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Introducing a Teaching Framework for BDA Curricula With the SAP and ERPsim Games: Pedagogy and Assessment

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ABSTRACT

This study introduces a modular teaching framework for business data analytics (BDA) curricula and programs. The framework integrates gamification features of the SAP business processes, ERPsim Games, and SAP data warehousing into the experiential learning of BDA curricula. The pedagogical practices of deploying the framework in an undergraduate BDA course are reported and assessed in virtual and face-to-face teaching modalities. The assessment shows that integrating the framework in business pedagogies enhances the BDA learning experience and teaching effectiveness. The paper concludes with the theoretical and practical implications of the study for business educators and practitioners in BDA learning, teaching, and training. The limitations and future research avenues of the study are discussed.

Keywords: Business data analytics, Pedagogy, Teaching framework, Assessment, SAP, ERPsim

1. INTRODUCTION

As companies "wring every last drop" of value from business processes, enterprise data becomes a superior asset in business operations, decision-making, and strategic planning. With the advancement of the Internet and social technology, the sources, types, volumes, and complexities of enterprise data have exploded exponentially, leading to the widespread adoption of business data analytics (BDA) in various industries and business sectors (Manyika et al., 2011).

The Institute for Operations Research and Management Science (INFORMS) defines BDA as "facilitating the realization of business objectives through reporting data to analyze trends, creating predictive forecasting models, and optimizing business processes for enhanced performance." The BDA includes the underlying data architecture, analytical tools, database management systems (DBMS), business applications, and methodologies (Chiang et al., 2012). The essence of BDA is to collect and analyze large volumes of data in structured, semi-structured, and unstructured forms for meaningful insights, knowledge, and opinions into the ever-evolving business processes and trends. Provost and Fawcett (2013) thus rely upon the general cross-industry standard process for data mining (CRISP-DM) to structure the fundamentals and specifics of BDA curricula in terms of business understanding, data preparation, data modeling, and model deployment in the organization.

During the past decade, information systems (IS) educators and practitioners have realized the enormous demand and potential of the BDA (Chen et al., 2012; O*NET, 2021) and incorporated BDA capabilities in business curricula and programs. Typically, a BDA curriculum "prepares students for

a successful career in a very fast-growing field of BDA with an emphasis on the development of BDA knowledge, skills and its practical application to effectively address business problems for data-driven decision making" (CSUN SOM Business Analytics, 2023). Initially, because of the emerging and evolving interdisciplinary nature of BDA, the inadequacy of the teaching frameworks and assessment of the pedagogical approaches has been and still is the leading challenge to initiatives of BDA curricula and programs (Chiang et al., 2012; Mills et al., 2022).

Meanwhile, simulation/gamification technologies have been widely used in business pedagogies (Ajayi Ore, 2020; Dicheva et al., 2015). Due to the shortage of faculty and pedagogical approaches, business educators have called for pedagogical innovations to introduce simulation and gamification features for better access to BDA resources (Ajayi Ore, 2020). As the design features of the SAP and the ERPsim (Simulations for ERP) Games – a real-time business simulation game platform – have long been used in the enterprise resources planning (ERP) pedagogies, how to systematically integrate the SAP data warehousing and the ERP simulated/gamified enterprise environment into BDA curricula becomes vital for enhancing learning experience and teaching effectiveness. Thus far, while ERP pedagogies abound, little research has explored the teaching frameworks and instructional practices that integrate design features of the SAP and the ERPsim Games for BDA curricula.

To meet the challenge, IS faculty need to expand their visions and capabilities in developing innovative teaching frameworks. Thus motivated, this study combines design features of the SAP and the ERPsim Games and our pedagogical practices to introduce a teaching framework for BDA curricula and programs. The framework integrates the built-in simulation/gamification features of the ERPsim Games and the SAP High-performance Analytic Appliance (SAP HANA) data warehousing – the version of the SAP S/4HANA was released in 2013 – in a cloud computing environment (ERPsim, 2023; SAP University Alliances Learning Portal, 2023). Built upon the simulated business context, the framework can be deployed in BDA curricula to instruct students to integrate business processes, visualize transactional data, analyze business transactions, develop executive reports, and make data-driven decisions. To further improve students' experiential learning, the framework can be used to assign various business domain roles among teams for students to practice and learn about business collaborations. In so doing, the game-playing features of the framework shall enhance students' learning experience and promote them to be actively engaged in business processes.

Our teaching practices in BDA curricula illustrate that the framework can be systematically integrated into various business pedagogies. This study discusses the deployment of the framework with multiple pedagogical approaches. We compare the score means of the coursework and the overall means of student ratings of teaching (SRT) of several sessions of one undergraduate BDA course – Introduction to BDA – against those of the prior course sessions. We further report the assessment results of the twelve pedagogical outcomes, illustrating that specifying the framework in BDA curricula properly enhances the learning experience and teaching effectiveness. The findings and pedagogical practices bear theoretical and practical implications for business educators and practitioners in BDA learning, teaching, and training. The limitations and future research avenues of the study are also discussed.

2. REVIEW OF RELATED WORK IN BDA PEDAGOGY

Since the inception of BDA education, the shortage of faculty who have in-depth analytical skills and know how to implement the computationally intensive techniques and technologies – and specifically, the pedagogical frameworks and assessments of BDA curricula – has been the leading barrier (Chen et al., 2012; Chiang et al., 2012; Wixom et al., 2014). A decade ago, Wixom et al. (2014) reported key findings that (1) academics were behind the curve in delivering effective BDA course offerings and (2) faculty should have better access to BDA skills and resources. Our literature review suggests that inadequacy of staffing, computational skills, and effective pedagogies is still a big challenge to initiatives of BDA curricula and programs (Mills et al., 2022).

