How mode of delivery affects comprehension of an operations management simulation

Online vs face-to-face classrooms

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Received 12 September 2016
Revised 2 November 2016
Accepted 9 December 2016

Abstract

Purpose – This study aims to understand how mode of delivery, online versus face-to-face, affects comprehension when teaching operations management concepts via a simulation. Conceptually, the aim is to identify factors that influence the students' ability to learn and retain new concepts.

Design/methodology/approach – Leveraging Littlefield Technologies' simulation, the study investigates how team interaction, team leadership, instructor's guidance, simulation's ease of use and previous software experience affects comprehension for both online and face-to-face teaching environments. Survey data were gathered from 514 undergraduate students. The data were then analyzed using structural equation modeling.

Findings – For the face-to-face population, this study found that team interaction, previous software experience, instructor's guidance and simulation's ease of use affected student comprehension. This differed from the online population who were only affected by the simulation's ease of use and instructor's guidance.

Originality/value – Understanding how the mode of delivery affects comprehension is important as educators develop new online teaching techniques and experiment with innovative technologies like simulation. As demand for online education grows, many instructors find they need to refine their methods to ensure students comprehend the concepts being taught regardless of modality.

Keywords Survey, Structural equation modelling, Simulation, Online teaching

Paper type Research paper

Introduction

In recent years, demand for online education has risen dramatically. Colleges and universities, in response, have greatly expanded their online offerings. Leveraging a variety of information and communication technologies (Guri-Rosenblit, 2005), administrators believe they can reduce expenditures by replacing existing face-to-face (F2F) classes with online courses (O'Neill and Sai, 2014). Specifically, they assert that universities can provide "an education of equal (or better) quality with fewer professors and thus bring the same type of cost savings to higher education that industry has long enjoyed through substituting machines for human labor" (Bok, 2015, p. 115).

While students have embraced the online platform, many administrators and faculty (and legislators for state funded institutions) have questioned the comparability of online and F2F classes. There is considerable dialogue about how instructors can develop and insure the quality of online classes (Stella and Gnanam, 2004). Questions about quality have

Journal of International Education in Business
Vol. 10 No. 2, 2017
pp. 183-200

2046-469X
DOI 10.1108/JIEB-09-2016-0025

been difficult to answer since there is no agreed upon learning outcome metrics (Allen and Seaman, 2015). Identifying measurement standard remains difficult as universities and colleges embrace new technological tools and teaching approaches. Today, instructors regularly use discussion boards, blogs, electronic books, videos and simulations when teaching in the online environment. In this work, we seek to understand how mode of delivery affects students' comprehension when teaching introductory operation management concept via simulation. We leverage Littlefield Technologies' simulation tool and investigate how team interaction, team leadership, instructor's guidance, simulation's ease of use and previous software experience affects comprehension for both online and F2F samples. This Web-based simulation challenges students to use forecasting, purchasing and capacity management concepts as they direct a make-to-order factory (Snider and Balakrishnan, 2013).

To spur students' interest, research suggests using games or simulations when teaching a topic (Singh *et al.*, 2010; Pasin and Giroux, 2011; Snider and Balakrishnan, 2013). Leveraging the Littlefield simulation, we seek to determine if the simulation can be used to reinforce forecasting, purchasing and capacity management concepts taught during an introductory operations management class. Students were assigned to teams (usually four students per team) and each team managed the simulated factory for two separate scenarios. The first scenario, "Capacity Management", lasts for seven days while simulating 268 days of orders and production activities. Students learn how to navigate the web-based tool by making decisions about capacity management. The second module, "Customer Responsiveness", again leverages capacity-management concepts, but also challenges students to manage the lead-time promised on customer orders, order quantity/reorder point associated with raw material purchases and workstation scheduling rules. The simulation enables instructors to engage the student's interest and reinforce key operations management concepts taught. By leveraging Littlefield as a pedagogical tool, students can experience what it would be like to manage a business in the safety of a simulation.

Using logic espoused by experiential learning theory, we posit that several team, instructor, student and simulation tool based factors affect students' comprehension level. Thus, we attend to five research questions:

RQ1. Does team interaction affect student comprehension differently, when considering mode of delivery (face-to-face or online)?

RQ2. Does team leadership affect student comprehension differently, when considering mode of delivery (face-to-face or online)?

RQ3. Does instructor's guidance affect student comprehension differently, when considering mode of delivery (face-to-face or online)?

RQ4. Does previous software experience affect student comprehension differently, when considering mode of delivery (face-to-face or online)?

RQ5. Does simulation's ease of use affect student comprehension differently, when considering mode of delivery (face-to-face or online)?

In the next section, we review the relevant literature including experiential learning theory. We then develop our hypotheses and explain the methodology used to collect data. Using structural equation modeling, we discuss fit and our findings in the analysis and results section. Finally, we conclude with a discussion of our results and future avenues of research.

Relevant literature

Experiential learning theory explains how humans learn new behaviors via experience. When using this theoretical frame, "learning is the process whereby knowledge is created through the transformation of experience" (Kolb, 1984, p. 38). The theory characterizes four learning stages, concrete experience, reflective observation, abstract conceptualization and active experimentation and explains how people move through the stages in a cycle as they form and re-form ideas (Kolb, 1984). When using experiential leaning techniques, the theory suggest that students can learn old concepts in new ways, learn new concepts from new material or apply lessons learned from an experience (Cuneen, 2004). O'Malley and Ryan (2006) put forth that simulations are experiential learning tools, as they allow students to experience an activity or event. Students can then reflect on the experience and transforms it into new knowledge.

In our investigation, we use a Web-based simulation as an experiential teaching tool, as it has been shown to enhance engagement and entice students to be active in the learning process (Singh *et al.*, 2010). Previous work has suggested that simulations are an appropriate way to teach the business curriculum, as it provides students a risk-free environment for engagement and experimentation (McCarthy and McCarthy 2006; Brandon-Jones *et al.*, 2012). This occurs as the simulation has created a setting that synthesizes reality (Bell *et al.*, 2008), yet provides a safe environment in which students can operate.

There is a long history of instructors using simulation games to improve students' understanding of operations management. The "Beer Distribution Game" for instance, allows students to experience, manage and mitigate the so-called bullwhip effect (Sterman, 1989). Similarly, Ammar and Wright (1999) designed a game called "ABC's Manufacturing" to teach production planning concepts. More recently, Wright (2015) introduced "Zu Zitter" a game that teaches both quantitative and qualitative operations management concepts.

