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Developing a Framework to Understand Student Engagement, Team Dynamics, and Learning Outcomes Using ERPsim

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ABSTRACT

The value of enterprise resource planning (ERP) systems to business organizations has long been recognized with their use being integrated into educational business curricula and training. ERPsim games incorporate live business simulations that enable students to learn about ERP concepts firsthand by working in teams and managing their own companies using SAP ERP software. Prior research has examined the use of ERPsim and learning outcomes, yet to date, there is little if any research that has explored the association of learning outcomes with student engagement and team dynamics, two areas that have continued to grow in importance in many business school programs. This research develops and tests a model to examine these relationships. Validated constructs and a validated survey instrument are created and verified. Study results indicate a positive association between student engagement, team dynamics, and learning outcomes. Results and implications are discussed, and recommendations for further research are presented.

Keywords: Simulation, Enterprise resource planning (ERP), Student engagement, Team dynamics, Learning goals & outcomes

1. INTRODUCTION

The value of enterprise resource planning (ERP) systems to business organizations is well known and is regularly integrated into educational business curricula and training. The utilization of simulation games to enhance learning has long been recognized, with many developed for this purpose. One such simulation, ERPsim, developed by HEC Montreal (Léger et al., 2007), is utilized to engage business students in collaborative, problem-based learning activities using ERP software. ERPsim games incorporate live business simulations that enable students to learn about ERP concepts firsthand by working in teams and managing their own companies using SAP ERP software (Léger, 2006). ERPsim games have been used for over 10 years in 200+ universities around the world (ERPsim Lab, 2018).

The current AACSB Standards for Business Accreditation underscore the importance of engagement, innovation, and impact to measure how effectively business schools are preparing students to enter the rapidly changing global workforce (AACSB, 2013). While these concepts are not new to business education, the current emphasis from AACSB provides an opportunity to further empirically explore relationships between teaching/learning methods and learning outcomes. Specifically, using a team-based simulation game platform, it is possible to explore factors associated with student engagement, team dynamics, and individual learning outcomes from the activity.

This research investigates the relationship between student engagement, team dynamics, and individual student learning outcomes. ERPsim, the collaborative problem-based learning simulation game, is used as the platform to test our hypotheses.

The paper begins with an introduction followed by a review of simulation games, learning outcomes, student engagement, and team dynamics. The research model and hypotheses are explained followed by the methodology of the research. Research results are presented and discussed, including limitations and recommendations for further research.

2. LITERATURE REVIEW

2.1 Computer-Based Simulation Games

The use of computer-based business simulation games to enhance learning in higher education has been recognized as a valuable learning tool that enables students to make real-world business decisions (Keys and Wolfe, 1990; Washbush and Gosen, 2001; Feinstein and Canon, 2002; Seethamraju, 2011; Whitton, 2011). In addition, simulation games have been found to promote systems learning, problem solving, and communication related to running a business, with favorable learning outcomes (Goodwin and Franklin, 1994; Jackson and Taylor, 1998). The business simulation game, ERPsim, developed by ERPsim Labs at HEC Montreal (Léger, 2006; Léger et al., 2007), has been used to engage business students in collaborative, problem-based learning activities for over 10 years in 200+ universities globally (ERPsim Lab, 2018). ERPsim is designed to be dynamic and fast-paced, allowing students to see the results of their decisions and actions immediately. Using a live version of SAP enterprise resource planning (ERP) software, student teams manage their company in a real-time competitive environment. The games use a problem-based learning approach. According to its developers (Léger et al., 2007), the instructional strategy focuses on guiding the learning process in a situated context through a series of realistic and potentially complex open-ended problems. There are several versions of the game that include managing either a distribution or a manufacturing company that sells its products in a competitive marketplace. As students play the game in teams, they analyze live business data from the sales of their products to determine optimal strategies associated with purchasing, production, logistics, and pricing. Each member of the student team has a unique role that is vital to the success of their company. Individually and together, their decisions and actions contribute to the active management of integrated business processes in their firm.

