Teaching Business Process Management with Simulation in Graduate Business Programs: An Integrative Approach

Satya Prakash Saraswat
Dennis M. Anderson
Alina M. Chircu
Information and Process Management Department
Bentley University
Waltham, MA 02452, USA
ssaraswat@bentley.edu, danderson@bentley.edu, achircu@bentley.edu

ABSTRACT

This paper describes the development and evaluation of a graduate level Business Process Management (BPM) course with process modeling and simulation as its integral component, being offered at an accredited business university in the Northeastern U.S. Our approach is similar to that found in other Information Systems (IS) education papers, and can best be described as Design Science Research applied to pedagogical innovation. We use a survey of 95 graduate business students, classified as Information Technology (IT)-oriented and Business (non-IT)-oriented, to evaluate how the proposed artifact – the BPM course and its modeling and simulation components – supports student learning. The survey explores process analysis, course design, and process integration issues. Statistically significant differences between the two student groups on the value of modeling and simulation are found on five out of 15 survey items: analyzing process performance, creating process models, mapping process structure, understanding process concepts, and implementing process controls. The paper discusses implications of these differences for designing and delivering graduate BPM courses in colleges of business administration.

Keywords: Business process management (BPM), Simulation, Pedagogy, Enterprise resource planning (ERP), Process improvement, Business modeling

1. INTRODUCTION

In order to meet the challenges of intensified competition and regulatory pressures in the global economic environment, organizations have long viewed IT-supported process change as a strategic priority (Davenport and Short, 1990; Lewis et al., 2007). Business Process Management (BPM) is a set of methodologies for defining, analyzing, changing (incrementally improving or radically reengineering) and managing organizational processes using lessons from three inter-related disciplines – quality control, performance management, and information technology (IT) automation (Harmon, 2010). Organizations are increasingly adopting BPM techniques to improve their processes and compete with business process outsourcing (BPO) countries such as India, Ireland, Hong Kong, Philippines, and Vietnam (Alonso et al., 2000; Cleveland, 2002; Profozich, 1998; Saltzman and Malhotra, 2001).

Because of its operations management roots, BPM concepts are included in many MBA programs as part of the operations management curriculum, but stand-alone courses are also starting to emerge (Bandara et al., 2010). Recently, BPM has also been gaining recognition in the Information Systems (IS) field – for both teaching and research (Chircu et al., 2010). At the graduate level, the MSIS 2006 curriculum notes that significant changes in both technology and business create a need to strengthen the emphasis on several important concepts in MSIS programs, either through specialized courses or integration throughout the curriculum: business processes, emerging technologies, globalization, human-computer interactions, and impacts of digitization (Gorgone et al., 2006). We expect that the upcoming revision of the curriculum will contain a similar emphasis on BPM as a "business fundamentals" graduate course. Not surprisingly, many universities are now offering courses in BPM due to the increasing industry demand for trained professionals (Lee, 2008; Peslak, 2005; Bandara et al., 2010).

One critical element of BPM is process modeling and simulation. Modeling involves the encoding of a process using standard notation; its importance has been widely recognized and the factors for its success have been identified in numerous academic studies (Bandara et al., 2005; Davies et al., 2006, Law and Kelton, 2000; Ray, 2004; Warren et al., 1995). Simulation involves the analysis of a process model under varying parameters (such as activity times, resource numbers and cost, or demand). Modeling and simulation are becoming powerful instruments for analyzing complex business processes and improving their performance (Davis et al., 2007; Hubbard and Bacoski, 2006; Kiziltas, et al., 2006; Koide et al., 2005; Marrs and Mundt, 2001; van der Aalst and van Hee, 2004; White and Miers, 2008). Simulation enables rapid analysis of process problems and evaluation of improvement/redesign alternatives, and is great medium for illustrating operations management concepts and implications in a dynamic environment. Given the growing interest of industry for simulation, understanding its mechanics, uses, and limitations is becoming an essential skill for business students (Laguna and Marklund, 2013). As a result, simulation is now being used in academia to enhance the effectiveness of BPM teaching (Roussev and Rousseva, 2004). And more complex business simulations enable students to understand the integrated nature of organizations and gain decision-making and leadership skills that can be applied in practice (Lainema and Lainema, 2007; Siewiorek et al., 2012).

The analysis of the content and pedagogy of BPM courses has been lagging behind the demand for them. Published work on this subject has compared process modeling tools and techniques with methodologies ranging from ontological analysis to representational analysis and their combinations (Gregoriades and Sutcliffe, 2008; Recker et al., 2009; Siau, 2004). In some recent studies, process modeling has been found by students to be valuable in understanding business process mapping, information gathering, quality improvement and process reengineering (Rozman et al., 2008; Jeyaraj, 2010). Similarly, several academic studies demonstrated the effectiveness of innovative teaching approaches such as simulation of integrated business processes with ERP (Léger, 2006; Pellerin and Hadaya, 2008; Pope and Reeves, 2005).

However, as far as we are aware, most studies focus on a handful of well-known, complex, dynamic, team-based process simulations that cannot be easily changed. In addition, few studies investigate differences in perceptions of students on the effectiveness of these simulations, although the differences among students coming into graduate programs with varied backgrounds, career objectives and motivations are very real. This is also important since BPM draws from three different traditions – and each can be appealing to different types of students.

In this exploratory research we address this gap in the academic literature by examining the design of a business graduate level BPM course with process modeling and simulation as its integral component, being offered at an accredited business university in the Northeastern U.S. Our research approach is similar to that found in other IS education papers, as it includes a pedagogical design description with corresponding literature underpinnings, as well as empirical assessment of the design using student perceptions of their learning experience (Alrushiedat and Olfman, 2013; Saltz et al., 2013; Scholtz et al., 2012; Winkelmann and Leyh, 2010). Specifically, our approach can best be described as Design Science Research applied to pedagogical innovation. Our contribution is to do with developing and evaluating a new artifact – a BPM course and its specific process modeling and simulation learning component – through a design science process: awareness of the problem, suggestion, development, evaluation, and conclusion (Vaishnavi and Kuechler, 2004). One important step in this approach, and in many other IS education papers focused on pedagogical innovation, is the evaluation of the proposed artifact – in our case, the business process modeling and simulation component of the course. We perform the evaluation by investigating the following two research questions: *(1) Is process modeling and simulation effective as an instrument of learning in a graduate level BPM course?* and *(2) Are there any differences in process modeling and simulation learning perceptions between business-focused and IT-focused graduate students?*

2. DESIGN OF A SIMULATION-BASED BPM COURSE

The BPM course is a required semester-long course for graduate business students in the MBA and IS master's programs. The typical student taking the course is a business or IT professional with several years of work experience, who takes classes at night while working full-time; some students, particularly in the IS master program, take classes full time on an accelerated schedule. Admission criteria include past educational and work experience and typical graduate admission tests (GMAT, GRE) results. Students take the BPM course at any time during their program.