To address the demand, IS scholars and educators have advocated that IS faculty expand their visions and unique expertise to deliver effective BDA pedagogies (Chen et al., 2012; Chiang et al., 2012). Among the endeavors, Chiang et al. (2012) provide an overview of BDA curricula, speculate on the role of BDA education, and discuss the role of curriculum development. Chaurasia et al. (2018) provide insights into creating BDA capabilities for higher education transformation. The study suggests an empirical foundation that can lead to a thorough analysis of BDA implementation in Higher Education. Nguyen et al. (2020) offer an overview of theoretical perspectives on BDA programs. The study proposes a set of unified definitions and an integrated framework for developing BDA programs. Mills et al. (2022) examine trends in how IS departments have incorporated BDA in naming conventions, majors, minors, concentrations, and course curricula. Very specifically, Nestorov et al. (2019) describe a data visualization class and its real-world project components in an undergraduate program.

These studies provide a set of constructive insights and empirical foundations for delivering BDA curricula and programs. However, as of our best knowledge, studies of this stream are still fragmented; very few have explored the development and assessment of the pedagogical frameworks for BDA curricula and programs.

Meanwhile, as ERP systems are widely implemented in the business world, over decades, the efforts and commitments among IS academia have largely increased in covering ERP systems in business curricula (Antonucci et al., 2004). Among them, Hawking et al. (2004) indicate that, since the 1990s, there has been considerable growth and implementation of ERP systems. As a result, teaching focuses and debates have arisen surrounding the ERP curricula. For example, Iriberri et al. (2015) report students' perceptions of usefulness, ease of use, and intention to use the ERP systems. Kohers (2015) integrates ERP pedagogies into IS core courses based on the modifications of the Guidelines for Undergraduate Degree Programs. Topi et al. (2010) report issues of the ERP education. Wang (2011) proposes a framework integrating the SAP ERP systems in IS curricula.

Accordingly, research calls have been made for integrating innovative technologies (e.g., simulation/gamification) to enhance learning experiences and teaching effectiveness of the

ERP curricula. The HEC Montreal (A bilingual public business school in Montreal, Quebec, Canada) developed the ERPsim Lab – a dynamic learning platform – and integrates the SAP simulation and gamification technologies for teaching the ERP systems (ERPsim, 2023). With many game-playing experiences in the ERPsim Lab, students learn and practice business processing and associated data transactions. Moreover, through the game-playing experience, students learn to analyze transactional data and make business decisions.

As such, the ERPsim Lab constructs a series of business features in manufacturing, distribution, logistics, and retailing – a complete set of business management processes in which a large volume of transactional data is captured, processed, and analyzed. Thus far, the ERPsim Games have been widely deployed in business curricula and programs (Labonte-LeMoyne et al., 2017; Wang, 2011; Wang, 2018; Wang, 2022). As of 2023, more than 1,000 instructors are trained and certified to teach the ERPsim Lab in more than 250 higher education institutions worldwide (ERPsim, 2023).

As a result, research in business pedagogy has scrutinized the SAP and the ERPsim Games in IS curricula. For example, Chen et al. (2015) examine how the ERPsim Games can enhance learning objectives. The study provides empirical evidence that students' playful experience and cognitive appraisal of the ERPsim Games positively affect teaching effectiveness of business processes and ERP systems. Hwang (2018) suggests that IS students are more active than other majors in engaging in teamwork learning in a gamified environment such as the ERPsim Games. Labonte-LeMoyne et al. (2017) investigate issues of using the ERPsim Games to teach BDA curricula. Wang (2018, 2022) presents the importance, framework, and delivery models of integrating the SAP and ERPsim Games into IS curricula. Dick and Akbulut (2020) conclude that the use of the ERPsim Games can be extended from the IS domain to other business curricula.

As business educators have increasingly integrated the simulations/gamification technology in business curricula, the practice produces encouraging pedagogical outcomes. However, our literature review indicates that little research has explored the ERPsim simulation/gamification features in developing and assessing pedagogical frameworks in BDA curricula. Recognizing the research gap, this study introduces a teaching framework that combines the ERP data repository and design features of the SAP and ERPsim Games to enhance learning experience and teaching effectiveness of BDA curricula.

3. INTRODUCING A TEACHING FRAMEWORK FOR BDA CURRICULA

Building upon pedagogical practices and perspectives and findings of prior literature (e.g., Kohers, 2015; Labonte-LeMoyne et al., 2017; Wang, 2018; Wang, 2022), we introduce a teaching framework for BDA curricula and programs. Typically, a BDA curriculum combines pedagogical contents and resources on BDA fundamentals and specific knowledge, skills, and applications for data-driven decision-making (CSUN SOM Business Analytics, 2023). The BDA fundamentals focus on the essential understanding of business processes and BDA principles and theories, whereas BDA specifics on knowledge, skills, and practical applications of BDA capabilities in an organizational context (Provost & Fawcett, 2013). The proposed framework integrates key features of the SAP business processing, data architecture, and data warehousing tools in the ERPsim environment to address the fundamentals and specifics of BDA curricula. Figure 1 illustrates the four teaching modules of the framework. The technical details of the SAP and the ERPsim Lab can be found at the SAP University Alliances Learning Portal (2023) and ERPsim (2023), respectively.

3.1 Module 1: Business Processes in the SAP S/4HANA

As is illustrated in Figure 2, this module shall instruct students to follow the SAP lab manual to navigate and integrate business processes (BP) throughout business domains such as material management (MM), manufacturing, sales distribution (SD), and financial accounting (FI) in the SAP S/4HANA. In this module, students shall be instructed to understand the underlying enterprise system and gain firsthand experience with business processing and associated data transactions. The SAP S/4HANA simulations help students lay a solid business ground to understand keys (e.g., business processing and data preparation) to BDA fundamentals.