The AACSB (Association to Advance Collegiate Schools of Business) mission statement stresses the importance of fostering engagement, accelerating innovation, and amplifying impact in business education (AACSB, 2013). Standard 13 of the 2013 AACSB Standards for Business Accreditation further states that curricula must "facilitate student academic and professional engagement appropriate to the degree program and learning goals" (AACSB, 2013, p. 40). The Standard defines student academic and professional engagement as when "students are actively involved in their educational experiences, in both academic and professional settings, and when they are able to connect these experiences in meaningful ways" (AACSB, 2013, p. 40). The Standard recommends that the teaching and learning model or method employed should engage students through challenging activities and problem solving. Suitable pedagogical approaches therefore include problem-based learning, projects, and simulation games like ERPsim.

2.2 Learning Outcomes using ERPsim

Enterprise Resource Planning (ERP) systems are considered to be the digital backbone of many organizations, providing the foundation for effectively managing integrated business processes. Most companies use some form of ERP software. They tend to be large, complex systems that are tailored specifically for each organization in order to automate business operations and processes based on best practices (Monk and Wagner, 2013). The leading developer of ERP software is SAP. SAP ERP is used in more than 404,000 companies in over 180 countries and in over 91% of the Forbes Global 2000 companies (SAP, 2018).

Many business faculty use hands-on ERP activities to teach students about business processes. The value of using a live simulation game such as ERPsim, however, is that students can learn experientially, as opposed to merely reading and memorizing facts or following step-by-step instructions. The experience enables students to view the ERP system holistically instead of getting bogged down with step-by-step keystrokes to perform a transaction (Cronan et al., 2009). Students learn as they interpret their business data from the live SAP system, develop strategies, and make decisions in the pursuit of winning the game.

Many business students continue to be challenged with the complexity of ERP systems, even though business students are considered very computer-literate (Léger, 2006). Prior research has examined the use of ERPsim and student learning of ERP and business process concepts. Seethamraju (2011) explored the influence of ERPsim on learning outcomes through a pre- and post-test of student perceptions before and after their ERPsim experience. Overall, his students reported significant levels of improved knowledge of ERP concepts, SAP transactions, business process knowledge, and process management as a result of their active learning experience.

Cronan and Douglas (2012) conducted a longitudinal study over a six-semester time-frame to examine the impact of using the ERPsim game on ERP knowledge and skills among students taking an ERP course. Similar to Seethamraju (2011), pre- and post-tests revealed increased knowledge and skills related to SAP transactional (operational) skills, business processes, and enterprise systems knowledge. In addition, they found that students' acceptance of the ERP technology was positive after their ERPsim participation. Charland et al. (2015) extended these studies by focusing on ERP competencies as they relate to basic and complex knowledge. Using a revised model of Bloom's Taxonomy (Anderson and Krathwohl, 2000), they measured SAP transaction skills, business processes, and enterprise systems knowledge to distinguish the levels of learning outcomes in terms of complexity. Basic knowledge was related to Level 1 of Bloom's model (recognition), while complex knowledge was related to Levels 2–4 (comprehensive, application, and analysis). Using the ability of student team members to contribute to their company's profitability as an indicator of competency, they concluded that complex knowledge, rather than basic knowledge, is a predictor of ERP competency. Labonte-LeMoyne et al. (2017) expanded the work on basic and complex knowledge by using ERPsim for operational business knowledge and associated business intelligence software using "big data" for problem-solving and analysis. Consistent with Charland et al. (2015), they found that applying and using knowledge for decision-making through data analysis resulted in higher levels of complex knowledge.

Drawing upon these findings, this research builds on this previous work by exploring the association of student engagement and team dynamics with ERPsim learning outcomes.

2.3 Student Engagement

Measuring student engagement in a gaming environment is challenging as there are many definitions of engagement, such as behavior, motivation, and cognition (Whitton, 2011). Additionally, there are a variety of student aptitudes and a diversity of games that are difficult to generically categorize for the purposes of measuring similar learning processes (Wolfe, 2016). As a result, there is little research that has explored student engagement with learning games. In one study, Whitton (2007) conducted a series of in-depth interviews to develop a set of factors and a model for student engagement with games. Positively correlated factors with engagement were (1) students being able to see changes in the game outcomes and (2) an awareness of being good at the game. Negatively correlated factors that detracted from engagement were (1) problems with running the game, (2) getting stuck in a part of the game, (3) lacking confidence in the game, and (4) being bored.

