Teaching Tip
Enhancing ERP Learning Outcomes through Microsoft Dynamics

Amir H. Zadeh, Hamed M. Zolbanin, Arijit Sengupta,
and Todd Schultz

Teaching Tip
Enhancing ERP Learning Outcomes through Microsoft Dynamics

Amir H. Zadeh
Department of Information Systems and Supply Chain Management
Wright State University
Dayton, OH 45435, USA
Amir.zadeh@wright.edu

Hamed M. Zolbanin
Department of MIS, OM, and DS
University of Dayton
Dayton, OH 45469, USA
Zolban@okstate.edu

Arijit Sengupta
Department of Information Systems and Business Analytics
Florida International University
Miami, FL 33199, USA
Asengupt@fiu.edu

Todd Schultz
School of Computer & Cyber Sciences
Augusta University
Augusta, GA 30912, USA
Tschultz@augusta.edu

ABSTRACT

Enterprise resource planning systems (ERP) are the most essential and critical information systems that are widely used to build all the functions of a business into a unified and efficient enterprise system. Although the essence of ERP systems are easy to understand, students, especially those who do not have technical experience, have difficulty appreciating how different components of these systems interrelate and work together to improve the efficiency and effectiveness of business processes. This paper illustrates how an MIS course that incorporates Microsoft Dynamics ERP into the curriculum is designed. We demonstrate how technical aspects of ERP systems can be incorporated into ERP courses to help business students recognize the importance of technical knowledge in today's marketplace and develop technical skills in their learning process. We focus on Microsoft Dynamics AX as a unified ERP system along with its associated products and technologies (i.e., SQL, Power BI, Visual Studio, etc.) to ensure the highest level of competency. Examples of the course description, hands-on labs, exercises, and resources are provided. Results of student assessments are included, which support that hands-on learning on Microsoft Dynamics AX ERP system can lead to improved learning outcomes, both functionally and technically.

Keywords: Enterprise systems, Enterprise resource planning (ERP), Enterprise systems education, Experiential learning & education, Pedagogy, Business processes

1. INTRODUCTION

As ERP systems have become more vital to the functioning of businesses, it has become equally important to educate business students on their functions and to develop the students' technical expertise using hands-on ERP training (Chauhan and Jaiswal, 2016). Businesses need managers competent with ERP systems, and students with these competencies are often offered greater salaries than their peers with higher academic performance (Sager et al., 2006; Cronan and Douglas, 2012; Hepner and Dickson, 2013). Many business schools have responded to this demand by integrating ERP into their curriculum (Bradford, Vijayaraman, and Chandra, 2003; Strong et al., 2006; Winkelmann and Leyh, 2010) and partnering with ERP vendors to provide industry relevant skills (Hepner and Dickson, 2013; Iriberri, Kwon, and Henson, 2015). However, for many institutions, it is not feasible to purchase commercial ERP systems even with educational discounts, especially when the system is only used in a small number of courses. The use of freely available, open-source ERP systems is even suggested by ERP educators as an alternative to commercial software such as SAP (Ayyagari, 2011). Some ERP vendors provide hosted ERP systems, which waive or reduce the implementation, operation, and maintenance costs, for universities seeking to integrate ERPs into their curriculum. The costs become even more unjustifiable when these systems are only utilized in selected courses, rather than throughout the whole curriculum (Hawking and McCarthy, 2004).

In addition, given that the ERP system is hosted by a hub university that would offer hosting services and technical support to other educational institutions participating in the University Alliance, educational institutions may not be granted full access to various technological layers of the system. Therefore, such an environment is limited in its capability, and educational institutions do not have full control over how to manage and configure the ERP system. As a result, many courses offered by these educational institutions only surf on the functional aspect of ERP systems and do not go deeper to provide technical experience with these systems.

While functional and organizational aspects of ERP systems have been the center of ERP pedagogy over the last two decades, little attention has been paid to the technical perspective of ERP systems. The majority of the articles in the *Journal of Information Systems Education* on ERP education have largely focused on functionality and managerial aspects of the hosted ERP systems. None of these studies, however, has reported using a system that allowed them to cover the technical aspects of ERP in the classroom. In the post-modern ERP era, it is imperative for ERP educators to offer ERP courses that are both technically and theoretically oriented with an emphasis on "know-how" and "know-why" (Ruhi, 2016). Given the importance of technical skills in today's world, this paper presents our experience in employing an experiential learning approach to offer technical training with Microsoft Dynamics AX in a tier-one undergraduate course. We treat the classroom as an organization such that students can learn the ERP content more effectively. Students begin their ERP journey by configuring the ERP system and performing various tasks as part of an organization. Besides providing a comprehensive set of hands-on lab exercises that cover various aspects of ERP processes in an enterprise-wide landscape, we present our

findings and learning outcomes obtained from the experiential learning opportunities we provided throughout the course. Our study encourages students to learn ERP systems in a greater depth and instill more awareness about these systems, an investment that can ultimately be instrumental for their careers.

The next section presents a background on ERP and experiential learning which is followed by a description of the course setting. Subsequently, we explain the course design and discuss how learning outcomes were implemented in teaching exercises. The paper ends with a discussion and conclusion section.

2. ERP: RELATED WORK ON PEDAGOGY

The educational benefits of courses that offer ERP training are at their greatest when they engage students with hands-on and learning-by-doing exercises, as opposed to lecture-based instruction (Chen, Razi, and Rienzo, 2011). A hands-on approach to ERP systems in the classroom shows students business processes, functional role-playing, and decision-making opportunities. Such an approach results in improving student self-efficacy, competence, and satisfaction with the course (Scholtz, Cilliers, and Calitz, 2012). In order to keep business students interested in the ERP technology, it is important to employ a holistic approach to ERP instruction combining practice and theory (Nisula and Pekkola, 2019). The forefronts of this approach are ERP courses in the Information Systems (IS) curricula of major institutions (Cronan and Douglas, 2012, 2013; Hepner and Dickson, 2013) that integrate practice-based knowledge with theoretical knowledge of enterprise systems (Hustad and Olsen, 2014). These courses offer great insight into the best practices and methods to be employed while increasing students' technical knowledge of ERP systems. These programs involve students in a dynamic environment to perform functional processes and practice real-time decision-making using business intelligence (BI) tools (Cronan et al., 2011). The availability of ERP systems gives students access to a large amount of data to hone these skills with practice (Dunaway, 2018). Such hands-on course structures also allow students to develop an understanding of the technical aspects of ERP systems, including the database, workflow, business intelligence and reporting tools, and the development environment. Students can also learn the security of the ERP system and its underlying infrastructure if a fully implemented ERP system is available in the classroom (Barkhi and Kozlowski, 2017). IS courses can also benefit from ERP simulation tools such as ERPSIM, Lemonade Tycoon, or ProcessModel. While the first two are simulation games in which students can practice functional aspects of ERP systems (Léger, 2006; Chen, Keys, and Gaber, 2015; Nightingale, 2019), the latter is an integrated graphical interface for process modeling that enables students to create process maps, identify inefficiencies, and make changes to improve performance (Saraswat, Anderson, and Chircu, 2014).

