan, & da Silveira, 2010). By engaging students, experiential learning techniques also contribute to increased learning by increasing student interest in a topic relative to a traditional lecture based approach. Schiefele (1991) describes multiple studies (some as far back as 1913) that reveal the importance of student interest for a topic on the subsequent learning that is accomplished. Student interest, facilitated from involvement, concentration, activation, and enjoyment, was shown to relate to the level of comprehension. Schiefele (1991) summarized the findings by stating "subject matter interest has a stronger and more consistent impact on the quality of experience in class than do achievement motivation or ability" (p. 314). Furthermore, semistructured experiential learning exercises such as in

Figure 2: Sample submission form template.

GROUP #: _____

FORECAST
Item: M-4L942L-D

P13	P14	P15	P16	P17	P18

class competitions have been used to overcome business student apathy toward complex quantitative lecture content such as inventory management (Robb, Johnson, & Silver, 2010) and forecasting (Gavirneni, 2008). Forecasting is a management science technique that improves business decision making, however the topic may be omitted from business school programming because of its complexity (Albritton & McMullen, 2006). Most forecasting exercises tend to be highly technical and or intended to be used after forecasting techniques have already been introduced in lectures (Albritton & McMullen, 2006; Gardner, 2008; Gavirneni, 2008). Recognizing that teaching forecasting techniques can often be difficult, Craighead (2004) does provide a prelecture dart-throwing exercise; however there appears to be no spreadsheet based introductory exercise that has been shown to build significant student interest in learning forecasting techniques. This teaching brief fills that void by providing a semistructured experiential learning exercise where students are typically unable to "beat the instructor," resulting in increased student eagerness to learn the time-series forecasting techniques that were used by the instructor.

INSTRUCTOR PREPARATION

Prior to class, the instructor needs to prepare four template student submission paper forms for each group (see Figure 2 for an example). Using different colored paper for each of the four items (such as green for the first, blue for second, etc.) is recommended as it reduces confusion for both students and the instructor. In addition, the instructor should post the student template spreadsheet file to the course Web site for download at the start of the exercise. Finally, the instructor needs to load the instructor template on the instructor's computer in the classroom. All student and instructor files are available electronically by e-mailing the authors.

EXERCISE SET-UP

There is minimal physical set-up for the exercise, other than facilitating students getting into groups of four or five students, and ensuring at least one group member has a laptop to access the student template file previously posted to the course Web site. More important is the psychological setup for the students, that: (i) the forecasting techniques will be formally covered later (ii) the exercise is designed for

discovery learning, and (iii) the challenge/incentive is to outperform the instructor. The instructor then explains that groups will be competing on forecast error and that the lowest cumulative error wins. We use error squared to illustrate that being far off with a forecast has significant "penalties" for businesses (inventory excess/shortage, etc.), though any forecasting error measure could be used (e.g., MAD, SE). The instructor template file has a tab/worksheet for each item and one cumulative error tab/worksheet. In addition to motivating the students with the challenge of "beating the instructor" who will be using the forecasting techniques they will be learning in the subsequent lecture content, a small food prize (e.g., cookies) for the winning team increases the student interest in the game even more.

THE GAME

Groups are instructed to download the student template file and to organize the 12 periods of historical data (Table 1) for each of the four items (initially sorted by period, then item number) so they will be able to analyze it and subsequently make a demand prediction for the next six periods. Most groups quickly recognize they need to re-sort the data (by item number, then by period) and that graphing the item's historical demand would be valuable, reinforcing two previously learned key spreadsheet skills. The instructor should then provide the item 1 template submission form (Figure 2) to each group and announce that the template submission form for item 2 will be distributed after item 1's actual demand is generated (and forecast errors determined), and so forth. We recommend providing approximately 8 minutes for item 1's template submission, and approximately 5 minutes between the other submissions. From a time efficiency standpoint, having a volunteer or a teaching assistant enter each group's forecast into the instructor template file is recommended.

For each round/item, the following instructor steps are recommended:

(1) Enter all groups P13-P18 forecast for the item.

(2) Ask class to describe P1-P12 demand pattern and provide a possible product example.

(3) Reveal each group's forecast on graph (one at a time or all together).