The course was developed and enhanced over more than 10 years by several instructors. We discuss the version of the course as taught by authors of this paper, and the assignments developed by one of them for the course. The main course goal is to "provide an overarching framework within which students will learn to define, model, measure, evaluate, and improve business processes to enhance an organization's competitive position." This is achieved through several learning objectives, including: (a) recognizing the existence of different types of processes in organizations, (b) understanding the cross-functional and inter-organizational process linkages, (c) describing, analyzing and stating and supporting conclusions about processes, (d) understanding the integrated nature of enterprise systems for business process support and (e) understanding enterprise systems functionality (through hands-on experience with a leading-edge ERP system, SAP).

The course consists of four interrelated parts: (1) general BPM concepts, (2) process modeling and simulation, (3) ERP systems and ERP-supported processes, and (4) practical project. In the first part of the course, we discuss the importance of BPM in the strategy of the organization in the emerging global business environment, the emergence of the process enterprise, and the important architectural elements of business processes. Then we introduce methodologies such as Six Sigma DMAIC (Define, Measure, Analyze, Improve and Control) and SIPOC (Supplier-Input-Process-Output-Customer) high-level process mapping. This foundational background prepares students to perform manual analysis of simple processes based on process capacity, demand, cycle time, and efficiency. At this point, we introduce a simulation modeling software. Then students are required to complete three individual modeling and simulation exercises of gradually increasing complexity. In the third part of the course, we discuss core business processes in organizations as implemented in SAP, a leading ERP, using hands-on interaction. We also use process modeling and simulation to analyze the differences between manual and ERP-supported processes. The last major component of the course is a project in which teams of students find a real business process in an organization, analyze it to discover areas of improvement, and then redesign it. The teams use process modeling and simulation to demonstrate, with precise measures, how their recommendations will improve the process.

2.1 The Process Modeling and Simulation Component of the Course

Our investigation centers on the second and third part of the course, where we employ modeling and simulation about business processes and ERP systems. Our choice is motivated by the educational benefits of simulation reported by many studies, including to support learning by doing with immediate feedback regarding one's decisions, allow multiple approaches and solutions (rather than a unique "right" answer), enable autonomous learning where students control the learning pace and instructors act as facilitators, and motivate students and create enthusiasm for learning (Cronan and Douglas, 2012; Lainema and Lainema, 2007; Seaton and Boyd, 2008; Siewioreck et al. 2012).

We focus on simulation as a tool to facilitate early learning (Seaton and Boyd, 2008) on core business processes supported by ERP, by introducing them to a variety of simple process and system behaviors in an environment that is easily manipulated by the instructor and the student. To this end, we use discrete event simulation (DES) – the most widely used method by researchers in the supply chain management, operations management, manufacturing, and process engineering fields (Jahangirian et al., 2010). We implement the course exercises using a commercially-available DES software package, ProcessModel (www.processmodel.com), that includes not only the simulation engine, but also advanced features such as an integrated graphical interface for easy modeling, Excel integration, advanced logic, subroutines, expressions, user-defined distributions, and action logic (Pidd and Carvalho, 2006). We find that the student version of ProcessModel is particularly powerful, as it allows access to all software features for a limited amount of time (120 days) for a reasonable fee. However, other tools with similar DES capabilities exist and could also be used. While explaining the details of the process modeling, simulation and analysis is beyond the scope of this article, interested readers can refer to a variety of works on the topic (see for example Pidd and Carvalho, 2006; Recker et al., 2009; Chand and Chircu, 2012; Laguna and Marklund, 2013).

The simulation software enables the creation of the process model using template graphic shapes, in a very rapid and easy fashion. A process model is a flow diagram consisting of objects (graphic shapes in the flowchart) and connections (lines connecting the graphic shapes). Objects represent the elements of the process while connections depict element relationships. Operational data for each object and connection - such as timings, quantities, costs, demand , etc. - are maintained as "properties" of the model elements and are used to simulate the behavior of the process over the desired duration (from minutes to years). The operational information comes from a process narrative provided by the instructor.

During simulation, entities (the things that are acted on in the process, such as phone calls that need to be answered, customers that need to be served, documents that need to be processed, etc.) enter the process based on a pre-determined demand. The software provides many realistic options for demand (such as continuous processing, scheduled events, daily patterns, etc.). The entities then move through the process based on the flow logic encoded in the model diagram and the action logic encoded in the properties of the model objects. To achieve this, the simulation engine sets the simulation clock to 0, then follows the regular three-phased DES algorithm: it executes the next event in the queue followed by all unconditional events and then all conditional events during that period, updates the simulation statistics, advances the clock to the next time period, and repeats processing until the end condition (such as simulation duration) is met (Pidd, 2005). The simulation engine uses a pseudo-random number generator for random variables needed in the simulation (such as arrival rates for entities or variable processing times).

The simulation can be set to run for a specified time (from seconds to years) in order to accommodate a variety of real-world situations, but the simulation engine produces the results in real-time (in a few seconds up to a few minutes, depending on model complexity). The software then generates simulation reports that include basic information (quantity processed, cycle time, value-added time, and cost per unit) and more sophisticated information (resource utilization, cost summaries, etc.). Detailed process data can be graphed (over time, by activities, resources, etc.) as well. From this students compute process performance metrics, identify bottlenecks, and make model changes to improve performance.

We introduce students to some of the mechanics of DES and the ProcessModel simulation engine so they can better interpret the results – thus making them aware of the simulation "world view". However, our primary goal is to demonstrate the dynamic behavior of processes and experiment with improvement scenarios (Laguna and Marklund, 2013; Pidd, 2005). Consequently, the purpose of this paper is not to discuss the pros and cons of a specific simulation method (such as DES) or simulation software, but to show how the simulation exercises support early learning (Seaton and Boyd, 2008).