In the general game engagement literature, a commonly cited theory measuring engagement is the flow theory of Csikszentmihalyi, Abuhamdeh, and Nakamura (2014) that describes a state of engagement where the person involved disregards everything except the activity itself (Whitton, 2011). In the flow theory, a student could be considered to be engaged in flow if there is balance between the student's skills and the game's challenges, if the game has a clear set of goals, and if the game allows for feedback during play. When flow occurs, the student's attention is directly focused, they feel a sense of control, and the time passes quickly during the simulation game. When attention is focused, any distractions such as self-consciousness are gone, and no other attention-getting activities disrupt that focus. When a game player feels a sense of control, anxious feelings are abated, and the game can be a very positive experience. When one is bored, time passes very slowly. However, if a game player is in flow, the dimension of time is forgotten and no longer a distraction. Flow can be associated with student learning game engagement; it is a state of mind where everything else is forgotten except the game one is playing. However, the flow balance is precarious. If the challenges of the game surpass the student's perceived skill level, then they become anxious. If the student's perceived skill level exceeds the challenges of the game, they become bored (Csikszentmihalyi, Abuhamdeh, and Nakamura, 2014).

In this research, student engagement is examined through three constructs that correspond with flow theory's engagement criteria: action and awareness, control, and time.

2.4 Team Dynamics

The use of a game environment such as ERPsim within the classroom typically requires teams of three to five students to work together in order to manage their own companies using SAP ERP software. Several studies have indicated that team interactions are associated with influencing perceptions of a team's characteristics (Losada and Heaphy, 2004; Anderson, 2005; Johnson et al., 2007; Fisher et al., 2012; Bhagwatwar, Bala, and Barlow, 2017). These patterns of interlocked behaviors among team members are referred to as team dynamics (Losada and Heaphy, 2004; Anderson, 2005).

Prior research has shown that certain characteristics associated with team dynamics, such as trust and the ability to collaborate, are associated with team interdependence and also with team performance (Losada and Heaphy, 2004; Johnson et al., 2007; Fisher et al., 2012; Kwak et al., 2013; Bhagwatwar, Bala, and Barlow, 2017). In addition, studies indicated that shared knowledge and mental models of a group also contribute to performance (Nelson and Cooprider, 1996; Greenberg, Greenberg, and Antonucci, 2007). A shared mental model of a team refers to the organized understanding of knowledge among the team related to effective ERPsim task completion (Johnson et al., 2007; Bhagwatwar, Bala, and Barlow, 2017). Team performance ability is measured by perceived team effectiveness (Nelson and Cooprider, 1996; Bhagwatwar, Bala, and Barlow, 2017) and perceived team performance (Fisher et al., 2012; Bhagwatwar, Bala, and Barlow, 2017). Furthermore, team interdependence has been linked to positive team performance (Wageman, 2001) where team members depend on each other to successfully complete their tasks while competing with other teams. In another study about team characteristics, Edmonson (1999) examined implicit coordination. Implicit coordination refers to the actions individual team members take in response to the needs of other team members and task demands, contributing to collaboration ability. Edmonson's (1999) findings suggested that the variations of learning among the students may be influenced by their team experience.

Some studies have examined different aspects of team dynamics specifically with individual learning outcomes using ERPsim. Kwak et al. (2013) explored the relationship between team cohesion and participants' attitudes towards learning. They found that when students felt positively aligned with their teammates, they tended to be more positive about learning and more satisfied with the learning experience. Bhagwatwar, Bala, and Barlow (2017) examined the influence of team dynamics on team performance. They proposed that team characteristics would moderate participants' perceptions of process complexity, process rigidity, and process radicalness associated with managing a set of logistics processes using ERPsim. Perceptions of higher complexity, rigidity, and radicalness were expected to have a negative impact on team performance in the simulation. Team performance was measured by the net profit of the team's company at the end of the simulation. Team characteristics included perceptions of a shared mental model, mutual trust, and coordination within their teams. As hypothesized, all were found to negatively affect the impact or process perceptions when these characteristics were viewed as positive and strong.