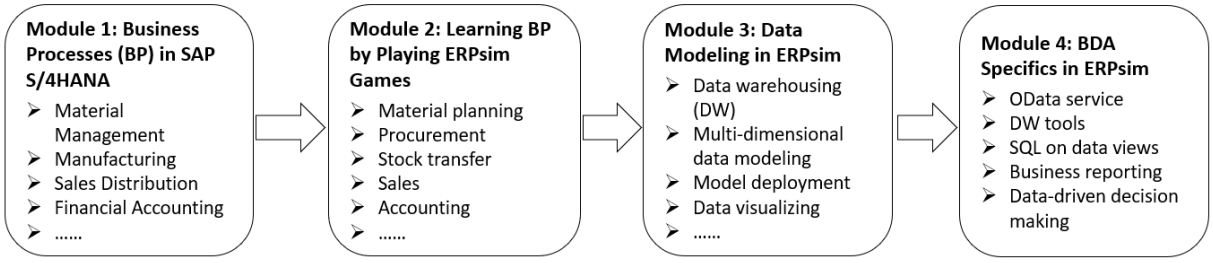


Figure 1. The Four Modules of the Teaching Framework

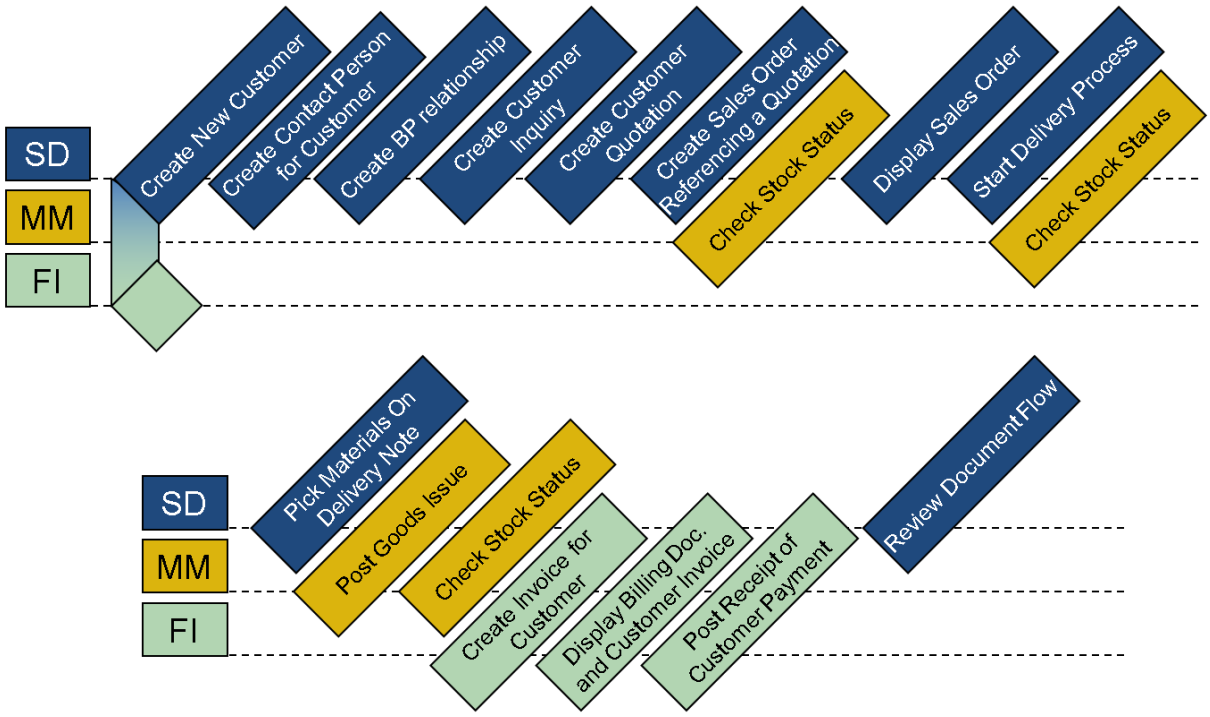


Figure 2. The Integrated Business Processes in the SAP S/4HANA (SAP University Alliances Learning Portal, 2023)

In this module, using Figure 2, an SAP S/4HANA diagram of the integrated business processes, the instructor shall direct students to hands-on exercises on preparing an experiential learning approach in the ERPsim Lab. With the remarkable visual effects of the SAP S/4HANA, the set of experiential learning activities helps students gain a better understanding of key business processes. In this module, the traditional classroom activities can be flipped from the regular conceptual lectures to student interactive and collaborative practices that shall further enrich student learning experiences (Wang & Zhang, 2017).

3.2 Module 2: Learning Business Processes by Playing the ERPsim Games

The ERPsim Lab builds a simulated enterprise environment with a web-based or client-server interface. When the ERPsim Games run, the business decision-making process is simulated for the player to practice business processes (BP) and integration, such as material planning, procurement, and stock transfer. Transactional data generated from the BP can be visualized in real-time through data charts and reports. Based on the data reporting, the player can adjust product prices, purchasing, and stock transfers according to team roles. The player can also practice creating data analytics charts and reports with the built-in SAP Lumira, Predictive Analytics, and other analytical tools via the OData Service 2.0 connectivity on the ERPsim platform, an open data (OData) protocol for creating HTTP-based data services.

Moreover, in this module, the class shall be divided into teams to play the ERPsim Games. Each team member shall be assigned a managerial role for a business process, such as the planning manager, the material management manager, the sales manager, and the executive officer (CEO, Team Leader). Wang (2018) illustrates a set of integrated business processes in ERPsim games, demonstrating the essence of managerial roles of student teams in business processing such as the planning manager creates planned independent requirements and forecasts sales; the material manager reads the inventory report and creates stock transfers in a push or pull mode; the sales manager changes prices and reads the summary and detailed sales reports; and the CEO receives and reads financial statements and summary and detailed reports from sales and inventory.

For students to dig deeper into the business processes, the ERPsim Games automate major tasks and transaction codes of the managerial roles (refer to the table in Appendix A). While all business units interrelate to establish the set of business processes and transactions, the ERPsim Games are well-designed to illustrate team collaboration, visualize business processes, and make workflows efficient and effective. This shall enhance students' understanding of BDA fundamentals in business understanding and data preparation.