To this end, we run tutorials and assign several simulation exercises that require students to create a process model, run a simulation of the model, and interpret the output generated by the simulation. The instructors provide intermediate feedback on each assignment in class and to each student, and teaching assistants are available for technical support. We start with an instructor-led tutorial and demonstrate simple processes, then ask students to apply the basics of process modeling in a simple exercise. We then introduce a series of additional assignments in which students model manufacturing and service processes which gradually become more complex. In one assignment, we introduce more realistic modeling features such as different entity arrival patterns to model demand, different sizes for activity queues, limits to the time an entity can wait before dropping out of the process without completing it, cross-training of resources, and random activity times based on distributions. Several iterations of simulation enable students to hone in on an efficient and effective process. Another assignment requires students to organize their models into departments (swim lanes), implement resource schedules, and define demand in a manner which enables all entity arrivals to be completely processed by the end of the work day. When students are sufficiently skilled at creating and enhancing models from instructor-defined scenarios, they are challenged to work in teams to identify an appropriate business process problem in the real world, collect sufficient data to model and simulate the process, discover issues with the current process, and implement changes to improve it.

2.2 Using Simulation to Support the ERP Component of the Course

ERP system support for business processes represents another important component of the BPM course. Students read about ERP systems to acquire context, study typical business processes to understand how they work in a manual setting and with ERP support, and execute these processes using a live commercial ERP environment (SAP). Instructors can monitor student progress by initiating appropriate displays and reports in SAP. Early iterations of the course presented process modeling and ERP as separate topics, and students did not see any connection between them. We implemented a simulation exercise to connect the two topics, and students have responded very positively to this integration.

The processes we study in this part of the course are procurement and fulfillment (simple production can also be included at instructor's discretion). Students learn about procurement, what it is, what activities are involved, who in the business does each activity, and what makes procurement "cross-functional." After students are familiar with the generic process, they complete the "requisition-to-pay" process using SAP, including the creation of master data. Similarly, students learn about the fulfillment process, first by studying the basics of the process, followed by creating the appropriate customer data and completing the SAP "order-to-cash" process for selling stock to customers and collecting payment for the sale. Instructors can also discuss a simple production process, where raw materials are procured, assembled into finished goods, and sold to customers. This is conceptually more challenging for students, but greatly enriches their ERP understanding. The ERP assignments require students to pay close attention to detail, which often seems difficult for them to do.

After becoming familiar with process modeling and simulation and ERP systems, students have to model and simulate one of the core processes studied earlier (procurement or fulfillment), paying special attention to how the process is defined as a computer-based process versus a manual-based process. This enables instructors to draw attention to different perspectives of the modeling process. Whereas a student specializing in IT may be modeling a procurement or fulfillment process in order to develop the software used to accomplish this process, without paying attention to specific process performance metrics, a business-focused student (specializing in finance or marketing, for example) would be modeling the process to determine the resources necessary to achieve appropriate performance goals. The assignment enables instructors to facilitate early learning (Seaton and Boyd, 2008) for both process modeling and ERP topics, as well as develop skills for deeper learning through future applied and practical integration (Kachra and Schnietz, 2008).

3. REPRESENTATIVE MODELING AND SIMULATION EXERCISES

3.1 A Process Modeling and Simulation Exercise

A course exercise was developed to encourage early learning in the process modeling and simulation part of the course. The exercise models a customer contact center (CCC), and is designed not only to demonstrate modeling and simulation, but also expose students to the global dimensions of BPM and encourage extensive discussion in the classroom. Effective operation of CCCs to maintain competitiveness has been an integral part of organizational strategy with business process reengineering since the 1990s (Caro et al., 2003; Dooman and Jungum, 2008; Gans et al., 2003; Gunasekaran and Kobu, 2002; Muehlen, 2004).

The setting is a small-scale CCC located in a country such as India, providing customer support to its clients as an off-shore BPO organization for credit card processing operations of two client banks - one located in the United States and the other in the United Kingdom. The CCC handles predominantly inbound calls such as those commonly associated with customer support centers, help desk services, airline reservation systems, order taking, and hotel reservations. To keep the complexity of the exercise manageable, outbound calls traditionally associated with telemarketing and surveys are not included in the model. The students are told that the primary objective is to help the CCC management with hiring, training, and allocating resources to process activities. The model analyzed by students is depicted in Figure 1.

The CCC initially employs three call center assistants (CCAs) responsible for receiving calls, logging them, and directing them towards customer service representatives (CSRs). Calls from each client country are separated at the arrival and routed to a CSR who logs the call and determines whether it is a simple call or complex call. While simple calls are answered by the CSR for simple inquiries, complex inquiries are forwarded by this CSR to specialized representatives who address them in detail.

Initially, among the 16 CSRs, 8 respond to the US clients and 8 to UK clients. Three of the CSRs in each group have specialized training to solve more complex problems for clients requiring longer interaction. Middleware is used by this CCC to closely integrate the telephone and computer based information system so that a CSR can speak with the client while displaying information about her from the organization's database via a customer resource management (CRM) system on a monitor.

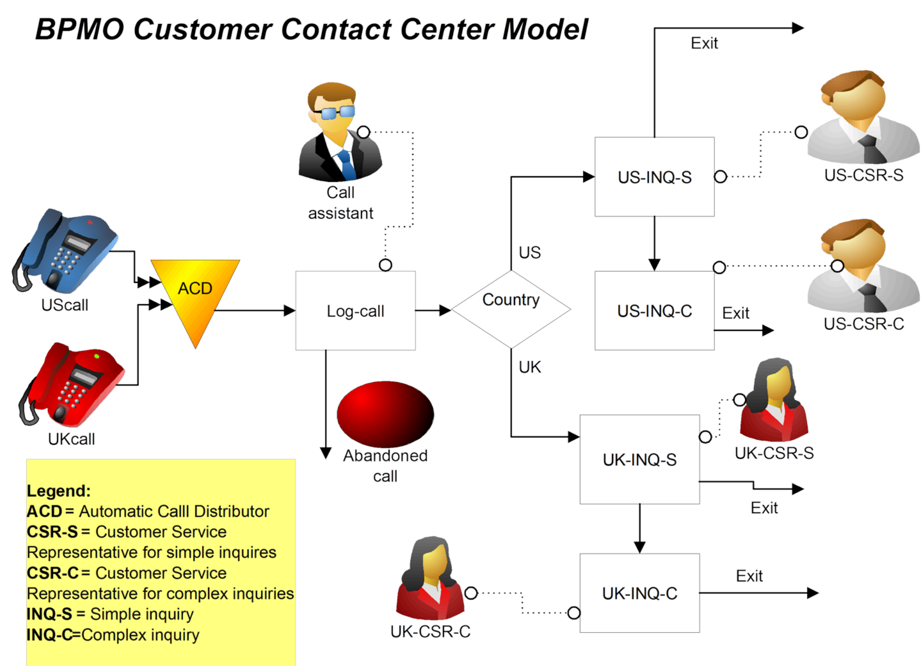

Figure 1. BPO CCC model (modeled using ProcessModel software)

We provide the students with information about the arrival patterns for calls and the processing times for each activity, and ask them to simulate the model for a typical 8-hour shift. We have designed the exercise so that significant process inefficiencies are immediately apparent: low utilization rates for some resources, long wait times, large number of calls abandoned by customers tired of waiting, and large overall processing times for customers who get through – all indicating inadequate process design, human resources capacity, and skills mix. Students are asked to improve the process, for example by employing additional staff or cross-training, and then simulate the process again. After several rounds of simulation experimentation, most students find an improved process design for which the number of abandoned calls and overall processing time decrease and resource utilization increases.