Extending the findings of these related studies, this research investigates the association of team dynamics, including shared mental model, implicit coordination, team effectiveness, and team interdependence, with student engagement and individual student learning outcomes.

3. RESEARCH MODEL AND HYPOTHESES

The research model (Figure 1), extends the team dynamics research of Bhagwatwar, Bala, and Barlow (2017) and Anderson (2005) to include student engagement (Whitton, 2001; Csikszentmihalyi, Abuhamdeh, and Nakamura, 2014; Wolfe, 2016) and learning outcomes (Charland et al., 2015; Labonte-LeMoyne et al., 2017). Based on the previous research on student engagement and team dynamics, it is expected that levels of student engagement and levels of team dynamics will be directly related to individual student learning outcomes. Furthermore, levels of team engagement characteristics and the characteristics associated with team dynamics will be associated with each other.

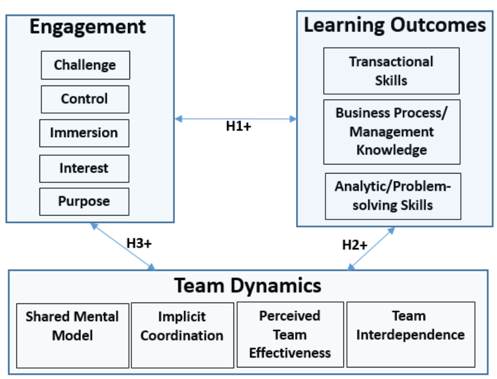

Figure 1. Research Model

3.1 Learning Outcomes

Learning outcome measures in this study are based on several studies that evaluate ERP learning and assess ERPsim game knowledge and ERP competencies (Seethamraju, 2011; Cronan and Douglas, 2012; Charland et al., 2015; Labonte-LeMoyne et al., 2017). A survey was developed, adapting scales from Cronan and Douglas (2012) and Seethamraju (2011), to examine the first four of the six levels of learning based on the revised Bloom's model: remember, understand, apply, and analyze (Anderson and Krathwohl, 2000.) In addition, a new set of questions were developed to focus on Level 5 of the revised Bloom's model: evaluate. Using a 5-point Likert scale, students were asked questions about their knowledge of SAP and ERP. The adapted model includes five of the six learning levels in Anderson and Krathwohl's (2000) revised model of Bloom's Taxonomy that were characterized based on demonstrated levels of ERP knowledge (Table 1).

Six questions considered students' recognition and understanding of SAP concepts and transactions (SAP Transaction skills). The objective was to assess whether students believed they had the knowledge to perform the required business transactions using SAP to manage their company in the ERPsim simulation. Ten questions were asked to understand students' self-assessed levels of business process knowledge, adapting questions from Seethamraju (2011) and Cronan and Douglas (2012). These questions, which measured students' understanding of managing and sharing information in an integrated business, were mapped to Bloom's Levels 3 and 4, Apply and Analyze. These two levels are focused on how well students could extend their SAP and ERP knowledge to how their business activities impact the firm. A third group of questions, corresponding to Bloom's Level 5, Evaluate, were developed for this study to understand how well students believed they could use and interpret their business data for operational decision-making in their companies using ERPsim.

Learning Objective	Description of Learning	Application of ERP Knowledge	Assessment
1. Remember	Recall and recognition of information	SAP Transaction skills	Students can use their ERP knowledge to perform business transactions in the simulation.
2. Understand	Interpreting, summarizing, inferring, comparing, explaining		
3. Apply	Executing, implementing procedures	Business process knowledge	Students can extend their ERP knowledge to how their activities impact the firm.
4. Analyze	Discovery of relationships, differentiating, organizing, attributing		
5. Evaluate	Making judgements based on criteria, checking, critiquing	Problem-solving/ Decision-making	Students can use and interpret business data for operational decision-making.
6. Create	Plan, produce new original ideas, products	*Not evaluated*	

Table 1. Alignment of Revised Bloom's Taxonomy with Levels of ERP Knowledge Assessments (adapted from Anderson and Krathwohl, 2000; Labonte-LeMoyne et al., 2017)

Five questions were asked to assess students' confidence in explaining the performance of their firm based on their understanding of the business data, including their use of a business dashboard.