While ERP education has largely focused on the functional side of ERPs over the last two decades, little or no attention has been paid to the technical details of ERP systems. Business, and in particular MIS, students are expected to possess a deep knowledge on both business value and technical details of ERP systems. Therefore, not only the functionality of ERP systems but also the underlying technological components need

to be integrated into business students' education. This includes database, workflow, BI and reporting tools, and development environments of ERP systems. The continuous availability of ERP systems provides business students with large amounts of data with which various fundamental concepts ranging from BI, reporting, and visualization to security, governance, development, customization, and configuration can be explored within the same platform.

3. COURSE OBJECTIVES AND LEARNING GOALS

The objective of enterprise systems courses in business schools is introducing the students to typical business processes seen across different functional areas in organizations, such as sales, purchasing, accounting, finance, human resources, and operations. The ERP system serves as an enterprise model to integrate data and processes from all functional areas of an organization.

This paper presents an overview of an existing ERP course at a major, midwestern university in the United States. The focal point of the course is the strategic and tactical uses of ERP systems to help business organizations achieve operational excellence. This course presents an overview of enterprise systems for data and business process integration and introduces students to how enterprise systems are used to manage operations and make effective business decisions. The course also uses a life cycle approach to demonstrate a methodology for ERP implementation. Topics include requirements, functionality and architecture of leading enterprise systems, implementation methodologies, and the future roadmap of ERP. An ERP course describes the main functionality of ERP systems, how they work, how they communicate, how they are used, their architecture, data flows, and how they are organized into modules. Given the fast changing nature of ERP technology, modern ERP courses also cover current technologies and trends (e.g., internet of things, mobile computing, cloud computing, and block chain) and discuss how they may impact the enterprise.

In addition, through experiential learning using Microsoft Dynamics, the same software used by many organizations in industry, students learn how to work with a real-world ERP system. The course materials provide both theoretical background and hands-on learning with Microsoft Dynamics AX. It introduces a real-world ERP system through illustrating the system's various modules such as the general ledger, accounts receivable, sales and marketing, accounts payable, and purchasing. Assignments include ERP case studies and hands-on work with Microsoft Dynamics AX in order to supplement the theoretical materials.

Upon successful completion of the course, students will be able to:

- Understand the role of Enterprise Systems in organizations
- Identify, model, evaluate, and reengineer business processes in organizations
- Understand integrated business processes in ERP systems
- Understand the components of an ERP system and the process of selecting an ERP system

- Build knowledge and skills for the development and implementation of ERP systems
- Develop competency for participating in analysis, design, implementation, and control of ERP projects
- Understand the broad functionality provided in an ERP solution and in Microsoft Dynamics AX
- Use ERP effectively through hands-on experience with the Microsoft Dynamics' ERP modules

As far as prerequisite courses are concerned, the first prerequisite for this course is fundamentals of information systems which ensures that students understand the role of information systems, in general, and enterprise systems, in particular, in organizations and are able to use these systems as a resource in decision making. The second prerequisite for this course is system analysis and design that is considered as one of the most critical skills needed for a successful ERP implementation. The rationale for this prerequisite is to ensure that students are able to participate as a user in analysis, design, and control of an ERP system, develop process maps, identify bottlenecks and inefficiencies in the process workflow, and take necessary corrective actions in the ERP system. The third prerequisite is data and information management which is the ability to understand ERP database schema, use entity-relationship diagrams to demonstrate the business rules through a combination of relationships and cardinalities between entities, and recognize various types of data that are stored in the ERP database. Finally, having experience or knowledge with respect to IS infrastructure, information security, and business intelligence and visualization through course work or practice is helpful in learning course material.

4. EXPERIENTIAL LEARNING APPROACH IN BRIEF

In recent years, there has been a great emphasis on experiential learning in higher education as a way to enhance learning outcomes (Jewer and Evermann, 2015). Experiential learning emphasizes the development of meaningful experiences and reflecting on those experiences to transform them into knowledge. The four stages of experiential learning are concrete experience, reflective observation, abstract conceptualization, and active experimentation (Kolb and Kolb, 2005). When combined with classroom-as-organization (McDonald, Spence, and Sheehan, 2011) and group-role-play (Shen, Nicholson, and Nicholson, 2015) approaches, this process can be applied to the development of functional and technical ERP skills in students. As noted by other ERP educators, ERP courses can greatly benefit from an experiential learning approach through which various student learning styles can be accommodated resulting in higher student engagement, academic performance, and self-efficacy rates with the help of enterprise systems (Ruhi, 2016). Fathelrahman and Kabbar (2018) also demonstrated the effectiveness of experiential learning in enterprise systems courses and reported that students exposed to the real-life implementation of ERP systems produced high-quality work at different stages of their learning experience. Through experiential learning via a real-world system such as Microsoft Dynamics, a tier-one ERP system, students learn how to perform a wide range of functional and technical tasks in a live ERP environment. Because an ERP system serves as an implementation of best

business practices, it simulates a real-world business environment to a great extent and facilitates seamless information sharing for operations and decision-making. One way to create a new learning experience for students through the experiential learning cycle is to incorporate hands-on activities with a live ERP system in the IS curriculum. The hands-on experience helps students learn how an ERP increases performance by streamlining business processes, optimizing its resources, and supporting informed decision-making. While incorporating ERPs provides many opportunities to improve an MIS program through experiential learning, little work has been done to demonstrate technical aspects of ERP systems. Therefore, in this study, we demonstrate how a university can use a hands-on approach to provide experiential learning opportunities to students on both functional and technical areas of ERPs.

5. COURSE CONTENT

We provided specific course content in two phases that closely followed the experiential learning approach described in the preceding section. The two phases were composed of fifteen assignments and included additional labs. The first phase covered practical ERP usage and functionalities of ERP modules, while the second phase covered the technical aspects of ERP platforms. All topics were accompanied by relevant, weekly lab assignments. A summary of course content, learning objectives, and lab exercises is presented in Table 1.

	Module	Learning Objectives	Virtual Labs
ERP Life Cycle: Planning, Implementation, and Operation and Maintenance	Introduction to Enterprise Resource Planning Systems	– Understand the essence of ERP systems – Recognize why firms need an ERP system – Understand the strategic benefits of ERP systems – Understand the evolution of ERP systems	Lab 1
	ERP and Business Processes	– Understand organizational business processes – Recognize how ERPs support cross-functional business processes – Identify core functionalities and modules of a modern ERP system	Lab 2, 3, 4
	ERP and Human Resource	– Become familiar with various human resource processes – Understand functionality in the human resource module of ERP – Understand the employee self-services	Lab 5, 6
	ERP and Customer Relationship Management	– Differentiate between ERP and CRM systems – Become familiar with marketing, sales, and service functionality in a CRM module/system – Recognize various types of CRM metrics	Lab 7
	ERP and Supply Chain Management	– Recognize how ERP systems evolved from SCM systems – Understand how ERPs support operations and supply chain – Understand how ERP systems communicate via EDI – Become familiar with the functionality of material requirements planning to produce purchasing and production plans	Lab 8
	ERP and Business Process Reengineering	– Develop process maps and workflow diagrams – Identify bottlenecks and find solutions – Perform business process improvement	Lab 9
	ERP Technology	– Explain how ERP architecture has evolved over time – Become familiar with various types of ERP architectures – Understand the functions of the ERP database – Recognize different types of data stored in the ERP database	Lab 10
	ERP and Business Analytics	– Understand various types of business analytics – Recognize the role of KPIs in performance improvement – Become familiar with the dashboards and reporting tools in ERP	Lab 11, 12, 13
	ERP Development	– Understand differences between configuration and customization of ERP systems – Identify the advantages and disadvantages of using a customized ERP system – Recognize various development tools for ERP enhancements	Lab 14
	ERP Security	– Be familiar with the security functionality of ERP systems – Be aware of various types of internal controls and their objectives – Recognize weaknesses in internal controls such as a lack of segregation of duties	Lab 15

Table 1. Summary of Course Content, Learning Objectives, and Supporting Lab Exercise

5.1 Hands-on Lab 1: ERP Navigation and Configuration
The purpose of the first lab is to become familiar with basic navigation and configuration of the system. Several scenario-based exercises were included in this lab to help students get familiar with the interface and the basic functionality of ERP systems. As students go through the user interface exploration, they are instructed to pause in the highlighted areas and take a screenshot, paste the screenshot into a Word document, give it an appropriate caption, and write a line or two describing how they got to that screen. A summary of key scenarios in Lab 1 is presented in Table 2.