The pedagogical objectives can also be effectively achieved through the ZOOM Breakout Room in the virtual distributed modality. Overall, students' game-playing experiences in this module help achieve the learning/teaching objectives of (1) examining the ERP-related business processes and data transactions across business domains and (2) collaborating teamwork in business processes and transactions.

3.3 Module 3: The Multi-Dimensional Data Modeling in the ERPsim Games

In this module, to enhance the pedagogical capabilities of the framework, the SAP ERPsim data architecture can be connected to the SAP S/4HANA data warehouse. Students

shall be instructed to focus more on BDA fundamentals in data modeling and deployment (Provost & Fawcett, 2013) – specifically, the SAP S/4HANA data warehousing processes and multi-dimensional data modeling – through the Internet connection to the OData Service 2.0. Table 1 exemplifies the six SAP S/4HANA data analytical views generated by the data warehouse tool. Each view is multi-dimensional and can be further visualized through the online analytical processing (OLAP) of the ERPsim Lab or the relational database management systems (RDBMS). The pedagogical contents of this module shall instruct students to gain an essential understanding of the processes, principles, and best practices of data modeling and deployment.

Views of the SAP S/4HANA Data Repository	Data Visualization
Financial Balance	Show accumulative amounts for a given account.
	Use time series to analyze the balance of the account.
Financial Posting	Use financial statements that are updated in real-time.
	Show detailed views of accounting transactions.
Goods Movement	Analyze goods movement internally and externally.
	Analyze goods flow over time.
Inventory Key Performance Indicators (KPI)	To identify inventory and past and future stock out.
Sales	Understand customer demands.
	Show a detailed breakdown of sales.
	Calculate margins made on sales.
	Visualize price elasticity.

Table 1. An Example of Data Analytical Views

In this module, students shall be assigned with hands-on exercises and projects to gain training and practice on multi-dimensional data modeling with the SAP S/4HANA data warehousing tools. The experiential learning activities in the ERPsim Lab help students understand the BDA fundamentals and achieve pedagogical objectives of modeling and pivoting multi-dimensional data for analytics, model deployment, visualization, and reporting. Again, these learning objectives can be achieved in the virtual classroom environment through the ZOOM Breakout Room.

3.4 Module 4: BDA Specifics in the ERPsim Games

Integrating the ERPsim simulations and gamifications, this module focuses more on BDA specifics in knowledge, skills, and practical applications in an organizational setting. Students shall be instructed to apply their business understanding and BDA models to address business problems. Specifically, using the SAP S/4HANA data warehouse tools, students learn to code the Structured Query language (SQL) statements, visualize analysis results, and further develop data-driven executive reports through the deployment of BDA models – the key learning objectives of BDA specifics (CSUN SOM Business Analytics, 2023; Provost & Fawcett, 2013).

The instructor shall provide learning materials in this module such as the SAP S/4HANA Reference and transactional datasets. Further instructions on BDA specifics shall be integrated with the SAP S/4HANA data warehouse tools. Student teams shall be instructed to (1) create data-driven reports with visualization and (2) summarize business strategies based on the analysis results and reporting. In this regard, ERPsim (2023) exemplifies a dashboard report with data visualization of the sales revenue distribution in a regional map (Figure 3) created with the SAP S/4HANA data warehouse tools. Other data visualization software such as spreadsheets, RDBMS, R, and Tableau can be integrated into the module. Moreover, team interactions in this module allow students to learn and practice business collaborations. Once again, the learning activities of this module can also be achieved in the virtual classroom environment with the ZOOM Breakout Room.

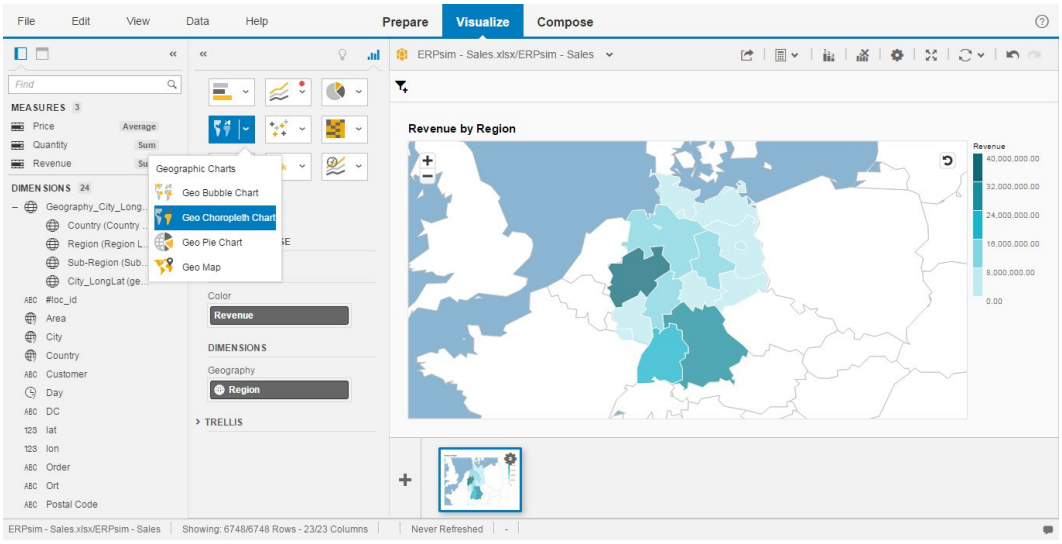


Figure 3. A Data-Driven Dashboard Report of the Sale Revenue Distribution (ERPsim, 2023)

4. INTEGRATING THE FRAMEWORK IN BUSINESS PEDAGOGY

With the systematical integration of other software tools and learning platforms, the framework can be integrated into multiple pedagogies for BDA curricula. Table 2 below summarizes the eight pedagogical approaches (Full names below) we have applied to the four teaching modules of the framework.