3.2. Exercises for Integrating Simulation Modeling with ERP Systems

As explained before, one of the difficulties encountered in the introductory stages of implementing the course was that students often perceived the simulation modeling and the ERP components of the course as two separate topics lacking a coherent logical connection. This concern is addressed by requiring students at the end of the second part of the course to create an executable model of one of the processes studied during the ERP module, both in its manual and ERP-supported versions.

Figure 2 contains the model of such a process – procurement – in its manual implementation, without ERP support. All activities are performed by human resources, without automation. The dashed lines in this model represent resource assignments to various activities and the associates attached to activities have to type all necessary information for processing a purchase request manually to generate various documents. Figure 3 contains the structure of the model after a number of activities are automated with ERP. As the resource assignment lines indicate, the purchase order is now created automatically from the information entered once for the purchase requisition, the vendor invoice is automatically received from the vendor without manual entry, the outgoing payment information is automatically retrieved, and the vendor balance report is automatically created.

A comparison of Figures 2 and 3 reveals several subtle changes in the graphical representation of the model. However, it is very difficult to evaluate the degree of improvement – a novice process modeler may even say the diagrams are rather similar and the improvement is minimal. Therefore simulation becomes essential in revealing the magnitude of the change.

We provide the students with details of the model parameters and simulation length, and ask them to change the manual process, simulate it, and analyze the output, iteratively, until they find the optimal automated process design. Eventually, after considerable "trial-and-error" simulation runs, students reach a point where the process works as intended. Through this experimentation, students discover significant improvements with the automated ERP system, including order of magnitude increases in process efficiency and decreases in the daily cost of operations. Thus we show the differences between the manual and the automated approaches and successfully establish the connection between the modeling and the ERP components of the course.

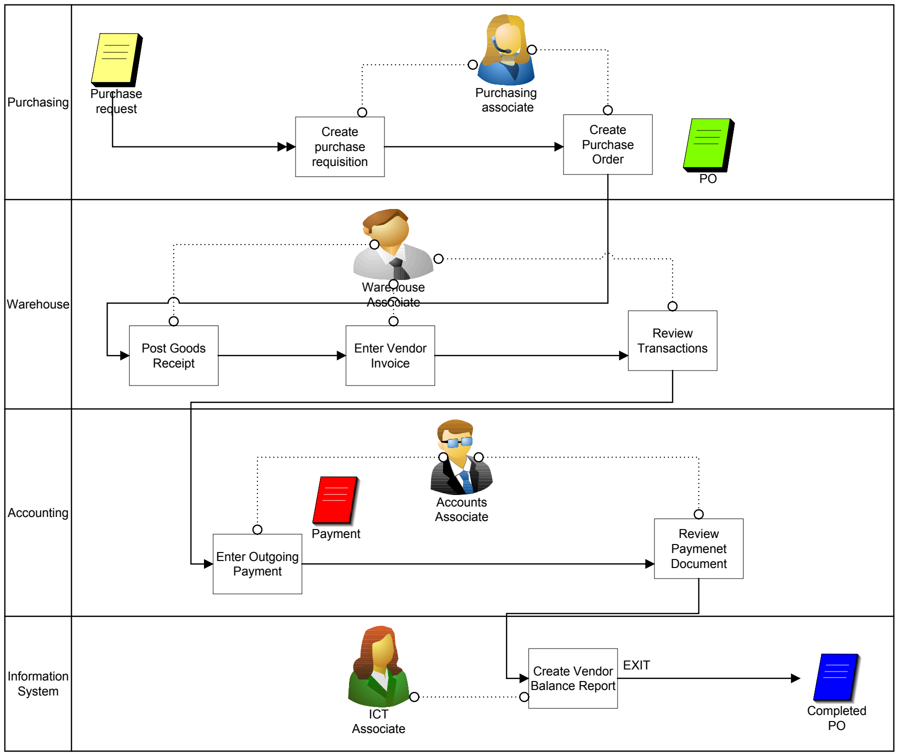

Figure 2. Manual procurement process model (using ProcessModel software)

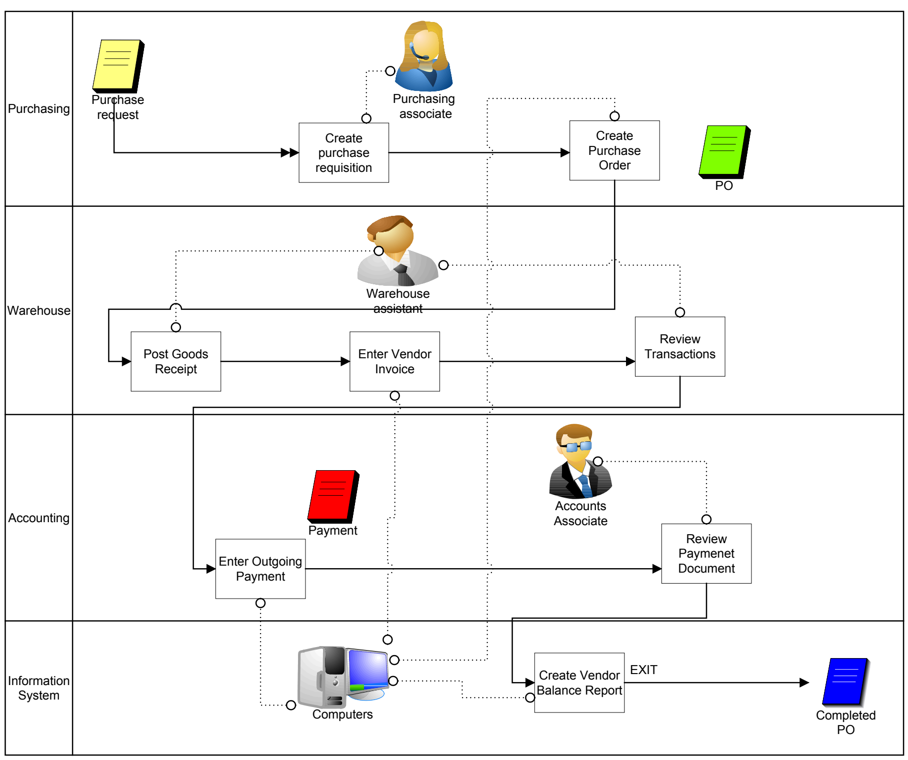

Figure 3. ERP-supported procurement process model (using ProcessModel software)