When considering the Littlefield Technologies simulation as an experiential learning tool, previous research indicates conflicting results. For example, Miyaoka (2005) and then again Snider and Balakrishnan (2013) found that the students perceived an improved understanding of the operations management concepts taught. Additionally, both studies also found similar results when students were asked if the Littlefield simulation increased their curiosity of the various concepts taught. Conversely, Steenhuis *et al.* (2011) found that even when students were exposed to capacity management before the simulation game that many struggled to apply the concept in a simulated environment. This led to the authors concluding that team performance in a simulation game was not a good measure of student learning. Rather than using performance as the dependent variable, our study asks students about their comprehension. In this work, comprehension alludes to the students' ability to understand information and concepts presented and then apply meaning to the concepts (Tangworakitthaworn, 2014). As the simulation is used to reinforce class concepts, we believe comprehension is a more appropriate outcome measure. We further differentiate our research from past work by splitting the sample between online and F2F students. This allows us to better understand how comprehension is affected by mode of delivery, which has been a recent topic of interest.

Following Moore *et al.* (2011), we use the terms online, e-learning and Web-based interchangeably and suggest that online learning is mediated through some sort of technology (e.g. computer or mobile device), which is connected to the internet, and utilizes a learning platform (e.g. Blackboard, Facebook and Khan Academy). In addition, the online environment enables a "flexible learning network (e.g. discussion groups, mobile learning, virtual environments, instant communication and social networks) that often carry the main signal of a course" (Dziuban *et al.*, 2013, p. 2). When teaching an online class, the instructor serves more as a facilitator and helps coordinate communication and actions throughout the learning process.

To extend the existing literature stream, we propose a conceptual model that links several team, instructor, student and simulation based factors to student's comprehension level. We frame the study using experiential learning theory, offer several propositions and test the relationships using structural equation modeling. We draw conclusions with a discussion of our findings and then offer both practical and theoretical implications.

Proposed model

This study investigates how team interaction, team leadership, instructor's guidance, simulation's ease of use and previous software experience affects comprehension. The various relationships and hypotheses are illustrated in Figure 1.

Team interaction

Using teams to promote learning has become a prevalent educational theme in recent years (Michaelsen *et al.*, 2002). Business school curriculums are designed to provide team-based learning experience. To achieve this intended learning outcome, instructors have students work in teams on their assignments and/or presentations. The goal is for students to develop a teamwork skillset that emphasizes communication, accountability, coordination and flexibility. While teamwork is important to business professionals, research suggests that understanding how groups interact needs to be further studied (Huang and Wei, 2000). Thus, one of our goals was to investigate the impact of team interaction on student's comprehension level.

Using small teams, we suppose students will interact as they develop and implement strategies within the simulation. In this context, team interaction refers to the interface between team members as they coordinate and perform activities. When interaction

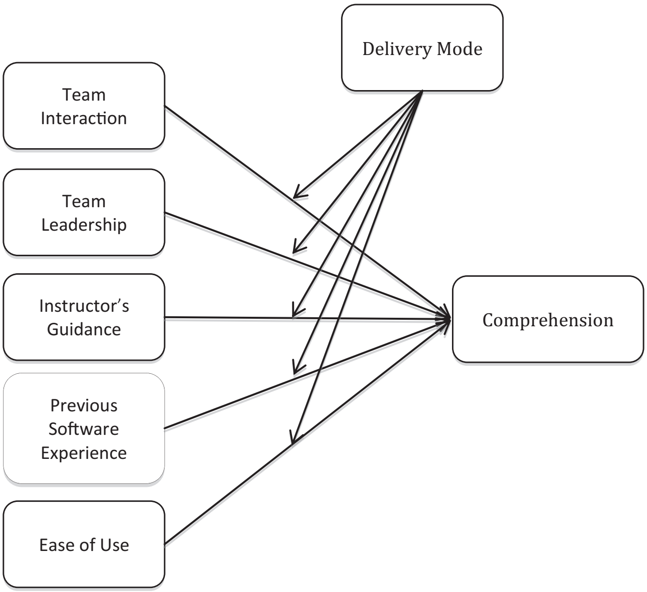

Figure 1.
Proposed model

properly occurs, participants should commit to the team's strategy and resulting goals, critically think and converse about the different experiences, and take action once a decision is made (Saenz and Cano, 2009). Thus, we expect that when participants interact that the team will have a better overall experience. However, we acknowledge that teamwork has its pitfalls as some members may diffuse responsibility or engage in social loafing.

From an experiential learning perspective, we expect that if a group of students works well together, they should better understand the simulation and make more informed decisions about their overall strategy and the resulting tactics. Simulated games, like Littlefield, offer a context within which cooperation is required. When cooperation occurs, the experiential environment promotes team interaction (O'Connor and Menaker, 2008). Increased interaction among members allows participants to hear differing views, which broadens their understanding beyond their own view. Team members with different experiences, backgrounds and skills, may provide insights and analysis that the team can leverage to increase comprehension. Hence, we posit that when team interaction increases, the individuals on the team will be able to communicate, resolve conflicts (Vliert *et al.*, 1999) and better comprehend the topics being taught. Thus:

H1a. Team interaction is positively related to student comprehension in the face-to-face teaching environment.

While the impact of delivery mode on student performance has been examined, many efforts have found no statistical differences in student performance (Dell *et al.*, 2010; Wagner *et al.*, 2011). Garrison and Kanuka (2004) noted that while students in online courses were not together in space and time, they were still able to succeed in an asynchronous learning environment. Conversely, other studies have found signficant differences in student performance when considering mode of delivery. Specifically, both Burns *et al.* (2013) and Xu and Jaggars (2014) found that online students underperformed relative to students in traditional F2F classroom settings.

As the online students do not share the classroom experience, they would need to utilize communication tools such as email, discussion boards and text messages to develop and execute their strategy. However, when considering team interaction styles, we expect that online students might not see the perceived value. Cooke and Szumal (1994) proposed three team interaction styles: constructive, passive and aggressive. As the participants have chosen the online platform, we believe that many would have a passive interaction style. Here, we assert that because of the online environment that many of the students are purposely looking for a class that deemphasizes team interaction and group work. Potter and Balthazard (2002) have argued that when online student are passive, that they will limit information sharing, avoid asking questions and remain impartial. Leveraging these arguments, we hypothesize:

H1b. The impact of team interaction on student comprehension is weaker in the online teaching environment than the face-to-face teaching environment.