Module 1	Module 2	Module 3	Module 4
EL	GBL	EL	EL
FCL	FCL	IBL	IBL
CL	CL	CL	CL
IL	IL	IL	IL
InterL	InterL	InterL	InterL
DL	DL	DL	DL

Table 2. Pedagogical Approaches

Experiential Learning (EL). Experiential learning, also known as "learning by doing or playing games," is a pedagogical approach with hands-on gamified practices in a real or simulated setting (Holmqvist, 2004). In the teaching module 1 of the framework, our experiential learning focuses on instructing students to follow the SAP lab manual to navigate and integrate business processes and data transactions in the SAP S/4HANA.

Flipped-Classroom Learning (FCL). The approach reverses the traditional classroom model by delivering course contents outside the classroom and instead using classroom time for demonstrations (Hall & DuFrene, 2016). The widespread online learning management systems (LMS such as Canvas, Moodle, and Blackboard) and streaming technologies make flipped classroom learning widely accessible. In our teaching practice, students are instructed to watch the videos of the ERPsim Games and explore BDA learning resources out of class at their own pace. In so doing, a large amount of class time is flipped for other pedagogical events and activities.

Game-Based Learning (GBL). A gamified environment provides game players and student learners with a set of enjoyable and challenging learning experiences (Prensky, 2003). The teaching framework of this study integrates many gamification features that can be used to motivate students to learn and apply many business concepts in the simulated environment. More importantly, the gamified context instructs students to understand the underlying reasons for business processing as it happens in the real world.

Inquiry-Based Learning (IBL). The pedagogy focuses on students' proactive role in learning and allows them to understand concepts by connecting them to other concepts (Pedaste et al., 2015). Our teaching encourages students to combine their experiences to interpret business transactions in each round of ERPsim games. As such, students are motivated to model transactional data, share data-driven insights, and develop business reports at their own pace. Instead of memorizing course materials, students learn BDA fundamentals and specifics through their explorations in enterprise games in these teaching practices.

Collaborative Learning (CL). The pedagogy instructs students to actively engage in learning activities by collaborating with teammates (Strijbos & Fischer, 2007). In our teaching, it is imperative that each student relies upon and is accountable to each other. Our teaching instructs students to play managerial roles and coordinate business performance for the valuation and net revenue of the firm. Learning to actively communicate and collaborate within and beyond the team is one key to achieving better teamwork performance.

Interactive Learning (IL). The pedagogy encourages students to integrate their knowledge, draw inferences, and develop learning strategies that help apply – rather than merely rehearse – business domain concepts in a simulated context (Aleven et al., 2003). Our teaching practice indicates that interactive learning supports deep learning and expedites the transfer of business concepts to actual applications in the real world.

Interdisciplinary Learning (InterL). In nature, BDA curricula combine multiple business domains such as accounting, finance, IS, marketing, and supply chain management. Our teaching practice instructs students to play managerial roles across different business domains. Students learn to make collaborative decisions via access to analytics reports that are generated from business domains.

Distributed Learning (DL). The SAP and the ERPsim Lab are well-designed and widely accessible over the Internet, making distributed learning highly effective in synchronous, asynchronous, or hybrid modalities. Our teaching instructs students to implement business processes on the SAP portal and play games in the ERPsim Lab. Many LMS and ZOOM Breakout Rooms provide support for such distributed learning activities. The BDA curricula can be flexibly scheduled, and pedagogies be effectively distributed over the LMS for various teaching modalities.

5. ASSESSING PEDAGOGICAL OUTCOMES

5.1 Methodology

As is discussed, a BDA curriculum combines pedagogical contents and resources on BDA fundamentals and specifics. The BDA fundamentals focus on an essential understanding of business processes and BDA principles and theories, whereas BDA specifics on knowledge, skills, and practical applications of BDA capabilities. Based on the rationale, the proposed teaching framework integrates key features of the SAP business processes, data architecture, and data warehousing tools in the ERPsim environment to address fundamentals and specifics of BDA curricula. As shown in Table 4, our teaching practice translates the fundamentals and specifics of BDA curricula into the pedagogical objectives and outcomes in the four teaching modules of the framework.

To assess the pedagogical outcomes of deploying the framework in BDA curricula, we performed a cross-sectional field survey of several sessions of one undergraduate BDA course – Introduction to BDA. The survey measures the twelve pedagogical outcomes of the course that were developed based on the BDA pedagogical contents and resources. The course has been taught in multiple sessions with the framework to be deployed for several semesters in business schools of three metropolitan public universities in Southern California. The survey instrument in Table 4 is constructed with multi-item scales at the 5-point Likert type, capturing the undergraduate business students' opinions about the pedagogical outcomes of the course. The measurement scales range from the least gain

(1) to the average (3) to the most gain (5) that students perceive about the course at each teaching module of the framework.

One additional question is included that asks students to rank their overall satisfaction with the course, ranging from the least satisfied (1) to the average (3) to the most satisfied (5). The structure and wording of the survey are adopted from those of the Student Ratings of Teaching (SRT) that have long been used in the universities (A sample of the SRT is provided in Appendix B). Demographic data – age, coursework hours, ethnicity, gender, school year, and student status – are also collected.

At the end of the three semesters – Fall 2021, Spring 2022, and Fall 2022, the survey was distributed among six course sessions in Canvas and Qualtrics. 223 business undergraduates participated in the survey, and 197 valid responses were collected at a response rate of 88.3%. In the data collection, we adopted the well-established common procedural remedies of Tehseen et al. (2017) to control the risk of the common method variance of the study.

5.2 Respondent Demographics

Table 3 summarizes respondent demographics as follows. Nearly 90% of respondents are juniors and seniors. The division of genders is nearly balanced. About 55% of respondents are between 18-25 years old. The largest respondent portion is Hispanics/Latinos (38.8%), followed by Whites (32.2%) and Asians and Pacific Islanders (15.3%); African Americans are 6.8%. Most respondents maintained full-time status (89.6%) and had coursework hours below 20 hours (71.9%).