4. EVALUATION OF BUSINESS PROCESS MODELING AND SIMULATION AS AN INSTRUMENT OF LEARNING

As mentioned previously, we adopt a Design Science Research approach (Vaishnavi and Kuechler, 2004) to propose and evaluate a pedagogical innovation artifact – the business process modeling and simulation component of the BPM course. An important step in the design science approach, as well as in other IS education papers focused on pedagogical innovation (Alrushiedat and Olfman, 2013; Saltz et al., 2013; Scholtz et al., 2012; Winkelmann and Leyh, 2010), is the evaluation of the proposed artifact based on actual use data. To perform this evaluation we employ the following research question: *Is process modeling and simulation effective as an instrument of learning in a graduate level BPM course?* In addition, while teaching the BPM course, the faculty observed from anecdotal evidence that the graduate students focused on IT reacted to some of the technical difficulties of the exercises (i.e. installing software, creating and debugging models, and interpreting the simulation output) differently than the students with a general business focus. This suggests an additional research question: *Are there any differences in process modeling and simulation learning perceptions between business-focused and IT-focused graduate students?*

Note that the empirical investigation reported in this paper is not about the advantages, mechanics, characteristics or comparability of simulation tools and approaches, but about their utility as an instrument of teaching and learning in the classroom. Understanding the overall effectiveness level for the modeling and simulation component of the course can help instructors and program administrators measure the attainment of the stated learning objectives – an important task required by many program accreditation agencies. This can also inform further course improvements. In addition, if differences between student groups are confirmed, they can suggest a need to design course experiences or even different courses to provide both student groups with a challenging experience while learning BPM.

To perform the evaluation, a survey that reflects the course learning objectives (previously summarized in Section 2) was developed through brainstorming by faculty involved in teaching and coordinating the course. The final survey contained 15 items focused, as in other similar studies (see, for example, Scholtz et al., 2012), on competency-based self-efficacy in three main categories (with five items each): process performance issues, course design issues, and process integration issues. Respondents were asked to indicate their agreement with each item on a 5-point Likert scale, from “Strongly Disagree” to “Strongly Agree.” The full survey instrument is included in the Appendix, and a summary of items is presented in Table 1. The survey was administered on a voluntary basis to four sections of the BPM course taught by one instructor over three semesters. A total of 95 of the 133 students enrolled returned the survey (24, 28, and 43 respondents out of 34, 37, and 62 total enrollees by semester, respectively). The total response rate was 71%, with the response rates by semester ranging from 69% to 76%. The final sample contained 57 business–focused students (60%) and 38 IT-focused students (40%); this was in line with the graduate student population taking the course at the time. Group differences were investigated with a t-test. This is comparable with other IS education studies: Scholtz et al. (2012) present evaluations from 33 students in one course, Winkelmann and Leyh (2010) provide evaluations from 51 students across three small seminar courses, while Alrushiedat and Olfman (2013) compare student participation across 86 subjects in two courses using a t-test.

4.1 Interpretation of Results

Table 1 presents the survey categories and item descriptive statistics by group (IT or business-focused) and t-statistic and significance level for group differences. Since all the averages are above the scale median of 3.0, it can be concluded that most students found the simulation exercises helpful to a degree in understanding BPM. The mean of student perceptions is the highest on “Analyzing business process performance” for business-focused students (4.19), and on “Describing the structure of business processes” for IT-focused students (3.88). The lowest means of 3.11 for IT-focused students and 3.28 for business-focused students both occur on “Exploring the root causes of process inefficiencies,” reinforcing the notion (learned from class discussion and readings on BPM) that process modeling is not very effective in finding these causes. Despite the rapid advances of the technology of stochastic modeling, finding root causes of process problems remains an issue that does not yield to mechanistic approaches, and the experience of the analysts remains crucial.

Statistically significant differences are observed on individual questions between IT and business students on five dimensions (A1, B1, B4, B5, and C5 in Table 1). The mean difference – 3.74 (IT) versus 4.19 (business) – is statistically significant on dimension A1, “Analyzing business process performance.” The business students, who are generally from accountancy, finance, and marketing backgrounds and, consequently, more familiar with business processes, find the modeling exercises more “fun.” IT students, on the other hand, seem somewhat disadvantaged in this respect with their lack of formal business training. Indeed, a statistically significant higher mean of 3.83 on dimension B1, “Creating process models (including simulating and debugging)” indicates that IT-focused students find the procedural aspects of the modeling exercises more appealing due to their superior technical training and abilities. This result can be expected, but its implication to the design and delivery of the course is often not properly anticipated.

The mean differences between groups are also statistically significant on dimensions B4 “Mapping process structure (w/ SIPOC diagrams)” and B5 “Understanding process concepts.” The SIPOC analysis of B4, originating with the Six Sigma methodology, has become a widely accepted tool for creating high level process maps of the process. Such diagrams are useful for building a shared understanding about the process. But because they only include main process activities and no routing logic or resources, they are too abstract to implement as a process model that can be simulated or to highlight details of the

No.	Survey Categories and Item Summaries (See Appendix for details)	Student Focus	Mean	Std Dev	T-Stat	Significance
	(a) Process Performance Issues					
A1*	Analyzing process performance (efficiency and cycle time)	IT	3.74	0.97	-2.55	**.012**
		B	4.19	0.70		
A2	Describing the structure of business processes (elements and relationships)	IT	3.88	0.82	1.37	.173
		B	3.62	0.95		
A3	Defining process performance parameters more clearly	IT	3.64	0.87	1.16	.251
		B	3.87	0.99		
A4	Exploring the root causes of process inefficiencies	IT	3.11	0.99	0.81	.421
		B	3.28	1.05		
A5	Verifying the results of manual process analysis	IT	3.62	0.98	0.13	.899
		B	3.65	0.97		
	(b) Course Design Issues					
B1*	Creating process models (including simulating and debugging)	IT	3.83	0.81	2.20	**.031**
		B	3.35	1.17		
B2	Illustrating the process management concepts discussed in class	IT	3.46	0.88	0.88	.378
		B	3.63	0.92		
B3	Understanding the purpose of the course	IT	3.50	0.98	1.25	.213
		B	3.93	0.75		
B4*	Mapping process structure (w/ SIPOC diagrams)	IT	3.15	1.03	2.45	**.016**
		B	3.70	1.13		
B5*	Understanding process concepts	IT	3.56	0.97	2.07	**.042**
		B	3.93	0.72		
	(c) Process Integration Issues					
C1	Improving organizational communication for process improvement	IT	3.38	1.17	0.42	.674
		B	3.47	1.03		
C2	Developing a holistic BPM vision in the organization	IT	3.43	0.87	0.20	.841
		B	3.46	0.93		
C3	Implementing innovative processes and organizational structures	IT	3.79	1.08	1.42	.158
		B	3.48	1.02		
C4	Improving management of BPM projects	IT	3.77	1.01	0.23	.820
		B	3.72	0.96		
C5*	Implementing process controls	IT	3.28	0.85	2.21	**.029**
		B	3.89	0.82		