Team leadership

Team leadership is another team-based factor investigated. While not required to assign a leader, we expected that some teams might appoint a team leader, formally or informally. In a recent study, Bartel-Radic *et al.* (2015) found that a majority of teams functioned with a team leader that had been deliberately or implicitly chosen. Team leadership alludes to an individual's ability to coordinate other team members, organize meetings and direct activities (Salas *et al.*, 2008). We suppose that teams with a leader may have higher comprehension levels as the leader enables other participants to learn and understand the concepts being taught. We expect that some individuals may want to take the leadership reins because they are comfortable with the OM concepts being taught, have previous work experience or because they read the textbook and found the content interesting. In this capacity, we expect the team leader may act as a subject matter expert. In addition, a participant may prefer to lead the team's efforts because they do not trust or have confidence with the other members. These types of leaders have been called lone wolves, and even though they have to work on teams, they prefer to work by themselves (Shankar and Seow, 2010). Finally, we also envision that some members would take a leadership role to protect their academic standing. This could include students trying to maintain high grades or others worried about going below some minimum standard.

We posit that when the level of team leadership increases, that the ownership, motivation and accountability within the team should also increase (Daly, 2009). This occurs as team members become more motivated to accomplish tasks and more willing to put in effort to ensure the team is making good decisions. We also assert that internal accountability within the team could increase because of increased team leadership. Specifically, members hold themselves and others accountable to come up with the best solutions possible. In this sense, increased accountability drives students to do more extensive research to understand the concepts in the simulation. Leveraging the experiential learning framework, a team leader should encourage students to engage in observation, conceptualization and experimentation when using the simulation tool (Kolb, 1984). Thus, we expect that when a team has a leader, the team will make a concerted effort to compete in the simulation and in retrospect will learn more about the concepts taught. Leveraging this logic:

H2a. Team leadership is positively related to student comprehension in the face-to-face teaching environment.

When further considering team leadership, we suppose it becomes less important for online students. While we suspect that some team members might want to step up and take the leadership reigns, previous research suggests that a virtual team leader is the individual who keeps team deadlines and serves as a gatekeeper (Johnson *et al.*, 2002), not a strategic leader who makes decisions for the good of the team. Hence, we suspect the leader role is less needed within online teams because the class instructor communicates deadlines and serves as gatekeeper. Further, as we studied undergraduate students, we envision that most students would not have the motivation to take on a leadership role. From this foundation, we hypothesize the following:

H2b. The impact of team leadership on student comprehension is weaker in the online teaching environment than the face-to-face teaching environment.

Instructor's guidance

Beyond team leadership, we expect the class instructor provides guidance and influences how well students learn the concepts embedded within the simulation. Specifically, we investigate how instructors affect student's comprehension by motivating and guiding them to quickly engage with the simulation, apply the necessary concepts and perform well. Instructor guidance enables students to understand the overall purpose, the process and how to efficiently navigate through the simulation. Here, guidance gives students clarity and direction, which eliminates fears and confusion about the simulation. In addition to providing clear direction, instructor guidance can set the stage for the students to engage in the simulation with enthusiasm and excitement. We assert that an instructor can motivate students to move through the different experiential learning stages and improve their comprehension of the concepts being taught. Leveraging this perspective, we hypothesize:

H3a. Instructor's guidance is positively related to student comprehension in the face-to-face teaching environment.

We suspect that as compared to students in an online teaching environment, those in an F2F environment would value an instructor's guidance more. We posit that undergraduate students look to the instructor to frame the overall strategy and answer question on how to execute the actual simulation. Canning and Callan (2010) and Blaschke (2012) both suggest that less mature learners require more guidance. Further, due to the distributed nature of the online class, we assert that instructors provide motivation on how to best navigate the simulation. Instructors can discuss risks associated with the different actions. Without guidance from an instructor, we expect students to experience frustration, which we attribute to the absence of direction (Hove and Corcoran, 2008). From an experiential learning perspective, the professor should facilitate the learning process, rather than explicitly lead participants through the simulation. Leveraging this perspective:

H3b. The impact of instructor's guidance on student comprehension is greater in the online teaching environment than the face-to-face teaching environment.

Next, we investigate two factors associated with using the simulation tool. First, we seek to understand how previous software experience affects the student's comprehension level. Then, we look at ease of use to determine whether the simulation's user interface makes it easy or difficult to comprehend the operations concepts taught via the simulation.

Previous software experience

In today's digital age, many students have accumulated a mass of experience using different information technologies (IT) and software before they enter college. In fact, we expect some undergraduate students to be digitally literate and very familiar with simulations, as they might have had experience with playing online games. Being digitally literate refers to an individual's experience and skills with a variety of IT platforms. Such students would likely research topics on the internet, rather than at a library, and intuitively understand how to engage with new technologies (Bullen *et al.*, 2011). Basing our argument on the above logic, we hypothesize:

H4a. Previous software experience is positively related to the student comprehension in the face-to-face teaching environment.

Upon review of the extant literature, we find the impact of previous software experience seems to vary, depending on the research focus. Liu and Palomera-Arias (2015) found that additional software experience helped students reduce the time to complete an activity, but it did not help them obtain a higher grade. Similarly, Czaja and Sharit (2012) showed that previous software experience helps predict performance, but it depended on the age of the participant. In the Czaja and Sharit (2012) study, older adults, as compared to young adults, performed better when they had more knowledge of the software.

In our study, we posit that when students have more experience with software programs, that they will be more comfortable using the Littlefield simulation tool. This occurs as previous software experience facilitates understanding of the simulation tool and expedites the learning process. Thus, we expect students with previous software experience will progress through the experiential learning cycle at a faster rate, than students who have limited experience with technology. As we generally believe that online students will have greater familiarity with the technologies used in online classes, we put forth the following hypothesis:

H4b. The impact of previous software experience on student comprehension is greater in the online teaching environment than the face-to-face teaching environment.

Ease of use

Finally, we investigate if the simulation's perceived ease of use affects comprehension. Perceived ease of use is defined as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1993, p. 320). The actual phrase, ease of use, is said to describe how usable a technology is and reflects the degree to which a product or application is accepted (Motta *et al.*, 2013). As many of today's students are familiar with different information and communication technologies (Guri-Rosenblit, 2005), we believe they would be receptive to working with an easy to use simulation tool. If students perceived the simulation as easy to use, they would be able to quickly learn the different application controls and have a better overall experience. In this sense, students would spend less effort on learning how to use the simulation and more time exploring the tool, analyzing available information, and considering options as part of their decision-making processes. From an experiential learning perspective, ease of use of the simulation should propel students through the learning cycle. Based on these arguments, we hypothesize:

H5a. The simulation's ease of use is positively related to student comprehension in the face-to-face teaching environment.

For students participating in the online class, we posit that ease of use will be an important factor that directly affects comprehension. Hence, the strength of the linkage between ease of use and comprehension will be greater. We relate ease of use to the concept of self-efficacy. Thus, we believe that individuals with high self-efficacy will perceive a piece of technology or software as easy to use. Existing work highlights how student with high self-efficacy levels are more satisfied with online classes (Kuo *et al.*, 2013). This occurs as students believe in and have confidence in their capabilities "to organize and execute a course of action" (Bandura, 1997, p. 3). Leveraging this foundation, we hypothesize the following:

H5b. The impact of simulation's perceived ease of use on student comprehension is greater in the online teaching environment than the face-to-face teaching environment.