Table 1: Item historical demand (all four items in chart format)

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
Item #1	751	741	728	773	718	752	736	768	729	777	748	756
Item #2	250	268	289	314	337	367	391	409	433	459	481	500
Item #3	666	618	483	375	303	242	210	239	342	396	457	587
Item #4	287	352	416	313	359	440	520	391	449	550	650	489

Note: Student template data uses item codes (e.g., item #1 M-4L942L-D) and is listed with column headers of Item number, period, and demand quantity. This matrix format is to aid the teaching brief only.

(4) Instructor complete "quick calculation" technique for their forecast and show on graph.

(5) Generate P13-P18 random "actual" demand and reveal it on the graph.

(6) Discuss rankings (for that item and cumulative) and announce how many minutes the groups have until their next forecast is due.

Details of steps 2, 4, and 5 for each item are provided in Tables 2a, 2b, 2c, and 2d. The instructor "quick calculation" is designed to show students some techniques they will be learning in the subsequent lecture content. Do not explain the details of the calculation while conducting it in class, but rather provide a brief verbal explanation of the concept(s) as this builds interest in the eventual lecture details. Graphs of the four demand patterns are provided in Figure 1. Having all groups' and the instructor's forecast graphed provides a highly visual

Table 2a: Details for Item #1 (level demand pattern)

INSTRUCTOR QUICK CALCULATION:

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
Historical Demand	751	741	728	773	718	752	736	768	729	777	748	756
Average	748 ← *=AVERAGE(P1:P12)*											

	P13	P14	P15	P16	P17	P18
Quick Calculation Result	**748**	**748**	**748**	**748**	**748**	**748**

=average

RANDOMLY GENERATED CALCULATION:

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
Historical Demand	751	741	728	773	718	752	736	768	729	777	748	756
Average	748											
Standard Deviation	19											

	P13	P14	P15	P16	P17	P18
Resulting Random Demand	747	743	763	764	746	755 ← *=RANDBETWEEN(Avg-Std_Dev,Avg+Std_Dev)*

Table 2b: Details for Item #2 (upward trend demand pattern)

INSTRUCTOR QUICK CALCULATION:

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
Historical Demand	250	268	289	314	337	367	391	409	433	459	481	500
Linest Function Result	23 ← *=LINEST(P1:P12)*											

	P13	P14	P15	P16	P17	P18
Quick Calculation Result	**523**	**547**	**570**	**594**	**617**	**640**

=Prev. Per. Demand + Linest Result

RANDOMLY GENERATED CALCULATION:

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
Historical Demand	250	268	289	314	337	367	391	409	433	459	481	500
Period Difference		18	21	25	23	30	24	18	24	26	22	19
Min Period Difference	18											
Max Period Difference	30											

	P13	P14	P15	P16	P17	P18
Random Increase / Decrease	28	25	23	29	28	29 ← *=RANDBETWEEN(Min Period Diff, Max Period Diff)*
Resulting Random Demand	528	553	576	605	633	662

Table 2c: Details for Item #3 (cyclical demand pattern)

INSTRUCTOR QUICK CALCULATION:

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
Historical Demand	666	618	483	375	303	242	210	239	342	396	457	587
Average Demand = 410												
Cyclical Index	1.63	1.51	1.18	0.92	0.74	0.59	0.51	0.58	0.83	0.97	1.12	1.43

= Period Historical Demand / Average Demand

	P13	P14	P15	P16	P17	P18
Quick Calculation Result	**666**	**618**	**483**	**375**	**303**	**242**

*= Average Demand * Cyclical Index*

RANDOMLY GENERATED CALCULATION:

	P13	P14	P15	P16	P17	P18
Cyclical Index Basis	*P1*	*P2*	*P3*	*P4*	*P5*	*P6*
Cyclical Index	1.63	1.51	1.18	0.92	0.74	0.59
Max Index (+ .05)	1.68	1.56	1.23	0.97	0.79	0.64
Min Index (- .05)	1.58	1.46	1.13	0.87	0.69	0.54
Random Cyclical Index	1.63	1.53	1.21	0.92	0.70	0.61
Resulting Random Demand	668	627	496	377	287	250