Lab 1 Scenario 1	The purpose of this scenario is to become familiar with the organizational structure, roles, responsibilities, and privileges each user may have in the Contoso Entertainment Company (USMF), a fictitious organization created by Microsoft. Students are performing various tasks in the System Administration module. They are instructed to select one additional business role and understand the description, responsibilities, and privileges associated with the role through the role center, user profile, and security role options. Using the role center, students are able to view the ERP system through the lens of each individual role.
Lab 1 Scenario 2	The purpose of this scenario is to retrieve information from Microsoft Dynamics. Students are tasked to visit the Account Receivable module to retrieve some basic information regarding a customer inquiry.
Lab 1 Scenario 3	The purpose of this scenario is to have students register the basic data in Microsoft Dynamics. They are tasked to visit the Accounts Payable module to create a purchase order for an existing vendor warehouse according to basic workflows for USMF.

Table 2. Summary of Lab Exercise 1

These fairly simple navigation exercises play a vital role in familiarizing the students with the course structure. They help the students understand how the system works and what they will need to do for all the remaining hands-on labs.

5.2 Hands-on Labs 2, 3, and 4: Core Business Processes
The purpose of this series of labs is to become familiar with basic sales and purchasing features in an ERP system. Students work with various modules such as System Administration, Human Resource, Organization Administration, and General Ledger in the Microsoft Dynamics AX ERP System. A business scenario with an emphasis on cross-functional organizational processes is defined to cover activities from procure-to-pay and order-to-cash processes, as shown in Figure 1. We focus on the minimum needed to get the base scenario to work out. This would involve students going deeper and finding ways to configure the system for streamlined processing or to meet particular needs. In this business scenario, the same item – a portable hard drive or PHD – is purchased and sold. ERPs can, and usually should, be configured to provide much more granular tracking of items (e.g., tracking blank PHDs as raw materials, partially configured PHDs as work in progress, fully configured and labeled PHDs as finished goods; managing various locations and current transportation status). Students process different steps of this work as individual postings depending on the date they make and commit the transactions. The transactions are typically collected in batches for processing. Students have been given broad authority to process a wide variety of transactions so they can execute all the required activities; typically, separation of duties would limit their activities and divide entry, confirmation, and posting authority among different individuals. Each student will create individualized, but duplicate and redundant, items, vendors, and customers. However, only one Amazon vendor, the university's Bookstore customer, or PHD item would be typically established within an ERP and shared among users. The individualization creates a set of course exercises where all students execute the transaction cycle. Warehouse is not necessarily a large building for inventory; instead, it is used in ERPs and in this scenario to represent part of a site. Each "warehouse" is a locker to hold an individual student's products. This scenario is broken into three separate exercises that build on each other. A summary of key steps in these exercises is presented in Table 3.
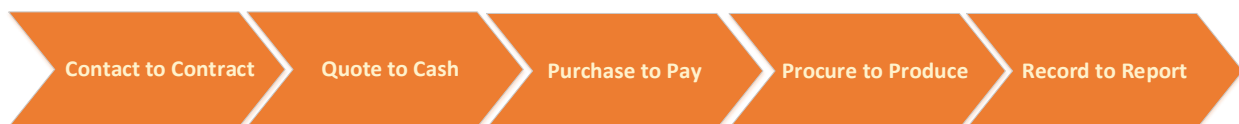

Figure 1. Core Processes

	Task
Lab 2: Business Unit Setup	Establish your role as a system administrator
	Establish yourself as a contractor
	Create your business unit
	Create a bank account for your business unit
	Make yourself the manager of your business unit
	Post Contoso check providing seed money for your business unit operations
	Create a Trial Balance Report
Lab 3: Procurement	Establish a warehouse for your business unit
	Establish a portable hard drive item
	Release a portable hard drive item to your business unit
	Add a vendor for 'raw' PHDs
	Follow the money
	Record order, receipt, and payment for 25 PHDs
	Create a Trial Balance Report
Lab 4: Order Processing	Add a prospect, and convert it to a customer
	Add a customer for 'finished' PHDs
	Record sale, delivery, and collection for 10 PHDs
	Create a Trial Balance Report

Table 3. A Summary of Key Activities in Labs 2, 3, and 4

Throughout this series of exercises, students explore some of the newest aspects of Dynamics 365, such as workspaces, which brings many related features in one place and enables an efficient and quick completion of the work. Most students will quickly notice that Dynamics 365 is designed in such a way that one can essentially find most of the relevant information and complete many activities related to a certain task without leaving the workspace. In other words, they will stay in one screen from the beginning to the end when completing the task.

5.3 Hands-on Labs 5 and 6: ERP & HR

These two labs introduce students to the "recruit to retire process" (Figure 2) and how it is handled in an ERP system. In this scenario, Contoso has expanded its sales and marketing department and is looking for skilled candidates to support that expansion. Claire (an HR manager) asks Jacob (a recruiter) to find the qualified candidates, either internally or externally, and to leverage the necessary resources to hire the right ones for the position. One of the key requirements is to have a clear match between the applicants' skills and the skills that are needed to deliver on the job. The second scenario walks the students through the retiring process of either a position or an employee (off-boarding).

This set of labs introduces a streamlined hire to retire process in Microsoft Dynamics and provides an overview of the major concepts. Moreover, it introduces students to how Microsoft Dynamics AX automates the hiring process, thereby eliminating redundant data. It also demonstrates how the processes for employee transitions and retirement can be streamlined. This process includes initiating the workflow to manage user provisioning, set up security, and maintain key benefit enrollment information.

5.4 Hands-on Lab 7: ERP & CRM – RFM Analysis

While ERP systems are comprehensive and their core capabilities are robust, there are always opportunities on the fringes for external vendors in areas such as Customer Relationship Management (CRM), Supply Chain Management (SCM), and Business Intelligence (BI) to offer specialized software. For example, CRM systems include the front-end, customer facing processes such as marketing, sales, and customer service which are not extensively available in traditional ERP systems. Specialized SCM systems provide advanced modules in procurement, manufacturing, transportation, and warehouse management. However, since all these systems ultimately generate accounting transactions, they need to be integrated into the ERP system. This is one of the reasons SAP bought Ariba (a specialized supplier network solution) and why Oracle attempts to acquire Salesforce.