5.3 Key Findings

Firstly, we calculated the means and standard deviations of the responses to assess the pedagogical outcomes of the course that has deployed the framework with learning objectives in each of the four teaching modules. As is shown in Table 4, the means and standard deviations of students' ranking of the twelve pedagogical outcomes in the three categories and their overall satisfaction are all higher than the average, indicating the most gains from and overall satisfaction about the pedagogical outcomes were well perceived. The findings indicate the encouraging learning experience and teaching effectiveness of the course in which the four modules of the framework were integrated into the pedagogies.

Secondly, as our literature review reveals, little research in business pedagogy has explored the ERPsim simulation/gamification features for developing pedagogical frameworks in BDA curricula. To address this research gap, we turned to the grounded theory procedure for theory building from raw data (Glaser & Strauss, 1967; Wiesche et al., 2017). Based on the primary findings of the field survey study, we treated the learning objectives of each module of the framework and overall satisfaction as the principal reflective variables (e.g., BDA Fundamentals, Multi-Dimensional Data Modeling, BDA Specifics, and Overall Satisfaction). We loaded the pedagogical outcome items as reflective measures on these variables, respectively. Following the standard assessment procedure (e.g., Benitez et al., 2020; Chin, 1998), we tested the psychometric properties of the reflective measurement model and validated the content, convergent, discriminant validities, and internal consistency reliability of the study.

Measure	Value	Frequency	Percentage
Gender	Male	98	49.7%
	Female	96	48.9%
	Prefer No Answer	3	1.4%
Age	18-22	67	34.1%
	23-25	41	20.7%
	26-30	49	25.1%
	30 +	40	20.1%
Ethnicity	White	63	32.2%
	African American	13	6.8%
	Hispanic/Latinos	76	38.8%
	Asian or Pacific Islander	30	15.3%
	Prefer No Answer	14	6.9%
Student Status	Full-Time	177	89.6%
	Not-Full-Time	20	10.4%
Coursework Hours	Less Than 5 Hours	5	2.3%
	5-10 Hours	48	24.5%
	10-20 Hours	89	45.1%
	20-30 Hours	38	19.1%
	More Than 30 Hours	18	9.0%
School Year	Freshmen	9	4.4%
	Sophomore	11	5.7%
	Junior	74	37.8%
	Senior	103	52.1%

Table 3. Respondent Demographics (N = 197)

We then ran the multi-linear regression on the four principal reflective variables. As is illustrated in Figure 4, students' most gains in the three categories are significantly positively associated with their overall satisfaction ($\beta = 0.469$, $p < 0.001$; $\beta = 0.322$, $p < 0.01$; $\beta = 0.587$, $p < 0.001$; respectively). The three variables jointly explain 72.7% of the variance in overall satisfaction ($R^2 = 0.727$). The R^2 value suggests the acceptable level of the explanatory power of the regression model. Moreover, following the common practice of field survey studies, we treated the respondent demographics – age, coursework hours, ethnicity, gender, school year, and student status – as control variables, controlling for the effect on the four principal variables. None of them is found significant.

Thirdly, as is shown in Table 5, we collected and compared data on mean scores of the coursework (i.e., the teamwork project and in-class quiz) and the overall means of the SRT of the several sessions of the course against those of three sessions of the same course that have been taught in Spring 2020 and Fall 2019 without adopting the framework. We found that the coursework score means and the overall means of the SRT of the course that has deployed the framework are higher than those of the prior course sessions that did not use the framework. While many factors can affect students' perceptions of the course teaching, these findings provide reasonable evidence indicating the encouraging pedagogical

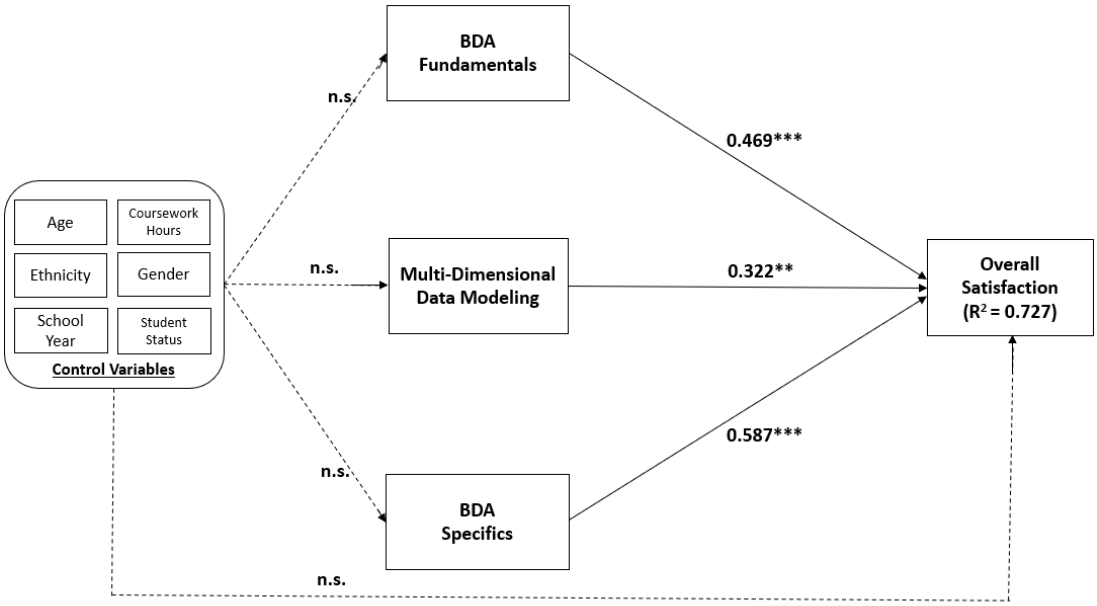
performance and outcomes that have been achieved through the deployment of the framework.