*=RANDBETWEEN(Min_Index*100,Max_Index*100)/100*

=Average Demand * Random Cyclical Index

Table 2d: Details for Item #4 (cyclical + trend demand pattern)

INSTRUCTOR QUICK CALCULATION:

	"Q1"	"Q2"	"Q3"	"Q4"	Total	% Growth
"Year 1"	287	352	416	313	1368	
"Year 2"	359	440	520	391	1710	*25.0%*
"Year 3"	449	550	650	489	2138	*25.0%*
Average	**365**	**447**	**529**	**398**		
Grand Average	**435**					
Cyclical Index	**0.84**	**1.03**	**1.22**	**0.91**		

"Year 4" projected Total	**2673**	*=Year 3 Total * 1.25*
"Year 5" projected Total	**3341**	*=Year 4 Projected Total * 1.25*

	P13	P14	P15	P16	P17	P18
1/4 of Year 4/5 Projected Total	668	668	668	668	835	835
Cyclical Index (from above)	0.84	1.03	1.22	0.91	0.84	1.03
Quick Calculation Result	**561**	**688**	**813**	**611**	**701**	**859**

RANDOMLY GENERATED CALCULATION:

	"Q1"	"Q2"	"Q3"	"Q4"	Total	% Growth
"Year 1"	287	352	416	313	1368	
"Year 2"	359	440	520	391	1710	25.0%
"Year 3"	449	550	650	489	2138	25.0%
Average	**365**	**447**	**529**	**398**		*26.0%* → Random Year 4 Total of: *2694*
Grand Average	**435**					*26.0%* → Random Year 5 Total of: *3394*
Cyclical Index	**0.84**	**1.03**	**1.22**	**0.91**		
Max Index (+ .05)	0.89	1.08	1.27	0.96		*=RANDBETWEEN(Growth%-0.02,Growth%+0.02)*
Min Index (- .05)	0.79	0.98	1.17	0.86		

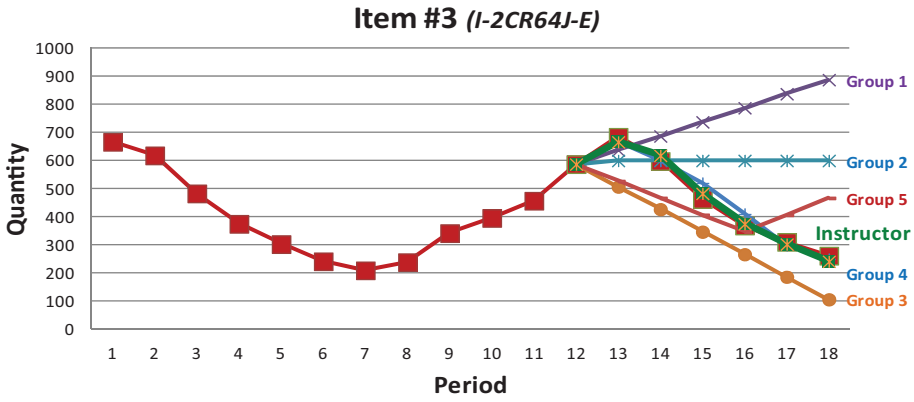
	P13	P14	P15	P16	P17	P18
1/4 of Year 4/5 Random Total	673	673	673	673	849	849
Random Cyclical Index	*0.80*	*1.00*	*1.24*	*0.96*	*0.87*	*0.98*
Resulting Random Demand	539	673	835	647	738	832

*=RANDBETWEEN(Min_Index*100,Max_Index*100)/100*

=Quarterly Value * Random Cyclical Index

Note: Since the data shows a repeating pattern of "three up, one down," the P1-P12 historical data can be viewed as a 4 period cycle (quarterly demand over the previous 3 years).

Figure 3: Visual display of forecasts and actual demand. Revealing student group forecasts graphically prior to revealing the actual demand is recommended.



exercise while also building suspense for the randomly generated actual demand, as shown in Figure 3. The yes/no control to show each group's forecast on the graph is based on basic "if" statements. In addition, using conditional formatting color scales on the resulting forecast error (per item and cumulative) provides immediate feedback to each group on their relative forecasting performance. Acknowledging the top three performing groups after each item's actual demand is generated, is recommended as it seems to further increase the competitiveness of the groups.