Methodology

Four operations management faculty members at a medium size regional university in the southwest USA conducted the study. The participants were college of business students taking an undergraduate operations management class. The data were collected over a one-year period (spring 2015, summer 2015 and fall 2015) from both F2F and online classes.

To examine how delivery mode affected the various relationships, we adapted existing survey instruments to measure the different relationships and then analyzed the data collected using structural equation modeling. To develop the survey instrument, we initially reviewed existing literature to identify available definitions and measures. The overall response rate was 84.3 per cent. We then used Q-sort procedures to refine questions and establish face validity, inter-rater reliability and construct validity. Using best practices established by Tabachnick and Fidell (2007), we test for outliers, skewness and kurtosis and report the descriptive statistics in Table I.

After the second portion of the simulation was complete, each student was asked to complete a survey about the factors influencing comprehension level (see Appendix for the text of the questionnaire). Students were informed that completing or not completing the survey would have no effect on either the team or the individual grades.

Out of a possible 15,934 response variables, only 98 data points were missing. As this accounted for less than one per cent and they appear to be scattered throughout the data set, we believe the data is missing completely at random (MCAR). Rather than exclude cases with missing variables, we follow the advice of Tabachnick and Fidell (2007) and use expectation maximization imputation to replace the missing data. To ensure normality, we transformed Instructor's Guidance 1 and Instructor's Guidance 2 by squaring the response values. After reviewing potential outliers, we used all 514 observations in our analysis.

In Table II, we present several reliability and validity measures, which are associated with the measurement instrument and the actual survey questions. Using 0.70 as a cutoff for Cronbach's alpha (Cronbach, 1951), we find the values associated with the different measures range from 0.728 to 0.965. This suggests the measures are reliable since they exhibit good psychometric properties. We then used confirmatory factor analysis (CFA) to assess each scale's unidimensionality and construct reliability. To determine the reliability of the measures, we evaluated the composite reliability scores associated with each

Name	Cases	Mean	SD	Median	Minimum	Maximum	Range	Skewness	Kurtosis
TeamInter1	514	5.30	1.76	6.00	1.00	7.00	6.00	−1.06	0.09
TeamInter2	514	5.21	1.81	6.00	1.00	7.00	6.00	−0.95	−0.19
TeamInter3	514	5.30	1.75	6.00	1.00	7.00	6.00	−0.97	−0.08
TeamLead1	514	5.14	1.66	5.00	1.00	7.00	6.00	−0.87	0.10
TeamLead2	514	5.20	1.59	5.00	1.00	7.00	6.00	−0.84	0.11
TeamLead3	514	4.93	1.61	5.00	1.00	7.00	6.00	−0.57	−0.28
InstGuide1-SQ	514	40.45	12.02	49.00	1.00	49.00	49.00	−1.51	1.77
InstGuide2-SQ	514	40.04	11.80	49.00	1.00	49.00	49.00	−1.29	1.08
InstGuide3	514	5.96	1.34	6.00	1.00	7.00	6.00	−1.59	2.32
InstGuide4	514	5.94	1.28	6.00	1.00	7.00	6.00	−1.50	2.25
EaseOfUse1	514	4.88	1.64	5.00	1.00	7.00	6.00	−0.70	−0.32
EaseOfUse2	514	5.05	1.56	5.00	1.00	7.00	6.00	−0.73	−0.20
EaseOfUse3	514	4.88	1.58	5.00	1.00	7.00	6.00	−0.55	−0.51
PreSoftExp1	514	5.06	1.62	5.00	1.00	7.00	6.00	−0.87	0.16
PreSoftExp2	514	3.58	1.79	4.00	1.00	7.00	6.00	0.21	−0.91
PreSoftExp3	514	4.78	1.77	5.00	1.00	7.00	6.00	−0.63	−0.53
Comp1	514	5.37	1.56	6.00	1.00	7.00	6.00	−1.15	0.76
Comp2	514	5.36	1.51	6.00	1.00	7.00	6.00	−1.18	0.93
Comp3	514	5.44	1.52	6.00	1.00	7.00	6.00	−1.21	0.98
Comp4	514	5.44	1.56	6.00	1.00	7.00	6.00	−1.23	0.89
Comp5	514	5.45	1.54	6.00	1.00	7.00	6.00	−1.26	0.95
RANK	514	1.88	0.81	2.00	1.00	3.00	3.00	0.14	−−1.28
CLASS	514	3.92	0.46	4.00	1.00	5.00	5.00	−5.21	40.71
GENDER	514	1.48	0.57	2.00	1.00	2.00	2.00	−0.55	−0.68
FIRST	514	1.53	0.53	2.00	1.00	2.00	2.00	−0.40	−1.22
NUM	514	2.59	0.85	2.00	1.00	4.00	4.00	0.11	−0.44
COLLEGE	514	1.00	0.28	1.00	1.00	7.00	7.00	18.96	413.73
MAJOR	514	6.49	3.83	6.00	1.00	13.00	13.00	−0.09	−1.15
ONLINE	514	1.68	0.47	2.00	1.00	2.00	1.00	−0.75	−1.44

Table I.
Descriptive statistics

Table II. Reliability and validity of the model constructs

Items	Standardized factor loadings	Cronbach's alpha	Composite reliability	Average variance extracted
Team interaction				
TeamInter1	0.802	0.926	0.929	0.829
TeamInter2	0.966			
TeamInter3	0.930			
Previous software experience				
PreSoftExp1	0.871	0.867	0.874	0.735
PreSoftExp2	0.706			
PreSoftExp3	0.919			
Ease of use				
EaseOfUse1	0.905	0.911	0.913	0.799
EaseOfUse2	0.937			
EaseOfUse3	0.799			
Team leadership				
TeamLead1	0.878	0.909	0.910	0.794
TeamLead2	0.920			
TeamLead3	0.835			
Instructor's guidance				
InstGuide1-SQ	0.903	0.728	0.935	0.803
InstGuide2-SQ	0.944			
InstGuide3	0.838			
InstGuide4	0.851			
Comprehension				
Comp1	0.936	0.965	0.965	0.858
Comp2	0.891			
Comp3	0.933			
Comp4	0.909			
Comp5	0.936			

construct. Following the guidance of Fornell and Larcker (1981), the scales ranged from 0.874 to 0.960, thus exhibiting acceptable composite reliability because they exceeded the 0.70 standard. We then calculated the average variance extracted (AVE) for each construct to determine the amount of true score variance captured by the latent variables. Again, the AVEs surpassed the 0.50 standard and ranged from 0.735 to 0.858. Thus, we conclude that our survey measures' have construct reliability. To evaluate criterion-related validity, we present the various correlations in Table III. Based on the calculated correlations, we concluded that constructs have acceptable criterion-related validity (statistically significant at $p < 0.05$). Finally, given that the constructs are appropriated correlated and directionally correct, we conclude that concurrent validity exists (positive and significant at $p < 0.05$).