Learning Objectives	The extent of the gains of pedagogical outcomes.	Mean	STD
BDA Fundamentals (Modules 1 and 2)	Business understanding.	4.51	0.43
	Business processing and integration.	4.46	1.26
	Transactional data processing.	4.48	0.92
Multi-Dimensional Data Modeling (Module 3)	Modeling multi-dimensional data.	4.50	0.82
	Pivoting multi-dimensional data.	4.51	0.79
	Data model deployment.	4.48	0.62
BDA Specifics (Module 4)	Real-time data visualization.	4.51	0.89
	Development of BDA reports.	4.62	1.33
	Data-driven decision making.	4.48	0.79
	Data access with analytics tools.	4.54	1.11
	SQL statements with data warehousing tools.	4.59	0.82
Overall Satisfaction	Overall, I am satisfied about the course in meeting pedagogical outcomes.	4.87	0.83

Table 4. Findings of Descriptive Analysis (N = 197)

	Coursework Score Means		
Semesters	Teamwork Project (Full Score: 100)	In-Class Quiz (Full Score: 10)	Overall Means of SRT (0-5)
Fall 2022	88.7	9	4.3
Spring 2022	88.2	8	4.2
Fall 2021	89.3	8	4.0
Spring 2020	83.6	7	3.4
Fall 2019	82.7	6	3.2

Table 5. The Score Means of Coursework and Overall Means of the SRT



*** Significance at $p < 0.001$; ** Significance at $p < 0.01$; n.s.: Not significant.

Figure 4. The Regression Model of Assessments

6. DISCUSSION AND CONCLUSION

Built upon the pedagogical practices and empirical findings of prior literature (e.g., Kohers, 2015; Labonte-LeMoyne et al., 2017; Wang, 2018; Wang, 2022), this study proposes a teaching framework for BDA curricula and programs. The framework integrates the SAP S/4HANA and ERPsim Games as a teaching platform that exposes students to a simulated enterprise context and instructs students to learn business processes, transactional data, data analytics, and data-driven reporting – the typical coverage of BDA curricula. The study suggests that the framework can be integrated into multiple BDA pedagogies. Our pedagogical practices indicate that, when effectively deployed, the framework can bring pedagogical value to BDA curricula in synchronous, asynchronous, hybrid, and face-to-face classroom environments.

6.1 Theoretical Implications for BDA Pedagogy

The development and assessment of the framework bear theoretical implications for BDA pedagogy. Firstly, as companies take up the opportunity to integrate BDA for digital transformation, there is an ongoing shortage of BDA expertise, teaching frameworks, and assessments of pedagogical approaches (Chiang et al., 2012; Mills et al., 2022). Recognizing the research gap, this study proposes a modular teaching framework and demonstrates its adoptability in various business pedagogies. The empirical assessments of the twelve pedagogical outcomes show that the deployment of the framework can address the inadequacy of staffing, computational skills, and pedagogies for initiatives of BDA curricula and programs. Research of the stream shall enrich the accumulative knowledge body of BDA pedagogy.

Secondly, the framework integrates simulation/gamification features of the SAP and the ERPsim Games that help build students' learning-by-doing experiences (Prensky, 2003; Wang, 2011; Wang, 2018). We demonstrate that the gamification designs can combine with the four modules of the framework in multiple pedagogies. In so doing, the experiential learning and teaching effectiveness of BDA curriculum can be enhanced. While little research in business pedagogy has investigated the deployment and effects of the SAP and ERPsim simulation/gamification designs in BDA curricula, insights and findings of this study complement the existing frameworks (e.g., Nestorov et al., 2019) and add empirical value to the BDA gamification literature.

6.2 Practical Implications for BDA Curricula

The BDA has become one of the most important trends in the business world. The reality provides a unique opportunity for IS educators and practitioners to tackle the increasing complexity of BDA curricula with depth and academic rigor (Chen et al., 2012; Chiang et al., 2012). In this regard, developing the teaching framework helps prepare business educators and students to build domain expertise and seize the technological advances of BDA.

Firstly, the framework allows flexible integration of various teaching modules in multiple pedagogies to achieve the BDA pedagogical objectives. Depending upon the focus and the depth and breadth of a BDA course, the four modules can be deployed in isolation or combined to cover more of the BDA contents. Our instructional practices have specified the framework in BDA curricula such as Introduction to BDA, Data Analytics and Modeling, Database Management, Data Visualization and Communication, Data Mining and Predictive Analytics, Accounting Analytics, and BDA for MBAs. For instance, we exercise the four modules in several undergraduate BDA courses. One colleague adopts Modules 3 and 4 to highlight the roles of the RDBMS schema, SQL, NoSQL, and NewSQL in the Database Management course.

Secondly, configuring the framework with pedagogical approaches has specific practical implications. The framework is easy for IS educators and students to learn and deploy. It allows trial and error – the essence of the experiential learning approach for students to repeatedly learn and practice in many ways (Iriberri et al., 2015; Wang, 2011; Wang, 2018; Wang, 2022). It consolidates the technical complexity and ease of use of the SAP data warehouses and the ERPsim Games in line with BDA curricula' interdisciplinary fundamentals and specifics. To help deploy the framework, a greater variety of discussions and educational resources, including software access, teaching materials, training manuals, research reports, and curriculum workshops, are widely accessible on the SAP UA platform and the ERPsim Lab.

6.3 Limitations and Future Research

There are certain limitations with the study that should be addressed in future research. As is reported in Figure 4, the regression model represents our attempts to advance theory building for research of BDA pedagogy. The preliminary field survey study can be enhanced by integrating more relevant variables, antecedents, and relationships to build a sophisticated structural equation model. In this regard, future research may rely upon qualitative methodologies such as literature review and student observations and reports. The model can be further validated by collecting and analyzing a bigger size of the pedagogical data.