THE DEBRIEF

Upon awarding the food prize to the winning team, we debrief the exercise by starting with a general discussion that it is not always reasonable to assume that the past is a good indication of the future (e.g., new product introductions with little or no history). While displaying the cumulative results, we emphasize that although forecasting is always wrong, how wrong (error) needs to be measured to help determine which forecasting method should be used. While displaying results of the third item (cyclical) or fourth item (cyclical trend), we discuss how short range forecasts are more accurate than long range forecasts (P13 performance vs. P18), and extending from this, that long replenishment lead times are challenging for organizations as they are subsequently required to conduct often inaccurate long term forecasting. Finally, we emphasize that using the forecasting techniques does not guarantee a first place finish, but they perform well consistently. In fact, we have found that in conducting the game 50+ times (using 10+ groups each time) the instructor has only finished out of the top three on one occasion.

CLASSROOM RESULTS

Student Survey

The game has been successfully incorporated into a required undergraduate management science course for 4 years. A recent survey of students who just completed

Table 3: Student survey responses (Likert scale statements)

Statement	−3	−2	−1	0	+1	+2	+3	Total	Mean	%–	%0	%+
The game was a good learning experience	4	7	9	20	66	91	50	247	+1.47	8%	8%	84%
The game has made me more interested in learning the various forecasting techniques	3	4	2	45	52	91	50	247	+1.48	4%	18%	78%

the exercise ($n = 247$, from six sections of the same instructor) found very positive results. First, a whopping 94% recommended the continued usage of the game based on a yes/no question. Second, we used a seven point Likert scale (–3 strongly disagree to +3 strongly agree) for measuring student perception of the learning experience and if their interest in learning forecasting techniques had increased as a result of playing the game (details are provided in Table 3). The statement "the game was a good learning experience" resulted in a mean score of +1.47 with 84% of students self-reporting a positive learning value from the game. More importantly, the statement "the game has made me more interested in learning the various forecasting techniques" resulted in a mean of +1.48, with 78% of the students indicating that the game made them more interested in learning forecasting techniques. This reveals that the 30-minute investment of introducing the forecasting topic via this game pays significant dividends in the form of increased student interest in learning the related forecasting lecture content. Student written comments captured in the survey also revealed that the game engaged students and that their poor performance created interest in learning the forecasting techniques:

> "*A* 9/10. *Would have been a 10/10 if we got rank 1 – but we got rank 2 (behind the instructor).*"
>
> "*It's entertaining. I wouldn't change anything."*
>
> "*I love competition and it brought me closer to my classmates*."
>
> *"It was a great way to get involved."*
>
> *"It was frustrating having no idea where to start and watching our forecasting be so far off."*

As described in the "Literature review section," increased student interest in a topic has been repeatedly shown to increase student learning of that topic (Schiefele, 1991). Given this positive correlation between interest and learning, we can conclude that this game not only creates an engaging hands-on experiential learning experience for students, but also contributes to their increased learning of forecasting. Considering that these significantly positive results were achieved in a required undergraduate management science course that students cannot self-select

into based on personal interest, and that the topic of forecasting is one of the more challenging management science topics to teach (Albritton & McMullen, 2006; Craighead, 2004), the teaching effectiveness of the game is further strengthened.

Classroom Observations

Our course schedule has forecasting covered late in the term, which historically contributed to student apathy toward the topic as they were tired of lectures while also distracted by various final assignments. Since implementing this game, forecasting has now become one of our most interactive and engaging topics in the course. We have even overheard students talking excitedly about the game in other courses, encouraging fellow students not to miss the forecasting class due to working on their final assignments. Observations during the game have revealed students highly engaged with strategizing ("do you think demand will go back down or continue up?"), and analyzing (calculating, graphing, etc.). Perhaps most impressive is that on multiple occasions we have actually found not a single student using social media/Internet during the exercise! Although business students are naturally competitive amongst themselves, it appears that the additional challenge of outperforming the instructor has increased student intensity even more. Similar to the first student's comment above, we have regularly had students comment that although they performed better than their classmates in the game, they really wanted to "beat the instructor."