Results

We used structural equation modeling (SEM) for the data analysis because the method is an effective approach to statistically confirm and reveal the strength of the proposed relationships (Bollen and Long, 1993). For the final analysis, we separated the data into an online (n = 167) and F2F (n = 347) population and test the various relationships. Using the procedure suggested by Satorra and Bentler (2001), we report the robust fit statistics in

Table IV. For comparison, we also analyze and report on both respondent populations (multi-group) simultaneously. Upon review, we find that the absolute and comparative fit statistics suggest the data fits the models well for all three groups (F2F, online and multi-group) (Hu and Bentler 1999). For the F2F group = Satorra-Bentler X^2 = 301.99, df = 174, CFI = 0.968, NNFI = 0.962, RMSEA = 0.046. For the online group = Satorra-Bentler X^2 = 236.1, df = 174, CFI = 0.977, NNFI = 0.972, RMSEA = 0.046). Lastly, for the total population Satorra-Bentler X^2 = 328.15, df = 174, CFI = 0.975, NNFI = 0.970, RMSEA = 0.042. For the CFI and NNFI, the literature suggests values greater than 0.95 indicate excellent fit (Hu and Bentler, 1999). Likewise, Riley *et al.*, (2016) purport that RMSEA values less than 0.05 should be considered excellent fit. Following best practices, the data fits the model well.

When evaluating team interaction (*H1a* and *H1b*), we found the relationship significant for only the F2F group (β = 0.098, p = 0.034). This suggests that F2F students utilized the value of team interaction and engaged with their fellow teammates when developing strategies and executing tactics during the simulation. This finding supports the work of Van Der Vegt and Bunderson (2005) who argue that when teammates with dissimilar paradigms would get together that interaction promotes learning by enabling the cross-fertilization of ideas. From the experiential learning perspective, we envision that when

No.	Latent variable	No. of items	1	2	3	4	5
1	Team interaction	4	*0.910*				
2	Previous software experience	3	0.176	*0.857*			
3	Ease of use	4	0.294	0.267	*0.894*		
4	Team leadership	3	0.116	0.169	0.262	*0.891*	
5	Instructor's guidance	3	0.362	0.208	0.521	0.264	*0.896*

Notes: Correlations bottom left triangle; square root of average variance extracted (AVE) on diagonal. This converts the AVE to the standard deviation scale, so it can be compared to correlations located in bottom left triangle

Table III. Correlations among constructs (square root of AVE on the diagonal)

Hypothesis	Face-to-face only (n = 347)	Online only (n = 167)	Multi-group (n = 514)
Team interaction → Comp	0.098 (0.046)**	0.067 (0.076)	0.080 (0.041)**
Team Leadership → Comp	0.028 (0.043)	−0.025 (0.076)	0.018 (0.043)
Instructor's Guidance → Comp	0.042 (0.009)**	0.034 (0.024)***	0.033 (0.007)***
Previous Software Experience → Comp	0.113 (0.046)***	0.015 (0.099)	0.080 (0.048)*
Ease of Use → Comp	0.424 (0.057)***	0.614 (0.083)***	0.506 (0.048)***
Absolute and incremental fit indices			
Satorra-Bentler X^2	301.99	236.1	328.15
Degrees of freedom	174	174	174
Comparative fit index (CFI)	0.968	0.977	0.975
Non-normed fit index (NNFI)	0.962	0.972	0.97
Root mean square error of approximation (RMSEA)	0.046	0.046	0.042
90% confidence interval of RMSEA	0.037 – 0.055	0.030 – 0.060	0.035 – 0.048

Notes: ***p < 0.001; **p < 0.05; *p < 0.1

Table IV. Unstandardized betas and fit indices teams interact well, that students move quickly through the learning cycle and improve their level of comprehension. However, when team interaction is stifled, we expect students to find other topics to occupy their time. Conversely, when evaluating the online group (*H1b*), we found that team interaction no longer had a significant affect (β = 0.067, p = 0.380). Originally, we hypothesized the relationship would be weaker than it was for the F2F class. With the non-significant results, we suspect that online students do not value team interaction or believe that it affects their level of comprehension. This could be because online students did not work at team interaction or maybe the course instructor did not push team interaction.

When evaluating linkage between team leadership and comprehension (*H2a* and *H2b*), we find that the path coefficient is not significant for either group (β = 0.028, p = 0.512 for F2F students and β = −0.025, p = 0.738 for online students). This runs contradictory to existing literature that finds a positive relationship between team leadership and team success (Northouse, 2015). We put forth that team success does not directly equate to comprehension and since Littlefield is a probability based game, uncoordinated actions or even a lack of action by certain teams could lead to success when compared to teams taking wrong actions. However, the students may have failed to comprehend the topics taught within the simulation.

Beyond the direction of the team leader, we also investigated the guidance provided by the instructor (*H3a* and *H3b*). For the F2F environment, the path coefficient from instructor's guidance to comprehension (*H3a*) is positive and significant, (β = 0.042, p = < 0.00001). Thus, our results support the hypothesis that when the instructor provides guidance students can, on average, experience enhanced comprehension. Furthermore, we had predicted that instructor's guidance was more important for the online environment, than it was for the F2F environment. Upon analysis of *H3b*, we found the affect was positive and significant (β = 0.034, p = 0.023). However, contradictory to our beliefs, the affect was less pronounced for online students. This runs contrary to previous work, which indicates that instructor's guidance is an important component of e-learning success (Desai *et al.*, 2008). Further, it could suggest that the instructors involved in this research did not provide necessary guidance.

When investigating the relationship between previous software experience and comprehension (*H4a* and *H4b*), we again found contradictory results. For the F2F environment (*H4a*), we found the linkage to be positive and significant, (β = 0.113, p = 0.016). This supports previous finding where participants described how "previous software experience affected their understanding of the target interface" (Capra, 2002, p. 1975). We expect that when students feel comfortable with software that they will explore the different aspects of the software, thereby propelling them through the experiential learning cycle. However, when looking at the online population (*H4b*), the analysis suggests the affect was not significant (β = 0.015, p = 0.882). Originally, we hypothesized that previous software experience was more important for the online environment because students would likely have a level of comfort with the online environment. We suppose that previous software experience is not a critical factor affecting comprehension because online students are extremely comfortable with the learning platform.