Secondly, the findings of the field survey are based on the data collection and analysis of business undergraduates' opinions and perceptions of the pedagogical outcomes of one BDA course that was taught in Southern California. We recognize that many factors can affect students' perceptions and opinions of the teaching/learning outcomes, and, at the same time, there are no adequate controlled comparisons or direct measures of these outcomes. As such, the evidence of the teaching effectiveness of the framework needs further validations. These limitations may limit the statistical inferences, generalizability, or transferability of the study. Future research should consider the limitations, collect data across more geographical and cultural areas, and compare the assessments. Such research shall enhance the transferability of the framework and theory building for BDA pedagogy.

Additionally, there are limitations with the proposed framework. Currently, the deployment of the framework is rather limited in several courses. For many BDA colleagues, the framework is more experimental than practical; there is a need for more specific teaching cases and tips to help instructors implement the modular framework. In this regard, we urge BDA educators and practitioners to expand their visions and capabilities, deploy the framework in various curricula, and share their lessons, insights, and best practices.

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APPENDICES

Appendix A. The Tasks and Transaction Codes of the Simulated Managerial Roles With the ERPsim Games

Managerial Role	Task	Transaction Code
Planning Manager	Create planned independent requirements and forecast sales.	MD61
	Run material requirement planning (MRP) and calculate requirements.	MD01
	Check the stock/requirement list.	MD04
	Create purchase orders.	ME59N
	Track purchase orders.	ZME2N
Material Manager	Read inventory reports.	ZMB52
	Create stock transfers in push or pull mode.	ZMB1B
Sales Manager	Change prices.	VK32
	Read summary sales reports.	ZVC2
	Read detailed sales reports.	ZVA05
CEO	Read financial statements.	F.01
	Read summary sales reports.	ZVC2
	Read detailed sales reports.	ZVA05
	Read inventory reports.	ZMB52

Appendix B. A Sample of the Student Ratings of Teaching (SRT)

SYSTEMS AND OPERATIONS MANAGEMENT (BATCH 270)	Tao Hu								
	Responses					Individual			
	P	TWO	T	F	E	N	Mean	Med.	Std Dev
Q1 Overall, this instructor is	0	0	0	2	24	**26**	**4.9**	5	.27

Responses: [**P**] Poor=1 [**TWO**] two=2 [**T**] three=3 [**F**] four=4 [**E**] Excellent=5

SYSTEMS AND OPERATIONS MANAGEMENT (BATCH 270)	Tao Hu								
	Responses					Individual			
	SD	2	3	4	SA	N	Mean	Med.	Std Dev
Q2 The instructor has distributed a clear syllabus.	0	0	1	1	24	**26**	**4.9**	5	.42
Q3 The instructor was well prepared for each class.	0	0	2	1	23	**26**	**4.8**	5	.56
Q4 The instructor presents the course materials well and explains clearly.	0	1	2	3	20	**26**	**4.6**	5	.79
Q5 The instructor stresses conceptual understanding, not just memorizing.	0	0	5	4	17	**26**	**4.5**	5	.80
Q6 The instructor encourages class participation.	0	6	6	3	11	**26**	**3.7**	4	1.23
Q7 The instructor made good use of examples and illustrations.	0	0	1	3	22	**26**	**4.8**	5	.48
Q8 The instructor answers questions carefully and precisely.	0	0	0	5	21	**26**	**4.8**	5	.39
Q9 The instructor used class time well.	0	0	1	6	19	**26**	**4.7**	5	.54
Q10 The instructor returns exams/written assignments in a reasonable length of time.	0	0	1	1	24	**26**	**4.9**	5	.42
Q11 The instructor is in his/her office during scheduled office hours.	0	0	0	1	25	**26**	**5.0**	5	.19
Q12 The instructor seemed genuinely concerned with students' progress and was actively helpful.	0	0	0	4	22	**26**	**4.8**	5	.36
Q13 The instructor is enthusiastic about the subject.	0	0	0	1	25	**26**	**5.0**	5	.19
Q14 The instructor has raised my interest in this subject.	1	0	0	10	15	**26**	**4.5**	5	.84

Responses: [**SD**] Strongly Disagree=1 [**2**] Two=2 [**3**] Three=3 [**4**] Four=4 [**SA**] Strongly Agree=5

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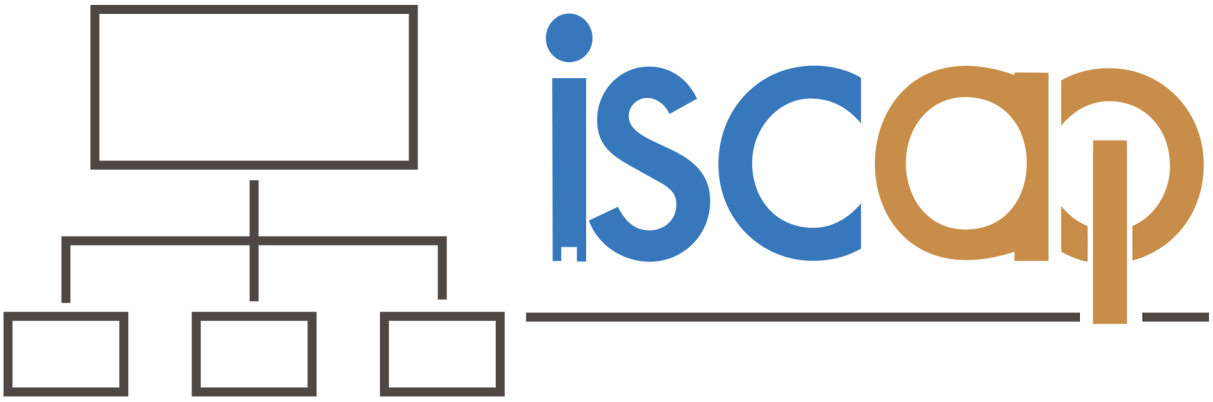

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