SUMMARY AND DISCUSSION

This highly visual 30-minute hands-on experiential learning game has proven to be a fun and engaging way to start the forecasting topic in an undergraduate management science/operations management course. Instructor preparation is limited to reviewing the spreadsheet files, posting the student template file, and potentially bringing a small prize for the winning team. Similar to the results of others who have used experiential learning techniques for business education, we have found this semistructured exercise builds strong student interest in learning the subsequent forecasting techniques as students seek to understand how the instructor performed so well. We concur with Mehrotra (2007) in that we found our students rose to the challenge of the game despite related concepts not yet being covered in class, with some even periodically outperforming the instructor. This spreadsheet based semistructured experiential learning game aids the teaching of the complex topic of forecasting, by providing a rare prelecture exercise. Furthermore, the game has proven to significantly increase student interest in learning the subsequent forecasting lecture content, contributing to increased student learning.

REFERENCES

Albritton, M. D., & McMullen, P. R. (2006). Classroom integration of statistics and management science via forecasting. *Decision Sciences Journal of Innovative Education*, *4*(2), 331–336.

Cotner, J., Jones, R., & Kashlak, R. (2004). Effectively integrating an international field study into the EMBA curriculum. *Journal of Teaching in International Business*, *15*(1), 5–20.

Craighead, C. (2004). Right on target for time-series forecasting. *Decision Sciences Journal of Innovative Education*, *2*(2), 207–212.

Daly, S. P. (2001) Student-operated Internet businesses: True experiential learning in entrepreneurship and retail management. *Journal of Marketing Education*, *23*(3), 204–215.

Gardner, L. (2008). Using a spreadsheet for active learning projects in operations management. *INFORMS Transactions on Education*, *8*(2), 75–88.

Gavirneni, S. (2008). Teaching the subjective aspect of forecasting through the use of basketball scores. *Decision Sciences Journal of Innovative Education*, *6*(1), 187–195.

Hamer, L. O. (2000). The additive effects of semistructured classroom activities on student learning: An application of classroom-based experiential learning techniques. *Journal of Marketing Education*, *22*(1), 25–34.

Mehrotra, V. (2007). Living (and learning) in the digital world. *OR-MS Today*, *34*(6), 14.

Paul, P., & Mukhopadhyay, K. (2004). Experiential learning in international business education, *Journal of Teaching in International Business*, *16*(2), 7–25.

Robb, D. J., Johnson, M. E., & Silver, E. A. (2010). An in-class competition introducing inventory management concepts. *INFORMS Transactions on Education*, *10*(3), 122–125.

Schiefele, U. (1991). Interest, learning, and motivation. *Educational Psychologist*, *26*(3–4), 299–323.

Snider, B., Balakrishnan, J., & da Silveira, G. (2010). Lessons learned from running "The Beer Distribution Game" for large classes. *Proceedings of Decision Sciences Institute (DSI) Forty-First Annual Meeting*, San Diego, CA, 3251–3258.

Williams, J. & Chinn, S. J. (2009). Using Web 2.0 to support the active learning experience. *Journal of Information Systems Education*, *20*(2), 165–174.

Brent R. Snider obtained his (Honors) Bachelor of Business Administration degree from Wilfrid Laurier University, a Certified Management Accountant (CMA) designation from The Society of Management Accountants of Ontario, and an MBA Thesis degree from the University of Calgary. He has been awarded four teaching excellence awards at the Haskayne School of Business, and has published teaching exercises in the Decision Sciences Journal of Innovative Education, and in INFORMS Transactions on Education. Brent's paper "ERP implementation at SMEs: analysis of five Canadian cases", won the Outstanding Paper Award from the International Journal of Operations & Production Management (IJOPM) for 2010.

Janice B. Eliasson earned bachelor's degrees in Commerce from the University of Alberta and in Industrial Engineering from the University of Toronto. She earned a master's degree in Systems Design Engineering from the University of Waterloo, and is a registered Professional Engineer in the province of Alberta. She has been awarded the Haskayne School of Business Commerce Undergraduate Society Award for Teaching and Learning. Janice's work has been published in the Journal of Operations Management, the Decision Sciences Journal of Innovative Education, and the Journal of Information and Operations Management Education.