Table 1: Difference in the Means for Business-focused (B) and IT-focused (IT) Students
Note: * and bold font denote questions with B & IT group differences significant at the 0.05 level

information systems supporting the processes. We asked all students to identify the SIPOC elements of the process before creating a simulation model of the process as a standard approach to process analysis. With a mean of 3.70, the business-focused students appear to find the delineation of the SIPOC elements of business processes more interesting than IT-focused students do. Again, this can be attributed to the systematic preparation of business students in identifying and describing the business elements of a process and their integration with other organizational processes, while the IT students are more prone to focus on the process details that can facilitate future implementation of a model or system. Statistically significant means difference between business and IT-focused students on dimension B5 "Understanding process concepts," confirm these findings.

Business-focused students are also more convinced about the value of simulation-based process modeling for understanding the underlying process control issues in BPM. The importance of business process controls resulting from the requirements of the Sarbanes-Oxley Act in the U.S., and the Basel-II accord in Europe, is frequently discussed in the accountancy and finance classes in MBA programs. Business-focused students seem to have an advantage over the IT-focused students in understanding and appreciating the process control issues in BPM.

The general conclusion is that IT-focused students are more interested in the technical and theoretical dimension of process simulation while business-focused students are more concerned about practical application of the tools and exercises in the business environment.

5. IMPLICATIONS

Taken together, the survey results suggest that students taking the BPM course and completing the modeling and simulation exercises find the modeling and simulation exercises valuable for improving their understanding of the BPM learning objectives. This validates the use of simulation for supporting early learning in BPM courses. However, the means for student answers are not extremely high, implying that modeling and simulation may not be enough to teach BPM concepts at the graduate level. Other materials, such as instructor-led discussions using textbooktype readings and in-depth case studies, can be used to offer additional insights, especially for the IT-focused students, who seem to need extra support in understanding business-related concepts such as analysis and control.

The differences between groups further suggest that graduate business programs should carefully consider the pros and cons of offering generic versus specialized graduate level courses in BPM. By virtue of their undergraduate education, career objectives, and natural proclivities towards the discipline, IT and business-focused students have different perspectives on learning BPM with modeling and simulation exercises. The course we analyzed in this study attempts to balance the theoretical BPM concepts, process modeling, and process implementation with ERP systems, and is appropriate for serving the needs of smaller graduate business programs. However, in a university with a sufficiently large body of students, consideration should be given to designing separate and distinct courses for different groups. A specialized course for IT-focused students can have greater emphasis on the technical issues of process modeling such as studying multiple advanced process modeling notations, automated process discovery, process execution packages, and real-time optimization. In contrast, a specialized course for business-focused students can be centered on the organizational implications of BPM, using simulation and modeling to make the improvement or reengineering business case, establishing process metrics for ongoing management, and working with the IT team on process execution issues. Last, but not least, our results pinpoint specific learning objectives and student differences that can inform future revisions of graduate IS curricula, such as MSIS (Gorgone et al., 2006).

6. CONCLUSIONS

Business process management, innovation, and reengineering are inherently complex topics. Learning BPM requires students to assimilate a variety of basic concepts and practice them in a realistic but simple enough environment in order to facilitate early learning on which more complex practical integration experiences can be built. Designing appropriate classroom exercises for BPM courses is therefore important. Appreciation of the differences between IT and business-focused students is essential to create learner-centered activities which can satisfy the needs of different groups of students. In this paper, we describe the design of a graduate level BPM course with process modeling and simulation as its integral and essential component for achieving these goals, and present evidence from a student survey regarding its success. Future research can focus on the design and evaluation of other pedagogical innovations. For example, new exercises can explore the development of soft skills for BPM, or group exercises can be created to pair up IT-focused and business-focused students to simulate real work environments. Alternatively, altogether different exercises can be created for IT oriented and business oriented students. Another approach could be to teach the course with several instructors who each have deep expertise in specific BPM technical or management areas.

If BPM is to be fully embraced by IS programs, as some suggested (Gorgone et al., 2006), more research about the design of the optimal BPM course is needed. Students differ not only on their business versus IT training, but their cognitive preferences, gender, age, and many other attributes. A multidisciplinary approach, including the considerations of competencies, tools, techniques, and frameworks, is essential to teach an inherently multidisciplinary subject like BPM. The essential contribution of our exploratory research is to create awareness and provide some empirical evidence for these pedagogical issues among the faculty teaching BPM courses in colleges of business administration.

7. ACKNOWLEDGEMENTS

The authors would like to thank all previous BPM course instructors who have contributed to the course design over the years, as well as a graduate assistant who helped with an earlier version of the paper. The authors are also grateful to the JISE Editor-in-Chief, Associate Editor, and reviewers for their constructive feedback during the review process.

8. REFERENCES

Alonso, G., Agrawal, D., El Abbadi, A., & Mohan, C. (2000). Functionality and Limitations of Current Workflow Management Systems. *IEEE Expert,* 12(5), 39-65.

Alrushiedat, N. & Olfman, L. (2013). Aiding Participation and Engagement in a Blended Learning Environment. *Journal of Information Systems Education*, 24(2), 133-145.

Bandara, W., Gable, G. G., & Rosemann, M. (2005). Factors and Measures of Business Process Modeling: Model Building through a Multiple Case Study. *European Journal of Information Systems,* 14(4), 347-360.

Bandara, W., Chand, D., Chircu, A. M., Hintringer, S., Karagiannis, D., Recker, J., van Rensburg, A., Usoff, C., & Welke, R. J. (2010). Business Process Management Education in Academia: Status, Challenges, and Recommendations. *Communications of the Association for Information Systems*, 27(1), 743-776.

Chand, D. R. & Chircu, A. M. (2012). Business Process Modeling. In Shankararaman, V., Zhao, J. L., & Lee, J. L (Eds.), *Business Enterprise, Process, and Technology Management: Models and Applications*, Hershey, PA: IGI Global.