This lab focuses on CRM functionality of ERP systems in general and RFM analysis in particular. Recency, frequency, and monetary (RFM) analysis is a simple, but effective, marketing tool that companies can use to evaluate the strategic value of customers. Students learn how to set up an RFM analysis in the Dynamics AX system based on the data that is generated by customer purchases. They are tasked to perform RFM analysis and classify Contoso's customers to understand how much (M), how recent/often (R), and how frequently (F) they buy from the company. Students then evaluate the RFM scores to monitor customers' dealings with the company.
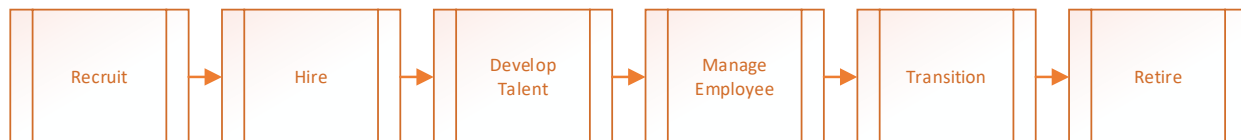

Recruit → Hire → Develop Talent → Manage Employee → Transition → Retire

Figure 2. Dynamics AX's Human Resource Processes

5.5 Hands-on Lab 8: ERP & SCM – Master Planning and MRP

Material requirement planning (MRP) is a fundamental component of the manufacturing module in an ERP system. This lab discusses MRP functionality of Dynamics AX (Figure 3). Throughout this lab, students get familiar with bill of materials (BOM) and master production schedule (MPS) functions and understand how a manufacturer uses an MRP function to schedule and place orders for items of dependent demand. Enough information is provided to students to set up a BOM for the finished portable hard drive that they had worked on in previous labs. In this scenario, Contoso plans to sell 100 portable hard drives in a given month based on sales and inventory data in the same month. These 100 portable hard drives are planned independent requirements, also known as planned production. Since every portable hard drive is produced using a printed circuit board (PCB), a cover, a power switch, and three capacitors, these 100 portable hard drives that students plan to sell on behalf of Contoso result in 100 PCBs, 100 covers, 100 power switches, and 300 capacitors. Based on these numbers, students are tasked to set up a BOM and perform an MRP analysis in Dynamics AX to calculate, considering the current on-hand inventory levels, how many portable hard drives they can actually produce and how many PCBs, switches, covers, and capacitors they need to procure. The MRP function creates a purchase plan which should be communicated to the purchasing staff department so they can order the materials.
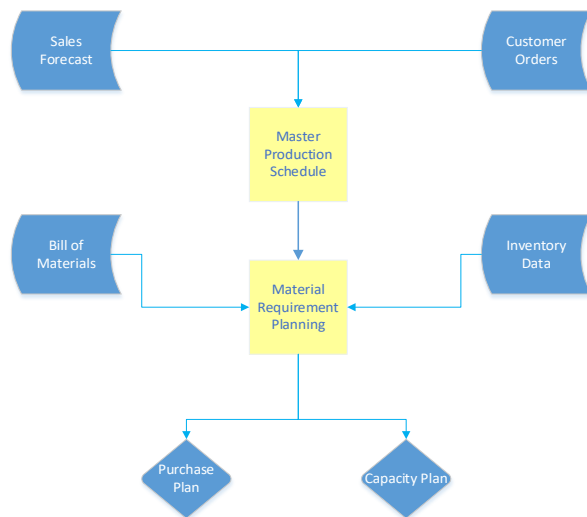

Figure 3. Dynamics AX's Manufacturing Process

5.6 Hands-on Lab 9: ERP & BPR – Workflow

Workflows are the most important feature for modern ERP systems, helping organizations to automate business processes and implement best practices. The purpose of this particular lab is to become familiar with the workflow environment of the Microsoft Dynamics ERP System to perform business process reengineering (BPR). Students will learn how to set up a workflow and integrate an ERP software into the actual workflow of an organization. In this scenario, we demonstrate one example of how workflows can be set up to make the process of approving a purchase order a bit easier for Contoso.

Students are advised to think of a situation where so many purchase orders are created in the Contoso organization that make it too onerous to review each one of them before they can be sent to the vendor. The clients have to print out a copy of their purchase orders and walk from desk to desk to get the necessary approval signatures even if it was not always necessary. In order to avoid long walks in the office, as well as reducing paper consumption, a workflow can be set up to take care of both of these common issues. Students were tasked to build a workflow to handle purchases for Contoso. More specifically, we defined a business rule requiring that only purchases of certain products whose amount was over $5,000 needed an approval process. Students used the workflow elements in Dynamics AX to build a workflow in which whenever the order amount for their own portable hard drives exceeded $5000, the order had to be forwarded to an authorized person (e.g., purchasing manager) within the company for approval. An example of this purchase order workflow in Dynamics AX is displayed in Figure 4. This particular exercise helps students develop a better understanding of the process through which an organization can configure the ERP system using appropriate parameters that tailor certain aspects of the system to their business rules.
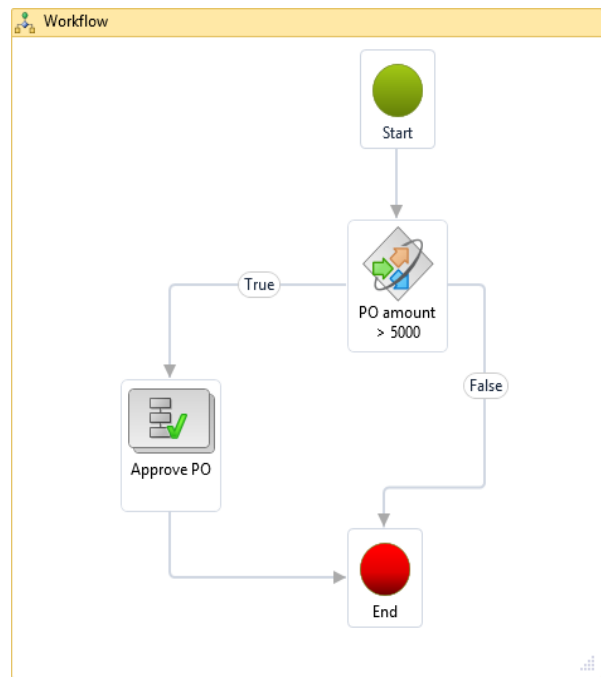

Figure 4. Purchase Order Workflow

5.7 Hands-on Lab 10: ERP Technology – Database

The objective of this lab is to explore the database layer of an ERP system. We provide the students with an understanding of how data is stored and managed in ERP systems for business decision-making. In this lab, students learn how to work with the database of an ERP in SQL server management studio, how to create queries, and how to use advanced query functions in Dynamics AX to perform OLAP analysis. Students recognize how complex the database schema for an ERP system is. In addition, students learn how to determine database tables that