Finally, when considering the relationship between the simulation's ease of use and comprehension (*H5a* and *H5b*), the evidence indicates the relationship is significant for both learning environments (β = 0.434, p = < 0.00001 for F2F students and β = 0.614, p = < 0.00001 for online students). These findings provide support for experiential learning theory and suggests that simulations let students experience real-world problems while they learn and develop new models about a phenomenon (Wu, 2013). Thus, we believe that when students like the simulation they may use it to better understand the operations management concepts being taught. As predicted the relationship between ease of use and comprehension is more pronounced for online students. Because, in general, the online population will have less contact with teammates and the instructor, the findings signify that online students will value an easy to use simulation/learning tool. In our case, the students find the Littlefield simulation easy to use.

Discussion

While much of the online learning literature focuses on how teaching and learning are affected by social media and/or mobile computing devices (Gikas and Grant, 2013), we seek to understand how mode of delivery affects student's comprehension level. Specifically, we investigate if mode of delivery affects student comprehension differently when using the Littlefield Technology simulation tool to reinforce several key operation management concepts. When we separated the data between the F2F and online teaching environments, we found that team interaction and previous software experience did not significantly affect the online student's comprehension level, but did affect students from the F2F group.

When considering the team interaction construct, this suggests that online student are not developing an appreciation for teamwork or working in groups to the same extent that F2F students do. This could pose a problem as many businesses and organizations repeatedly emphasize teamwork as a necessary employability skill. Staggers *et al.* (2008) indicates that students should be exposed to teams and develop teamwork skills to improve communication, develop alternate viewpoints and practice a necessary workforce skill.

As for the findings associated with previous software experience, our results suggest that online students do have the requisite skills to succeed in the online environment. In this context, online students regardless of previous software experience are able to work in the fast paced and challenging environment provided by the simulation (Wadhwa, 2013).

Finally, when considering the simulation tool's ease of use, we find the relationship strength to be more pronounced for online students. Hence, instructors need to ensure that the online learning platform is easy to use and that the interface can be easily navigated and understood. We contend that if students are not able to easily navigate the software, they may find it harder to comprehend the topics being taught. At a minimum, instructors will likely have to answer more questions and provide additional guidance on how to work with the simulation.

Conclusions and implications

Practical implications

From a practical perspective, when designing online coursework, professors should devote time and effort to make sure the learning platform and the technology medium is easy to use. We suggest making the interface and navigation easy to understand. Without an easy to use learning platform, both online and F2F students, may fail to comprehend the topics being taught as they struggle to understand how to use the software.

The instructor should also work to develop a sense of community among the team members. Most of the participants in this research worked in a team of four students. Developing strategies to improve bonds between teammates will likely pay dividends. If a community is built before conducting the simulation struggling students may first ask their teammates for guidance, rather than the instructor, thus, enabling the students to learn from each other.

Theoretical implications

Our results also provide several theoretical implications that may prompt additional research efforts. Foremost, our work explores several team, instructor, student and simulation based factors to determine if they can be leveraged to improve comprehension. While Kolb (1984) describes the experiential learning cycle, his model never identifies factors that enable or improve the actual learning experience (Matsuo, 2015). Thus, by testing these factors together in a single research model we expand the utility of Kolb's learning theory. In addition, our findings suggest that teaching modality has a significant effect on comprehension. Not only does the instructor have to understand how specific factors influence comprehension but he or she must also consider how the class is being taught. Without deliberate effort to consider modality, the instructor may inhibit the students' movement through the experiential learning cycle.

Limitation and directions for future research

A primary limitation of this research is that we used a self-reported survey with students from a single university. However, as we collected data from four different instructors over a one-year period, we argue the findings are generalizable. While we attempt to minimize validity concerns by linking our research to existing literature and using an item-to-construct matching procedure (Q-sort), the methodological concerns should be kept in mind when interpreting our results.

Looking ahead, we recommend two avenues of additional research. First, research should be done using another theoretical framework. Alternatives approaches such as theory of reasoned action offers insight into how individuals form attitudes and resulting behaviors. Thus, understanding how students form opinions and corresponding behaviors would add to our understanding of how students learn. Second, we need to recognize if other factors influence comprehension. Factors such as academic major or team size may influence how well students comprehend the operations management topics being reinforced by the simulation.

References

Allen, I.E. and Seaman, J. (2015), "Grade level: tracking online education in the United States", available at: http://onlinelearningconsortium.org/read/survey-reports-2015/ (accessed 10 March 2015).

Ammar, S. and Wright, R. (1999), "Experiential learning activities in operations management", *International Transactions in Operational Research*, Vol. 6 No. 2, pp. 183-197.

Bandura, A. (1997), *Self-Efficacy: The Exercise of Control*, Worth Publishers, New York, NY.

Bartel-Radic, A., Moos, J.C. and Long, S.K. (2015), "Cross-cultural management learning through innovative pedagogy: an exploratory study of globally distributed student teams", *Decision Sciences Journal of Innovative Education*, Vol. 13 No. 4, pp. 539-562.

Bell, B.S., Kanar, A.M. and Kozlowski, S.W. (2008), "Current issues and future directions in simulation-based training in north America", *International Journal of Human Resource Management*, Vol. 19 No. 8, pp. 1416-1434.

Blaschke, L.M. (2012), "Heutagogy and lifelong learning: a review of heutagogical practice and self-determined learning", *The International Review of Research in Open and Distributed Learning*, Vol. 13 No. 1, pp. 56-71.

Bok, D. (2015), *Higher Education in America*, Princeton University Press, NJ.

Bollen, K.A. and Long, J.S. (1993), *Structural Equations with Latent Variables*, John Wiley and Sons, New York, NY.

Brandon-Jones, A., Piercy, N. and Slack, N. (2012), "Bringing teaching to life: exploring innovative approaches to operations management education", *International Journal of Operations & Production Management*, Vol. 32 No. 12, pp. 1369-1374.

Bullen, M., Morgan, T. and Qayyum, A. (2011), "Digital learners in higher education: generation is not the issue", *Canadian Journal of Learning and Technology/La Revue Canadienne De L'apprentissage Et De La Technologie*, Vol. 37 No. 1.

Burns, K., Duncan, M., Sweeney, D., II., North, J. and Ellegood, W. (2013), "A longitudinal comparison of course delivery modes of an introductory information systems course and their impact on a subsequent information systems course", *Journal of Online Learning and Teaching*, Vol. 9 No. 4, pp. 453-467.