3.2 Student Engagement

Student engagement measures are supported by flow theory (Csikszentmihalyi, Abuhamdeh, and Nakamura, 2014) with questions categorized under each of the three aspects of flow: action and awareness, control, and passage of time. The results of the Whitton (2011) interview study informed the creation of the measures for this current study, along with the thesis of Whitton (2007).

Table 2 presents the three aspects of engagement associated with flow theory used in this study: action and awareness, control, and perception of time. Action and awareness indicates that students are fully attentive to the point of losing their self-consciousness. The measures in this area seek to find out the level of enjoyment and excitement during the game, the student's level of boredom, and the student's perception of fairness. These questions consider the balance between challenge and skill within the context of working in a team. Control is measured through perceptions of complexity, clarity, and understanding of directions. Questions were derived to ascertain whether or not students lost their sense of anxiety in playing the game. The third area, the passage of time, was measured with a single question. This question sought to measure whether students felt that they were so attentive to the game that the time in the class passed quickly.

The three areas of engagement: action and awareness, control, and perception of time are used to evaluate the association of student engagement to learning outcomes. Higher levels of action and awareness, and perceived control, with little attention to time, indicate higher student engagement. It is expected that student engagement will be positively related to learning outcomes.

H1: Student Engagement will be positively related to Learning Outcomes.

Engagement Theory	Assessment	Flow Occurs When:
Action and Awareness	Students' awareness of their enjoyment, fairness of the game, winning and losing, or boredom	Balance between challenge and skill
Control	Students control over actions, complexity, learning and success	Clear set of goals; feedback in the game
Passage of Time	Students feeling time passing quickly	

Table 2. Assessments of Engagement

3.3 Team Dynamics

Measures for team dynamics in this study are based on prior research examining the effects team characteristics have on learning (Wageman, 2001; Losada and Heaphy, 2004; Anderson, 2005; Johnson et al., 2007; Bhagwatwar, Bala, and Barlow, 2017) and group performance (Nelson and Cooprider, 1996). To measure team dynamics while using ERPsim, survey questions were developed, adapting scales from Bhagwatwar, Bala, and Barlow (2017), Anderson (2005), and Wageman (2001), to examine team performance, shared mental model, implicit coordination, and team interdependence (Table 3).

Team Dynamics Theory	Assessment
Perceived Team Performance	Students feel team members will help, work together, communicate, and adapt to other members (work well together); satisfied with team performance, felt team met or exceeded requirements, and performed tasks better over time (satisfied with team)
Shared Mental Model	Students feel team had a common understanding of tasks, made sure each team member understood objectives and their respective roles (shared mental model); can rely on each other, discuss problems and provide assistance (mutual trust)
Implicit Coordination (Collaboration)	Students feel they were a productive member and the team valued and used their skills
Reliability	Students feel team members were reliable