Trace Start		
SP:StmtCompleted	UPDATE SYSUSERLOG SET LOGOUTDATETIME=@P1,RECVERSION=@P2 WHERE ((RECID=@P3) AND (RECVERSION=@P4))	0
SP:StmtCompleted	UPDATE SYSLASTVALUE SET VALUE=@P1,RECVERSION=@P2 WHERE (((((((PARTITION=@P3) AND (USERID=@P4...	0
SP:StmtCompleted	UPDATE BATCHJOB SET STATUS=@P1,STARTDATETIME=@P2,RECVERSION=@P3,STARTDATETIMETZID=@P4 WHERE (...	0
SP:StmtCompleted	UPDATE BATCHGLOBAL SET LASTPROCFINISHEDJOBS=@P1,RECVERSION=@P2 WHERE ((NAME=@P3) AND (RECVERS...	0
SP:StmtCompleted	UPDATE BATCH SET STATUS=@P1,MODIFIEDDATETIME=@P2,RECVERSION=@P3 WHERE ((STATUS=@P4) AND (CONS...	0
SP:StmtCompleted	UPDATE BATCH SET STATUS=@P1,MODIFIEDDATETIME=@P2,RECVERSION=@P3 WHERE ((STATUS=@P4) AND (CONS...	0
SP:StmtCompleted	UPDATE BATCH SET STATUS=@P1,MODIFIEDDATETIME=@P2,RECVERSION=@P3 WHERE (STATUS=@P4) AND EXISTS...	0
SP:StmtCompleted	UPDATE SYSCACHEFLUSH SET CLEARDATA=@P1,RECVERSION=@P2,MODIFIEDDATETIME=@P3 WHERE ((RECID=@P4)...	0
Profiler Message Event	This is the end of file 0 of a rollover file. Next file is C:\Users\amir.zadeh\Desktop\w002ah...	
Profiler Message Event	This is file 1 of a rollover file. Previous file is C:\Users\amir.zadeh\Desktop\w002ahz.trc.	
Profiler Message Event	This is the end of file 1 of a rollover file. Next file is C:\Users\amir.zadeh\Desktop\w002ah...	
Profiler Message Event	This is file 2 of a rollover file. Previous file is C:\Users\amir.zadeh\Desktop\w002ahz_1.trc.	
SP:StmtCompleted	INSERT INTO ECORESPRODUCT (INSTANCERELATIONTYPE,DISPLAYPRODUCTNUMBER,SEARCHNAME,PRODUCTTYPE,P...	36
SP:StmtCompleted	INSERT INTO ECORESPRODUCTIDENTIFIER (PRODUCT,PRODUCTNUMBER,RECVERSION,PARTITION,RECID) VALUES...	14
SP:StmtCompleted	INSERT INTO ECORESPRODUCTTRANSLATION (DESCRIPTION,NAME,PRODUCT,LANGUAGEID,MODIFIEDBY,RECVERSI...	153
SP:StmtCompleted	UPDATE SYSLASTVALUE SET VALUE=@P1,RECVERSION=@P2 WHERE (((((((PARTITION=@P3) AND (USERID=@P4...	0
SP:StmtCompleted	UPDATE SYSCACHEFLUSH SET CLEARDATA=@P1,RECVERSION=@P2,MODIFIEDDATETIME=@P3 WHERE ((RECID=@P4)...	0
Profiler Message Event	This is the end of file 2 of a rollover file. Next file is C:\Users\amir.zadeh\Desktop\w002ah...	
Profiler Message Event	This is file 3 of a rollover file. Previous file is C:\Users\amir.zadeh\Desktop\w002ahz_2.trc.	
Profiler Message Event	This is the end of file 3 of a rollover file. Next file is C:\Users\amir.zadeh\Desktop\w002ah...	
Profiler Message Event	This is file 4 of a rollover file. Previous file is C:\Users\amir.zadeh\Desktop\w002ahz_3.trc.	
Trace Stop		

Figure 5. SQL Profiler Result

are being altered after a transaction is created in the ERP system. In this scenario, students use the SQL Server Profiler to determine what SQL tables are hit when a new product is added to the product information management module. SQL Server Profiler is an excellent interface that allows students to create traces to analyze SQL queries in order to understand the ERP database. Figure 5 illustrates an example of the result of the SQL Server Profiler.

5.8 Hands-on Lab 11: ERP & Business Analytics – Power BI

As more and more business processes are automated, more data than ever before are also collected and stored in ERP systems, making it hard to process such data using traditional database techniques. Because of this trend, business analytics capabilities have become an integral part of modern ERP systems. This lab focuses on business analytics for ERP systems, as well as on how BI tools such as Power BI in the extended Microsoft Dynamics system can enable deeper insights from the ERP data. Dynamics AX leverages all other products within the Microsoft suite to extend the application outside of what traditional ERP systems are able to do natively. In particular, Power BI is embedded in Microsoft Dynamics to provide advanced data analytics and reporting services. Real-time reporting is the key feature of power BI since the data used for the reports are sourced by the ERP system itself. This greatly improves an organization's strategic decision-making capabilities. This lab shows students some of the ways that Dynamics AX leverages other Microsoft products, allowing them to learn how to take advantage of these capabilities. More importantly, students are tasked to use Power BI capabilities to retrieve information from the ERP database and uncover valuable insights from the large volume of data gathered by an ERP system. For instance, students are guided to create a dashboard analysis with an overview of sales by location, channel, category, and more. Students can also display sales data from Dynamics AX in an interactive world map where the *total amount* tree-map can be drilled down to the page that reports the distribution of sales at the state-level. Use of Power BI to create data visualizations is illustrated in Figure 6. The heat map shows the location for each region where sales amounts are given. The small pie charts in each area represent the fiscal year and the amount of sales during that year. This type of map will help students discover which state/city has the most sales for each of the fiscal years.