Caro, J. L., Guevara, A., & Aguayo, A. (2003). Workflow: A Solution for Cooperative Information System Development. *Business Process Management Journal,* 9(2), 208–220.

Chircu, A. M., Grover, V., Majchrzak, A. & Rosemann, M. (2010). Business Process Management and The IS Field: Have We Finally Arrived Or Just Missed The Boat? *ICIS 2010 Proceedings*, Paper 142.

Cleveland, B. (2002). Five Steps to a Better Call Center. *Call Center Magazine*, 15(3), 547.

Cronan, T. P. & Douglas, D. E. (2012). A Student ERP Simulation Game: A Longitudinal Study. *Journal of Computer Information Systems*, 53(1), 3-13.

Davenport, T. & Short, J. (1990). The New Industrial Engineering: Information Technology and Business Process Redesign. *Sloan Management Review*, July 15, 11-27.

Davies, I., Green, P., Rosemann, M., Indulska, M., & Gallo, S. (2006). How do Practitioners Use Conceptual Modeling in Practice? *Data & Knowledge Engineering,* 58(3), 358-380.

Davis, J., Eisenhardt, K., & Bingham, C. (2007). Developing Theory through Simulation Methods. *Academy of Management Review,* 32(2), 480-499.

Dooman, R. & Jungum, N. (2008). Business Process Modeling, Simulation and Reengineering: Call Centers. *Business Process Management Journal*, 14(6), 838-847.

Gans, N., Koole, G., & Mandelbaum, A. (2003). Telephone Call Centers: Tutorial, Review, and Research Prospects. *Manufacturing and Service Operations Management*, 5(2), 79-141.

Gorgone, J. T., Gray, P., Stohr, E. A., Valacich, J. S., & Wigand, R. T. (2006). MSIS 2006. Model Curriculum and Guidelines for Graduate Degree Programs in Information Systems. *Communications of AIS*, 17(1), 121-196.

Gregoriades, A. & Sutcliffe, A. (2008). A Sociotechnical Approach to Business Process Simulation. *Decision Support Systems,* 45(4), 1017-1030.

Gunasekaran, A. & Kobu, B. (2002). Modeling and Analysis of Business Process Reengineering. *International Journal of Production Research*, 20(11), 2521-2546.

Harmon, P. (2010). The Scope and Evolution of Business Process Management, In vom Brocke, J. & Rosemann, M. *Handbook of Business Process Management I*, Berlin: SpringerVerlag, 37-79.

Hubbard, K. & Bacoski, N. (2006). The Use of Simulation Modeling and Factorial Analysis as a Method for Process Flow Improvement. *International Journal of Advanced Manufacturing Technology*, 29(1/2), 202-208.

Jahangirian, M., Eldabi, T., Naseer, A., Stergioulas, L. K., & Young, T. (2010). Simulation in Manufacturing and Business: A Review. *European Journal of Operational Research*, 203(1), 1-13.

Jeyaraj, A. (2010). Business Process Elicitation, Modeling, and Reengineering: Teaching and Learning with Simulated Environments. *Journal of Information Systems Education,* 21(2), 253-264.

Kachra, A. & Schnietz, K. (2008). The Capstone Strategy Course: What Might Real Integration Look Like? *Journal of Management Education*, 32(4), 476-508.

Kiziltas, S., Ergen, E., Karaesmen, I., & Keceli, F. (2006). Modeling and Analyzing the Impact of Technology on Data Capture and Transfer Processes at Construction Sites: A Case Study. *Journal of Construction Engineering & Management*, 132(11), 1148-1157.

Koide, A., Liu, T., & Ramachandran, B. (2005). Analysis and Simulation of Business Solutions in a Service-Oriented Architecture. *IBM Systems Journal,* 44(4), 669-690.

Laguna, M. & Marklund, J. (2013). *Business Process Modeling, Simulation and Design.* (2nd ed.), Boca Raton, FL: CRC Press.

Lainema, T. & Lainema, K. (2007). Advancing Acquisition of Business Know-How: Critical Learning Elements. *Journal of Research on Technology in Education*, 40(2), 183-198.

Law, A. & Kelton, D. (2000). *Simulation Modeling and Analysis*. (3rd ed.). New York, NY: McGrawHill.

Lee, J. (2008). Status of Business Process Courses in AACSB Accredited Undergraduate Programs of Business. *The Journal of Computer Information Systems,* 49(1), 1016.

Léger, P. M. (2006). Using a Simulation Game Approach to Teach Enterprise Resource Planning Concepts. *Journal of Information Systems Education,* 17(4), 441-447.

Lewis, M., Young, B., Mathiassen, L., Rai, A. R., & Welke, R. (2007). Business Process Innovation Based on Stakeholder Perceptions. *Information Knowledge Systems Management*, 6, 7–27.

Marrs, F. & Mundt, B. (2001). *Enterprise Concept: Business Modeling Analysis and Design.* New York: John Wiley & Sons, Inc.

Muehlen, M. (2004). Organizational Management in Workflow Applications – Issues and Perspectives. *Information Technology and Management,* 5(3/4), 271–291.

Pidd, M. (2005). *Computer Simulation in Management Science.* (5th ed). Chicester, UK: John Wiley & Sons, Ltd.

Pidd, M. & Carvalho, A. (2006). Simulation Software: Not the Same Yesterday, Today or Forever. *Journal of Simulation*, 1(1), 7-20.

Pellerin, R. & Hadaya, P. (2008). Proposing a New Framework and an Innovative Approach to Teaching Reengineering and ERP Implementation Concepts. *Journal of Information Systems Education,* 19(1), 65-73.

Peslak, A. (2005). Incorporating Business Processes and Functions: Addressing the Missing Element in Information Systems Education. *The Journal of Computer Information Systems,* 45(4), 56-61.

Pope, D. & Reeves, B. (2005). Simulation of Enterprise Resource Planning (ERP) - Enabled Business Processes. *7th Annual Simulation Solutions Conference*, Atlanta, GA.

Profozich, D. (1998). *Managing Change with Business Process Simulation*. Upper Saddle River: Prentice Hall.

Ray, P. (2004). Collaborative Information Systems and Business Process Design Using Simulation. *Proceedings of the 37th Hawaii International Conference on System Sciences*.

Recker, J., Rosemann, M., Indulska, M., & Green, P. (2009). Business Process Modeling- A Comparative Analysis. *Journal of the Association for Information Systems*, 10(4), Article 1.

Roussev, B. & Rousseva, Y. (2004). Active Learning through Modeling: Introduction to Software Development in the Business Curriculum. *Decision Sciences Journal of Innovative Education*, 2(2), 121-152

Rozman, T., Horvat, R. V., & Rozman, I. (2008). Modeling the Standard Compliant Software Processes in the University Environment. *Business Process Management Journal,* 14(1), 53-64.