Canning, N. and Callan, S. (2010), "Heutagogy: spirals of reflection to empower learners in higher education", *Reflective Practice*, Vol. 11 No. 1, pp. 71-82.

Capra, M. (2002), "Contemporaneous versus retrospective user-reported critical incidents in usability evaluation", *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, Vol. 46 No. 24, pp. 1973-1977.

Cooke, R.A. and Szumal, J.L. (1994), "The impact of group interaction styles on problem-solving effectiveness", *The Journal of Applied Behavioral Science*, Vol. 30 No. 4, pp. 415-437.

Cronbach, L.J. (1951), "Coefficient alpha and the internal structure of tests", *Psychometrika*, Vol. 16 No. 3, pp. 297-334.

Cuneen, J. (2004), "Adding rigor to the sport management internship", *Journal of Physical Education, Recreation and Dance*, Vol. 75 No. 1, pp. 20-21.

Czaja, S.J. and Sharit, J. (2012), *Designing Training and Instructional Programs for Older Adults*, CRC Press, Boca Raton, FL.

Daly, A.J. (2009), "Rigid response in an age of accountability the potential of leadership and trust", *Educational Administration Quarterly*, Vol. 45 No. 2, pp. 168-216.

Davis, F.D. (1993), "User acceptance of information technology: system characteristics, user perceptions and behavioral impacts", *International Journal of Man-Machine Studies*, Vol. 38 No. 3, pp. 475-487.

Dell, C.A., Low, C. and Wilker, J.L. (2010), "Comparing student achievement in online and face-to-face formats", *Journal of Online Learning and Teaching*, Vol. 6 No. 1, pp. 30-42.

Desai, M.S., Hart, J. and Richards, T.C. (2008), "E-learning: paradigm shift in education", *Education*, Vol. 129 No. 2, p. 327.

Dziuban, C., Moskal, P., Kramer, L. and Thompson, J. (2013), "Student satisfaction with online learning in the presence of ambivalence: looking for the will-o'-the-wisp", *The Internet and Higher Education*, Vol. 17, pp. 1-8.

Fornell, C. and Larcker, D.F. (1981), "Evaluating structural equation models with unobservable variables and measurement error", *Journal of Marketing Research*, Vol. 18 No. 1, pp. 39-50.

Garrison, D.R. and Kanuka, H. (2004), "Blended learning: uncovering its transformative potential in higher education", *Internet and Higher Education*, Vol. 7 No. 2, pp. 95-105.

Gikas, J. and Grant, M.M. (2013), "Mobile computing devices in higher education: student perspectives on learning with cellphones, smartphones and social media", *The Internet and Higher Education*, Vol. 19, pp. 18-26.

Guri-Rosenblit, S. (2005), "Distance education and e-learning: not the same thing", *Higher Education*, Vol. 49 No. 4, pp. 467-493.

Hove, M.C. and Corcoran, K.J. (2008), "Educational technologies: impact on learning and frustration", *Teaching of Psychology*, Vol. 35 No. 2, pp. 121-125.

Hu, L.T. and Bentler, P.M. (1999), "Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives", *Structural Equation Modeling: a Multidisciplinary Journal*, Vol. 6 No. 1, pp. 1-55.

Huang, W.W. and Wei, K.K. (2000), "An empirical investigation of the effects of group support systems (GSS) and task type on group interactions from an influence perspective", *Journal of Management Information Systems*, Vol. 172, pp. 181-206.

Johnson, S.D., Suriya, C., Yoon, S.W., Berrett, J.V. and La Fleur, J. (2002), "Team development and group processes of virtual learning teams", *Computers and Education*, Vol. 39 No. 4, pp. 379-393.

Kolb, D.A. (1984), *Experiential Learning*, Eaglewood Cliffs, NJ.

Kuo, Y.C., Walker, A.E., Belland, B.R. and Schroder, K.E. (2013), "A predictive study of student satisfaction in online education programs", *The International Review of Research in Open and Distributed Learning*, Vol. 14 No. 1, pp. 16-39.

Liu, R. and Palomera-Arias, R. 2015, "Term Project Design for Undergraduate Building Information Modeling Education", *ASEE Annual Conference and Exposition*, *Seattle, WA*.

McCarthy, P.R. and McCarthy, H.M. (2006), "When case studies are not enough: integrating experiential learning into business curricula", *Journal of Education for Business*, Vol. 81 No. 4, pp. 201-204.

Matsuo, M. (2015), "A framework for facilitating experiential learning", *Human Resource Development Review*, Vol. 14 No. 4.

Michaelsen, L.K., Knight, A.B. and Fink, L.D. (2002), *Team-Based Learning: A Transformative Use of Small Groups*, Greenwood publishing group, Westport, CT.

Miyaoka, J. (2005), "Making operations management fun: Littlefield technologies", *INFORMS Transactions on Education*, Vol. 5 No. 2, pp. 80-83.

Moore, J.L., Dickson-Deane, C. and Galyen, K. (2011), "E-learning, online learning, and distance learning environments: are they the same?", *The Internet and Higher Education*, Vol. 14 No. 2, pp. 129-135.

Motta, E., Cattaneo, A. and Gurtner, J.L. (2013), "Mobile devices to bridge the gap in VET: ease of use and usefulness as indicators for their acceptance", *Journal of Education and Training Studies*, Vol. 2 No. 1, pp. 165-179.

Northouse, P.G. (2015), *Leadership: Theory and Practice*, Sage publications, London.

O'Connor, D.L. and Menaker, E.S. (2008), "Can massively multiplayer online gaming environments support team training?", *Performance Improvement Quarterly*, Vol. 21 No. 3, p. 23.

O'Malley, L. and Ryan, A. (2006), "Pedagogy and relationship marketing", *Journal of Marketing Education*, Vol. 22, pp. 195-214.

O'Neill, D.K. and Sai, T.H. (2014), "Why not? Examining college students' reasons for avoiding an online course", *Higher Education*, Vol. 68 No. 1, pp. 1-14.

Pasin, F. and Giroux, H. (2011), "The impact of a simulation game on operations management education", *Computers and Education*, Vol. 57 No. 1, pp. 1240-1254.

Potter, R.E. and Balthazard, P.A. (2002), "Virtual team interaction styles: assessment and effects", *International Journal of Human-Computer Studies*, Vol. 56 No. 4, pp. 423-443.

Riley, J.M., Klein, R., Miller, J. and Sridharan, V. (2016), "How internal integration, information sharing, and training affect supply chain risk management capabilities", *International Journal of Physical Distribution & Logistics Management*, Vol. 46 No. 10.