5.9 Hands-on Lab 12: ERP & Business Analytics – Data Visualization

An ERP system offers a tremendous wealth of data for analysis. However, ERP systems may not have sufficient data analytic functionality. Oftentimes, additional BI tools are needed to turn the data to actionable information and intelligence. In this lab, students explore several ways to interface ERP systems with a business intelligence application such as Tableau data visualization tool. Students learn how to use an open database connectivity (ODBC) connection to export Microsoft Dynamics's data to the Tableau environment and explore Tableau's capabilities to visualize and display the data in a more meaningful and easy-to-understand manner. More specifically, students are tasked to develop a BI question, the answer to which they would like to know. Using the Tableau capabilities, students build a visual dashboard that is used to answer their question. This exercise helps students understand the significance of data by placing the data in a visual context. Such significance may not be discerned from the tabular format of ERP data. Figure 7 illustrates the use of Tableau to visualize ERP data.
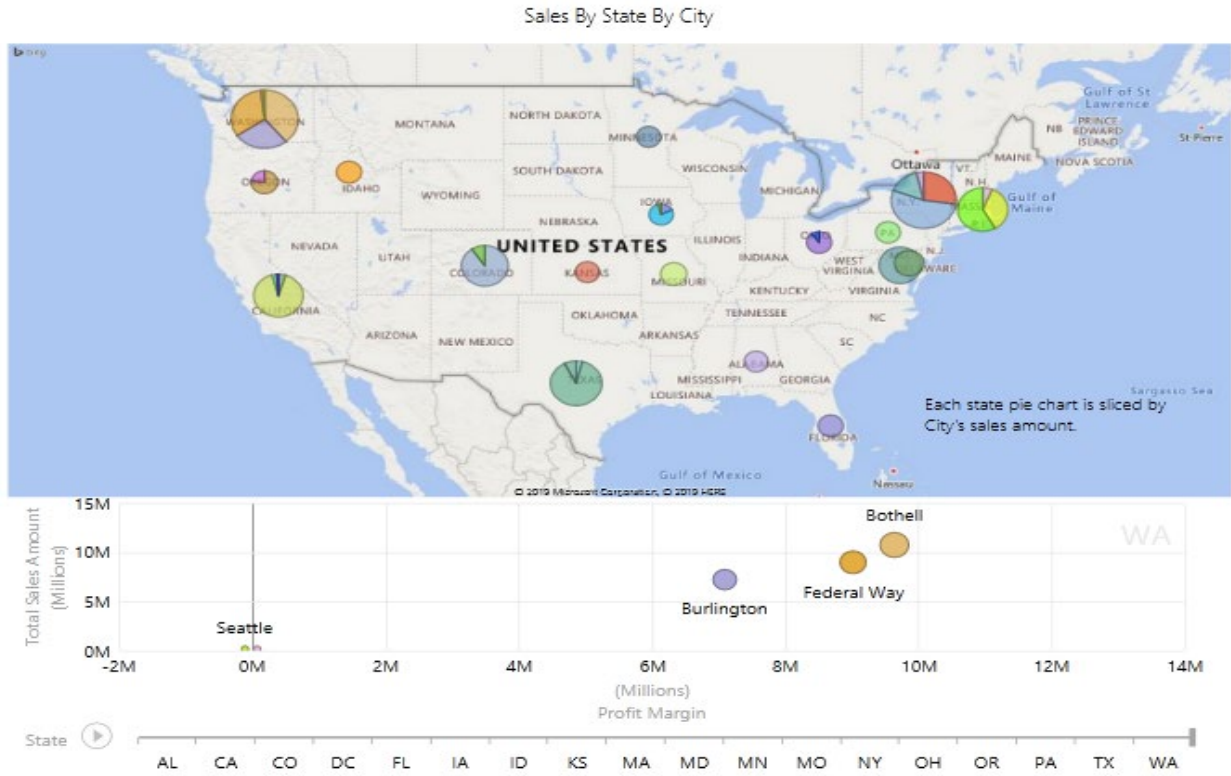
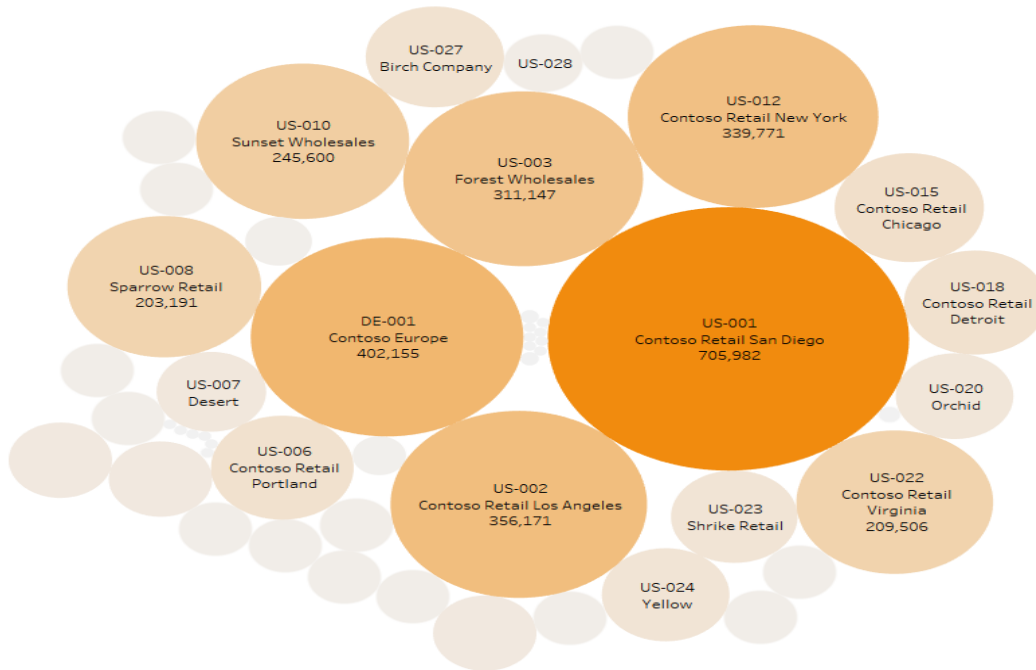**Figure 6. ERP Data Visualization with Power BI (Microsoft, 2016)**

Figure 7. ERP Data Visualization with Tableau (E-Business Solution, 2015)

5.10 Hands-on Lab 13: ERP & Business Analytics – Demand Forecasting

ERP systems can be used to answer "what has happened" type questions (i.e., descriptive analytics) and can also be used to predict future behaviors and probable outcomes (i.e., predictive analytics). Today's ERP systems have built-in predictive capabilities that use data from the past and extrapolate trends or patterns of the data into the future. To name just a few examples, the "available to promise" (ATP) feature in an ERP system combines data from sales, inventory, and production to predict more accurately the delivery lead time at time of purchase. Such information is used to communicate the delivery date with the customer. A sales forecast can similarly be performed in an ERP system via the use of sales histories and projections. Additionally, several optimization algorithms are built into the transportation management module of ERP systems to enable companies to plan freight transportation routes with multiple stops and to decide which carriers to use on which lanes or routes for the next period.

This particular lab focuses on demand forecasting. The purpose of the lab is to demonstrate how ERP utilizes big data to create predictive and prescriptive decision-based models. Students become familiar with demand forecasting in the Dynamics AX ERP system and learn how to use time-series forecasting models to generate a forecast for a given product based on historical data available in the master planning module of the ERP system. Dynamics AX's demand forecasting tool uses time-series forecasting models available via SQL Server Analysis Services (SSAS). SSAS models are a great example of Online Analytical Processing (OLAP) solutions that create cubes using data from ERP systems to deliver deeper and faster data analysis. Students are instructed to generate a two-year forecast for all products in the ERP system. With the integrated pivot table, students are able to organize the forecast data at the individual product and category level, examine the accuracy of the forecasting models by comparing the actual and forecasted data, and adjust and publish the forecast data back to the ERP system for planning and execution purposes.

5.11 Hands-on Lab 14: ERP Development – Customized Report

ERP systems are designed based on best business practices. However, companies implementing ERP systems oftentimes customize them and make them fit their unique needs. This involves modifying the exiting codes or adding additional codes to write custom, company-specific reports, forms, and interfaces in order to enhance the application.

The purpose of this lab is to become familiar with the basic operations in AOT (Application Object Tree), the development environment of Microsoft Dynamics AX ERP System. Students first explore various financial reports available in the general ledger module through the management reporter tool and then learn how to create a customized report in Microsoft Dynamics AX using AOT and Microsoft Visual Studio. This lab illustrates the step-by-step process of creating reports in Microsoft Dynamics AX. It shows how to launch a report in Dynamics AX and how to filter the data on the report. It also details how to develop a customized report, create data sources on the report in AOT, select tables/data fields in the data source, and create grouping, sorting, and filtering in a custom report. Students learn how to build the report and deploy it either to the source

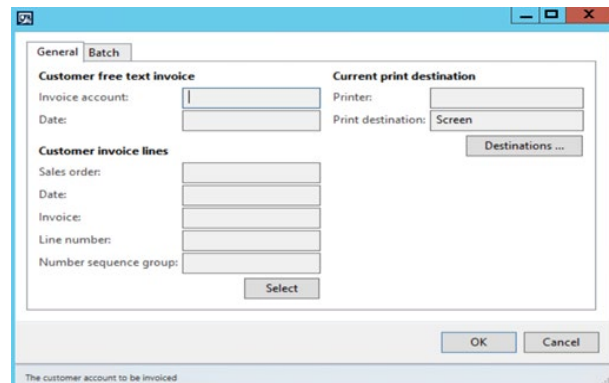control or directly to the Microsoft Dynamics report server. A custom report menu is shown in Figure 8.