Saltz, J., Serva, M. A., & Heckman, R. (2013). The GET Immersion Experience: A New Model for Leveraging the Synergies between Industry and Academia. *Journal of Information Systems Education*, 24(2), 121-131.
Saltzman, R. & Malhotra, V. (2001). A Call Center Uses Simulation to Drive Strategic Change. *Interfaces*, 31(3), 87-101.
Scholtz, B., Cilliers, C., & Calitz, A. (2012). A Comprehensive, Competency-Based Education Framework Using Medium-Sized ERP Systems. *Journal of Information Systems Education*, 23(4), 345-358.
Seaton, L. J. & Boyd, M. (2008). The Effective Use of Simulations in Business Courses. *Academy of Educational Leadership Journal*, 12, 107-118.
Siau, K. (2004). Information and Computational Equivalence in Comparing Information Modeling Methods. *Journal of Database Management,* 15(1), 73-86.
Siewiorek, A., Saarinen, E., Lainema, T., & Lehtinen, E. (2012). Learning Leadership Skills In A Simulated Business Environment. *Computers & Education*, 58(1), 121-135.
Vaishnavi, V. K. & Kuechler, W. (2004). Design Research in Information Systems. *DESRIST (Design Science Research in Information Systems and Technology) Knowledge Base*, January 20, 2004, last updated October 23, 2013. Retrieved October 1, 2014 from http://desrist.org/design-research-in-information-systems/.
van der Aalst, W. & van Hee, K. (2004). *Workflow Management: Models, Methods, and Systems (Cooperative Information Systems)*. Cambridge: The MIT Press.
Warren, J. R., Crosslin, R. L., & MacArthur, P. J. (1995). Simulation Modeling for BPR: Steps to Effective Decision Support. *Information Systems Management,* 12(4), 32-42.
White, S. & Miers, D. (2008). *BPMN Modeling and Reference Guide.* Lighthouse Point, Florida: Future Strategies, Inc.
Winkelmann, A. & Leyh, C. (2010). Teaching ERP Systems: A Multi-perspective View on the ERP System Market. *Journal of Information Systems Education*, 21(2), 233-240.

AUTHOR BIOGRAPHIES

Satya Prakash Saraswat is a Professor of Information and

Process Management at Bentley University, USA. He holds a bachelor's degree in Chemical Engineering from Harcourt Butler Technological Institute, India, an MBA from Murray State University, and a Master of Business Information Systems and a Ph.D. in Business Administration degree from Georgia State University. He has published more than sixty journal articles, conference papers, and book chapters on topics ranging from telecommunications policy and trans-border data flow to phenomenology and foundations of information systems. His research interests include business process management, information technology ethics and sustainability, and global implications of information and communication technology.

Dennis M. Anderson is an Associate Professor of

Information and Process Management at Bentley University, USA. He holds an Ed.D. degree from Ball State University. At Bentley, he serves as the coordinator of a required undergraduate course in business processes and systems, as well as the coordinator of IT-related internship programs for undergraduate and graduate students. He has extensive business experience, including working for a CPA firm and a financial services institution, and consulting with industry, and has formerly taught computer technology at Purdue University. His teaching and research interests include business process management, strategic information technology, and decision support systems.

Alina M. Chircu is an Associate Professor and department

chair in the Information and Process Management department at Bentley University, USA. She holds a Ph.D. degree in Management Information Systems and bachelor's and master's degrees in Computer Science. She has published articles in journals such as the *Business Process Management Journal, Journal of Product Innovation Management, Decision Support Systems, Journal of Management Information Systems, Communications of the ACM*, and others, and numerous book chapters and conference papers. Her research interests include business process management and the business value and adoption of transformational technologies such as e-business, e-government, mobile, and RFID.

Appendix

The survey instrument for measuring student perceptions on the use of business process simulation and modeling in a BPM course

Respondents were asked to indicate their agreement with each survey item on the following 5-point Likert scale:

Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
(1)	(2)	(3)	(4)	(5)

Process Performance

(A1). The simulation exercises enhanced my ability to analyze performance of business processes by examining process efficiency and resource bottlenecks.

(A2). The simulation exercises gave me a clear understanding of the structure of business processes in terms of their elements and relationships (activities, resources, decisions, buffers and routing, etc.)

(A3). After completing the exercises, I have a better understanding of process performance parameters and metrics such as activity time, value added time, and waiting time.

(A4). The simulation exercises improved my ability to understand the root causes of inefficiencies in business processes.

(A5). Comparing manually calculated results of process analysis with the output of simulation runs enhanced my confidence in the simulation exercises.

Course Design

(B1). I enjoyed creating, correcting, and simulating process models with the software available to the class.

(B2). The simulation exercises were very helpful in illustrating the process management concepts discussed by the instructor in class

(B3). The simulation of SAP processes such as Sales & Distribution and Procurement gave me a better understanding of the purpose of the course (integrating Enterprise Systems and Simulation Modeling).

(B4). Creating the Supplier-Input-Process-Output-Customer (SIPOC) diagrams before simulating various processes in the exercises was very helpful in understanding the scope and requirements of the process.

(B5). After completing simulation exercises, I have a better understanding of the importance of process definition, measurement, analysis, improvement, and control in organizations.

Process Integration

(C1). I can use simulation models to communicate the need for process improvement in my organization to managers and information technology professionals.

(C2). From the process analysis and design exercises I have learned the importance of developing a holistic view of business process management in organizations.

(C3). After taking the BPM course, I am better prepared to implement innovative processes and organizational structures in my company.

(C4). After taking the business process management course, I can effectively manage BPM projects in my organization.

(C5). The simulation exercises completed in the course have given me an enhanced appreciation for implementing process controls in organizations.

STATEMENT OF PEER REVIEW INTEGRITY

All papers published in the Journal of Information Systems Education have undergone rigorous peer review. This includes an initial editor screening and double-blind refereeing by three or more expert referees.

Copyright ©2014 by the Education Special Interest Group (EDSIG) of the Association of Information Technology Professionals. Permission to make digital or hard copies of all or part of this journal for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial use. All copies must bear this notice and full citation. Permission from the Editor is required to post to servers, redistribute to lists, or utilize in a for-profit or commercial use. Permission requests should be sent to Dr. Lee Freeman, Editor-in-Chief, Journal of Information Systems Education, 19000 Hubbard Drive, College of Business, University of Michigan-Dearborn, Dearborn, MI 48128.

ISSN 1055-3096