Saenz, M.J. and Cano, J.L. (2009), "Experiential learning through simulation games: an empirical study", *International Journal of Engineering Education*, Vol. 25 No. 2, p. 296.

Salas, E., DiazGranados, D., Weaver, S.J. and King, H. (2008), "Does team training work? Principles for health care", *Academic Emergency Medicine*, Vol. 15 No. 11, pp. 1002-1009.

Satorra, A. and Bentler, P.M. (2001), "A scaled difference chi-square test statistic for moment structure analysis", *Psychometrika*, Vol. 66 No. 4, pp. 507-514.

Shankar, P.G. and Seow, J.L. (2010), "The association between accounting students' lone wolf tendencies and their perceptions, preferences and performance outcomes in team projects", *Journal of Accounting Education*, Vol. 28 No. 2, pp. 75-84.

Singh, A., Mangalaraj, G. and Taneja, A. (2010), "Bolstering teaching through online tools", *Journal of Information Systems Education*, Vol. 21 No. 3, pp. 299-312.

Snider, B. and Balakrishnan, J. (2013), "Lessons learned from implementing web-based simulations to teach operations management concepts", *INFORMS Transactions on Education*, Vol. 13 No. 3, pp. 152-161.

Staggers, J., Garcia, S. and Nagelhout, E. (2008), "Teamwork through teambuilding: face-to-face to online", *Business Communication Quarterly*, Vol. 71 No. 4, pp. 472-487.

Steenhuis, H.-J., Grinder, B. and de Bruijn, E.-J. (2011), "Simulations, assessment and student learning", *International Journal of Information and Operations Management Education*, Vol. 4 No. 2, pp. 99-121.

Stella, A. and Gnanam, A. (2004), "Quality assurance in distance education: the challenges to be addressed", *Higher Education*, Vol. 47 No. 2, pp. 143-160.

Sterman, J.D. (1989), "Modeling managerial behavior: misperceptions of feedback in a dynamic decision making experiment", *Management Science*, Vol. 35 No. 3, pp. 321-339.

Tabachnick, B.G. and Fidell, L.S. (2007), *Experimental Designs Using ANOVA*, Thomson/Brooks/Cole, CA.

Tangworakitthaworn, P. (2014), "ILO diagram: a conceptual model for curriculum development", *IEEE Technology and Engineering Education (ITEE)*, Vol. 8 No. 3, pp. 12-19.

Van Der Vegt, G.S. and Bunderson, J.S. (2005), "Learning and performance in multidisciplinary teams: the importance of collective team identification", *Academy of Management Journal*, Vol. 48 No. 3, pp. 532-547.

Vliert, E.V.D., Nauta, A.E., Giebels, E. and Janssen, O. (1999), "Constructive conflict at work", *Journal of Organizational Behavior*, Vol. 20, pp. 475-491.

Wadhwa, G. (2013), "A balanced way of teaching art and design using E-learning", *Arts Education*, Vol. 69.

Wagner, S., Garippo, S. and Lovaas, P. (2011), "A longitudinal comparison of online vs traditional instruction", *Journal of Online Learning and Teaching*, Vol. 7 No. 1, pp. 68-73.

Wright, C.P. (2015), "The Zu Zitter game: a course-long tool for teaching operations management", *INFORMS Transactions on Education*, Vol. 15 No. 3, pp. 240-253.

Wu, Y.S. (2013), "Development and evaluation of an educational simulation game with role-playing and problem-solving strategies for chemistry experiment skills: analysis of flow, technology acceptance and learning process", Master's Thesis, Graduate Institute of Applied Science and Technology, Taiwan.

Xu, D. and Jaggars, S.S. (2014), "Performance gaps between online and face-to-face courses: differences across types of students and academic subject areas", *The Journal of Higher Education*, Vol. 85 No. 5, pp. 633-659.

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Appendix

Item	Item name	Loading
	Littlefield simulation survey	
Comprehension: seven-point Likert-type scale: strongly disagree–strongly agree (alpha = 0.965; CR = 0.965)		
Comp1	Overall, I understand the concepts taught in class better	0.936
Comp2	The simulation helped me understand the tradeoffs operation managers make	0.891
Comp3	The simulation improved my understanding of the capacity management concepts taught this semester	0.933
Comp4	I understand the operations management concepts the professor discussed this semester better	0.909
Comp5	The simulation improved my understanding of the inventory management concepts taught this semester	0.936
Team interaction: seven-point Likert-type scale: strongly disagree–strongly agree (alpha = 0.926; CR = 0.929)		
TeamInter1	Members of our simulation team asked each other for feedback on their work	0.802
TeamInter2	Members of my simulation team interacted well	0.966
TeamInter3	Members of my simulation team were social to one another	0.930
Software experience: seven-point Likert-type scale: strongly disagree–strongly agree (alpha = 0.867; CR = 0.874)		
PreSoftwareExp1	I have experience with a variety of software programs	0.871
PreSoftwareExp2	Playing with software is a hobby of mine	0.706
PreSoftwareExp3	I have used many different software programs	0.919
Ease of use: seven-point Likert-type scale: very difficult to use–very easy to use (alpha = 0.911; CR = 0.913)		
EaseOfUse1	My interaction with the simulation interface was enjoyable	0.905
EaseOfUse2	I found it easy to get the interface to do what I wanted it to do	0.937
EaseOfUse3	Interacting with the simulation did not require a lot of my mental effort	0.799
Team leadership: seven-point Likert-type scale: strongly disagree–strongly agree (alpha = 0.909; CR = 0.910)		
TeamLeader1	We had a clear leader on our simulation team	0.878
TeamLeader2	One student from the team took the leadership role during the simulation	0.920
TeamLeader3	Our team leader had significant decision-making responsibility	0.835
Instructor's guidance: seven-point Likert-type scale: strongly disagree–strongly agree (alpha = 0.728; CR = 0.935)		
InstructorGuide1	My professor was trustworthy	0.903
InstructorGuide2	I was sure that my professor acted in my best interest	0.944
InstructorGuide3	The professor is concerned about our team's welfare	0.838
InstructorGuide4	The professor considers how decisions affect us	0.851
Control variables		
CV1	Current classification (freshman, sophomore, junior, senior and graduate student)	
CV2	Gender (Female, male)	
CV3	First generation student (not a first generation student or first generation student)	
CV4	How many times did your operations management class meet? (one day a week, two days a week, five days a week, online classes, etc.)	
CV5	Which college are you affiliated to (business administration, criminal justice, education, fine arts and mass communication, health sciences, science, etc.)	
CV6	Primary academic major within college of business administration? (Accounting, economics, finance, international business, management, marketing, banking, entrepreneurship, general business administration, human resource management, management information systems, project management, more than one major)	

Table AI.
Survey instrument