Figure 8. Custom Report Menu

5.12 Hands-on Lab 15: ERP Security

For an ERP system to achieve its goals of providing accurate, reliable, and complete information, it must operate in a secure environment in which all users adhere to security policies within the organization. ERP security is a wide range of IT policies, procedures, and measures (internal controls) aimed at protecting ERP systems from vulnerabilities. The purpose of this lab is to become familiar with the security functionality of ERP systems, the various types of internal controls, and their objectives. Students learn how to implement and verify internal controls and segregation of duties in a typical ERP solution such as Microsoft Dynamics and recognize various risks that can occur as a result of a lack of segregation of duties. Students set up security rules in Microsoft Dynamics in order to separate tasks that must be performed by different users and identify and resolve conflicts that involve segregation of duties.

6. INFRASTRUCTURE AND INSTALLATION OVERVIEW

We utilized Dynamics AX and 365 for Finance and Operations from Microsoft. Dynamics can be brought into the classroom in many ways. One of the easiest and cost-effective ways is to collaborate with the Microsoft Dynamics Academic Alliance Program which provides free resources to universities to incorporate Dynamics into their curriculum and train students on its tools. Microsoft provides a pre-configured virtual machine (VM) for Dynamics that can be installed both on-premises and in the cloud (i.e., Azure). Through the Microsoft Dynamics Life Cycle Services (LCS) platform, universities can download the all-in-one OneBox version of Dynamics which is essentially a virtual desktop infrastructure (VDI) package. While Dynamics AX is primarily a desktop application, Dynamics 365 is completely web-based, which means it can be configured and integrated with the university's LDAP (Lightweight Directory Access Protocol) so that students can access it via a web browser from outside the VM without any hassles, such as having to memorize passwords or running remote access software. This configuration also supports the idea of classroom-as-organization, which allows multiple students to work with one instance of an ERP system. When the

ERP is installed via a vanilla implementation, students would then start their ERP journey with configuring the ERP system.

7. COURSE ASSESSMENT

We assessed students' feedback and learning outcomes for the course using a survey that was designed to rate the course's effectiveness and usefulness in employing the experimental learning approach described in this article. Eighty-six students participated in the survey over a period of four semesters. The results of the survey are presented in Table 4. The main goal of the course was to provide students with hands-on experience with functional and technical aspects of an ERP system.

#	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Helped me understand what ERP is and how it works	67	18	1	0	0
2	Improved my understanding of ERP modules and business processes	67	17	2	0	0
3	Demonstrated how to perform end-to-end tasks in the ERP system	50	36	0	0	0
4	Improved my understanding of ERP architecture (database, presentation, and application layers) without delving too much into the technical complexities of it	51	31	2	2	0
5	Improved my understanding of development/mechanics side of the ERP system without going too much into details	61	22	2	1	0
6	Demonstrated how to add new features (such as customized reports) to the ERP system using visual studio and AOT tools	40	35	11	0	0
7	Demonstrated how to perform data analytics in the ERP system	62	24	3	0	0
8	Demonstrated how built-in business intelligence tools (e.g., Power BI, Tableau) in ERP can help gain business insights and grasp trends/patterns in operational data quickly	72	13	0	1	0
9	The Dynamics AX was easy to run SQL queries	47	31	6	1	0
10	The SQL sequence analysis helped me to better understand the underlying Dynamics AX operations	34	37	7	8	0
11	Demonstrated which SQL tables are being hit in the ERP database when new data is entered/added to the system	49	24	11	2	0
12	The goals of the exercises were clearly stated and consistently pursued	69	16	1	0	0
13	The exercises were reasonable and useful	58	26	2	0	0
14	The exercises gave me a good awareness of the potential of ERP technologies.	65	20	1	0	0
15	The step-by-step handout helped me go through the exercise	66	19	1	0	0
16	The steps described in the handout were not working	0	2	2	23	59
17	This exercises were irrelevant for this course	0	0	2	10	74
18	I gained no new knowledge from these exercises	0	0	0	14	72
19	I like to learn more about Microsoft Dynamics AX system and ERP in general	55	18	13	0	0
20	I like to do more hands-on exercises with Dynamics AX	46	27	12	1	0
21	The Dynamics AX was easy to use and understand	57	24	5	0	0

Table 4. Teaching Exercises Evaluation (N=86)

Most students agreed that they gained knowledge in the course and that the ERP platform used for teaching the course was generally easy-to-use and understandable. Even though the course was set to be more technical, most students appreciated learning the technical material through practice. The overall acceptance was even higher among those students who seemed to have a more technical background. Additionally, business analytics and ERP exercises received very strong positive feedback from the students. This suggests that a huge benefit can be obtained through processing ERP data for more actionable information. For that reason, students enjoyed going beyond the ERP's data analytic functionality and using additional tools to unlock a wealth of information waiting to be explored. More importantly, students realized that things do not exist in a bubble and that they are all intertwined.

In addition, similar scores, sentiments, and feedback were recorded in the formal course evaluation. This is evidenced in student comments in the course evaluation such as:

- "The Microsoft Dynamics AX labs using the D.A.V.E. Lab were very informative."
- "Very good examples were used and I felt like I could apply this knowledge to ERP systems."
- "The hands on experience with Power BI and Microsoft Dynamics AX were beneficial to what we were learning."
- "Yes, the hands on labs and demonstrations were effective in developing our skills, and helped to reiterate the material we were learning."
- "Going into this course I knew almost nothing about how ERP systems worked and just after spending one semester, I feel like I have learned enough to already be proficient."
- "Excellent course, I learned a great deal about how to proceed with ERP projects."
- "This class taught dynamics ERP from the ground up. I feel able to do this type of analysis because of this class."

8. CONCLUSION

In this article, we provided an account of our practical experience from teaching ERP systems using Microsoft Dynamics, a less conventional but arguably more suitable tool. Rather than focusing exclusively on the functional areas of ERP systems, a more technical flavor was assumed with an emphasis on data management and analysis. As evidenced in student feedback, we believe the lab exercises and the guidelines provided in this teaching tip would provide practical directions to higher education institutions on how to deliver an ERP course, using Microsoft Dynamics, to business students. In this course, we strived to retain a balance between hands-on technical training and functional training needed to run businesses.

9. ENDNOTES

The teaching notes and lab assignments are available at http://techcats.solutions/.

10. REFERENCES

Ayyagari, R. (2011). Hands-on ERP Learning: Using OpenERP®, an Alternative to SAP®. *Journal of Information Systems Education,* 22(2), 123-134.

Barkhi, R. & Kozlowski, S. (2017). ERP in the Classroom: Three SAP Exercises Focused on Internal Controls. *Journal of Emerging Technologies in Accounting,* 14(1), 77-83.

Bradford, M., Vijayaraman, B., & Chandra, A. (2003). The Status of ERP Integration in Business School Curricula: Results of a Survey of Business Schools. *Communications of the Association for Information Systems,* 12(1), 437-456.

Chauhan, S. & Jaiswal, M. (2016). Determinants of Acceptance of ERP Software Training in Business Schools: Empirical Investigation Using UTAUT Model. *The International Journal of Management Education,* 14(3), 248-262.

Chen, K., Razi, M., & Rienzo, T. (2011). Intrinsic Factors for Continued ERP Learning: A Precursor to Interdisciplinary ERP Curriculum Design. *Decision Sciences Journal of Innovative Education,* 9(2), 149-176.

Chen, L., Keys, A., & Gaber, D. (2015). How Does ERPsim Influence Students' Perceived Learning Outcomes in an Information Systems Course? An Empirical Study. *Journal of Information Systems Education,* 26(2), 135-146.

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

Cronan, T. P. & Douglas, D. E. (2013). Assessing ERP Learning (Management, Business Process, and Skills) and Attitudes. *Journal of Organizational and End User Computing (JOEUC),* 25(2), 59-74.

Cronan, T. P., Douglas, D. E., Alnuaimi, O., & Schmidt, P. J. (2011). Decision Making in an Integrated Business Process Context: Learning Using an ERP Simulation Game. *Decision Sciences Journal of Innovative Education,* 9(2), 227-234.

Dunaway, M. M. (2018). An Examination of ERP Learning Outcomes: A Text Mining Approach. In Deokar, A., Gupta, A., Iyer, L., & Jones, M. (eds.) *Analytics and Data Science* (pp. 265-279). Springer.

E-Business Solution. (2015). Tableau – Driving Microsoft Dynamics Insights, Retrieved June 20, 2019, from https://community.dynamics.com/gp/b/encoreblogdynamics gp/archive/2015/09/15/tableau-driving-microsoft-dynamics-insights.

Fathelrahman, A. & Kabbar, E. (2018). Conceptualization of Enterprise Systems Education Using an Experiential Learning Framework. *Journal of Education for Business,* 93(2), 46-50.

Hawking, P. & McCarthy, B. (2004). Integrating E-Learning Content into Enterprise Resource Planning (ERP) Curriculum. *Issues in Informing Science & Information Technology, 1.*

Hepner, M. & Dickson, W. (2013). The Value of ERP Curriculum Integration: Perspectives from the Research. *Journal of Information Systems Education,* 24(4), 309-326.

Hustad, E. & Olsen, D. H. (2014). Educating Reflective Enterprise Systems Practitioners: A Design Research Study of the Iterative Building of a Teaching Framework. *Information Systems Journal,* 24(5), 445-473.

Iriberri, A., Kwon, O., & Henson, J. (2015). Integrating an ERP into the Curriculum at a Business School: The Students' Perceptions of SAP. *Academy of Educational Leadership Journal,* 19(2), 99.

Jewer, J. & Evermann, J. (2015). Enhancing Learning Outcomes through Experiential Learning: Using Open-Source Systems to Teach Enterprise Systems and Business Process Management. *Journal of Information Systems Education,* 26(3), 187-201.

Kolb, A. Y. & Kolb, D. A. (2005). Learning Styles and Learning Spaces: Enhancing Experiential Learning in Higher Education. *Academy of Management Learning & Education,* 4(2), 193-212.

Léger, P.-M. (2006). *Using a Simulation Game Approach to Teach ERP Concepts*. HEC Montréal, Groupe de Recherche en Systèmes d'Information.

Microsoft. (2016). Analyze Your Microsoft Dynamics AX Data with Power BI. Retrieved June 20, 2019, from https://powerbi.microsoft.com/en-us/blog/analyze-your-microsoft-dynamics-ax-data-with-power-bi/.

McDonald, M., Spence, K., & Sheehan, B. (2011). Classroom-as-Organization: An Integral Approach. *Journal of Integral Theory & Practice,* 6(2), 67-81.

Nightingale, J. (2019). Using a Simulation Game to Teach the Concept of ERP. In Al-Masri, A. & Curran, K. (eds.) *Smart Technologies and Innovation for a Sustainable Future* (pp. 457-463). Springer.

Nisula, K. & Pekkola, S. (2019). ERP Based Business Learning Environment as a Boundary Infrastructure in Business Learning. *Education and Information Technologies*, 25, 2547-2566.

Ruhi, U. (2016). An Experiential Learning Pedagogical Framework for Enterprise Systems Education in Business Schools. *The International Journal of Management Education,* 14(2), 198-211.

Sager, J., Mensching, J., Corbitt, G., & Connolly, J. (2006). Market Power of ERP Education: An Investigative Analysis. *Journal of Information Systems Education,* 17(2), 151-162.

Saraswat, S. P., Anderson, D. M., & Chircu, A. M. (2014). Teaching Business Process Management with Simulation in Graduate Business Programs: An Integrative Approach. *Journal of Information Systems Education,* 25(3), 221-232.

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.

Shen, Y., Nicholson, J., & Nicholson, D. (2015). Using a Group Role-Play Exercise to Engage Students in Learning Business Processes and ERP. *Journal of Information Systems Education,* 26(4), 265-280.

Strong, D., Fedorowicz, J., Sager, J., Stewart, G., & Watson, E. E. (2006). Teaching with Enterprise Systems. *Communications of the Association for Information Systems,* 17(1), 728-755.

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

Amir Hassan Zadeh is an associate professor of information systems at Wright State University. He holds a Ph.D. in management information systems from Oklahoma State University. His research and teaching interests are in business analytics, enterprise systems, and big data applications. His research has been published in journals such as *Decision Support Systems*, *Journal of Business Analytics*, *Information Systems Frontiers*, and *Production Planning & Control*. He is the recipient of the Outstanding Scholarship Award from the Raj Soin College of Business at Wright State University in 2019.

Hamed M. Zolbanin is an assistant professor of information systems at the University of Dayton. He had several years of professional experience as an IT engineer prior to receiving his Ph.D. in management science and information systems from Oklahoma State University. His research has appeared in journals such as *Decision Support Systems*, *Journal of Business Research*, and *Information Systems Frontiers*. His main research interests are healthcare informatics, business and data analytics, online reviews, and digital entrepreneurship.

Arijit Sengupta is associate dean of accreditation and technology systems and professor of information systems and business analytics at Florida International University's College of Business. He received his M.S. and Ph.D. in computer science from Indiana University. His research interests include technology adoption in organizations (particularly RFID and mobile technologies), improving student assessment and engagement, data analytics, databases and XML, data modeling, query languages, data mining, and human-computer interaction.
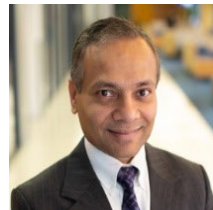
Todd Schultz is professor emeritus with Augusta University's School of Computer & Cyber Sciences. His academic background includes a doctorate in operations research – analytics in today's vernacular – but his research interests and practical experience of over 40 years are in quantitative programming, enterprise software, database, and business intelligence as an independent consultant and with firms such as American Management Systems and Ernst & Young Management Consulting Services. He currently serves on the advisory board of Microsoft Dynamics Academic Alliance.

Information Systems & Computing
Academic Professionals

EDSIG
Serving Information Systems Educators

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.