Table 3. Assessments of Team Dynamics

Team performance ability is measured by perceived team effectiveness (Nelson and Cooprider, 1996; adapted from Bhagwatwar, Bala, and Barlow, 2017) and perceived team performance (Fisher et al., 2012; adapted from Bhagwatwar, Bala, and Barlow, 2017). Since team performance involves several aspects of successful communication, interaction, effectiveness, and trust among team members (Losada and Heaphy, 2004), a group of eight questions were used to gather students' perceptions of their team's performance during the ERPsim game. Two questions dealt with students' perceptions of how well the team interacted and communicated, one was adapted from Bhagwatwar, Bala, and Barlow (2017) and the other was developed to include students' perceptions of how successful their team was communicating and interacting. To address trust, one question was used from Bhagwatwar, Bala, and Barlow (2017) and was adapted from Fisher et al. (2012). Three questions were used to address team effectiveness that were also used by Bhagwatwar, Bala, and Barlow (2017) and Anderson (2005), and two questions were used to directly measure performance that were adapted from Bhagwatwar, Bala, and Barlow (2017) and Nelson and Cooprider (1996). Six questions were used to assess students' perceptions of their team's shared mental model. All questions originated from Bhagwatwar, Bala, and Barlow (2017). Two of these questions were used to measure mutual trust in their study, however they had adapted these questions from Fisher et al. (2012) who originally used them to measure shared mental model. As such, we used these questions as measures of shared mental models. Four questions were adapted from Anderson (2005) and Bhagwatwar, Bala, and Barlow (2017) to measure students' perceptions of their team's implicit coordination during the ERPsim game. Each of these questions addresses the contribution of the team's collaboration ability. Based on Wageman's (2001) findings, a single question was created to address team interdependence by asking students' perceptions on how reliable their team members were during the ERPsim game.

Positive levels of team dynamics are measured by student perceptions of a positive team experience, including performance, shared mental model, collaboration, and reliability. The expectation is that higher levels of team dynamics will be positively related to student learning outcomes. Therefore, the following hypothesis is proposed:

H2: Team Dynamics will be positively related to Learning Outcomes.

When student participants perceive their team performance, shared mental model, collaboration, and reliability to be high, their level of focus on the activity and confidence in their participation should be higher, and student team engagement is expected to be stronger. Therefore, levels of team dynamics should be associated with levels of student engagement as indicated in the following proposed hypothesis:

H3: Team Dynamics will be positively related to Student Engagement.

4. METHODOLOGY

4.1 Survey and Data Collection

This research study was conducted at two universities in the Mid-Atlantic United States. A web-based survey using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree) was used to collect student perceptions of engagement, team dynamics, and learning outcomes after they had played the ERPsim Logistics game in their respective classes. From a total of 151 survey responses, 103 surveys were completed for the purposes of this study, yielding a usable response rate of 65%. The data were not normally distributed, therefore non-parametric tests were used for data comparison (Nachmias and Nachmias, 1987).

A Chi Square test was run to determine possible differences in responses between the two universities. No differences were found between respondents in terms of their previous ERPsim experience ($\chi(1) = 0.089$, $p = 0.763$), previous SAP experience ($\chi(1) = 0.724$, $p = 0.399$), or gender ($\chi(1) = 1.492$, $p = 0.221$). However, there were differences concerning previous SAP courses taken ($\chi(1) = 7.267$, $p = 0.003$), other previous ERP experience ($\chi(1) = 4.482$, $p = 0.032$), and work experience in business ($\chi(1) = 10.206$, $p = 0.001$). In each of these, university two had a higher number of students with these previous experiences.

A Mann-Whitney U test revealed no significant differences in respondents' previous ERPsim experience nor their previous SAP experience regarding their perceptions of engagement, team dynamics, and learning outcomes. Similarly, other previous ERP experience had no significance on respondents' perceptions of engagement or learning outcomes. There was a minor significance on one of the 19 markers for team dynamics, indicating respondents with other ERP experience had a higher level of agreement of their team working better together rather than individually ($U = 152.5$, $p = 0.040$).

Respondents with previous work experience had significantly higher levels of agreement to one of the 11 engagement questions ("I could tell what effect my actions had," $U = 883.5$, $p = 0.003$), one of the 19 team dynamics questions ("It was clear from the beginning what this team had to accomplish," $U = 954.5$, $p = 0.008$), and two of the 21 learning outcomes questions ("I am confident in my ability to use a business dashboard for decision-making," $U = 1028.5$, $p = 0.038$; "I am confident about what changes would be needed in our company to improve our competitive ranking if there was one more round," $U = 1051.0$, $p = 0.034$).

Furthermore, those respondents who had taken previous SAP courses showed some significance in higher levels of perceived engagement, team dynamics, and one area of learning outcomes. Previous SAP courses influenced engagement relating to the effects of their actions ($U = 74.5$, $p = 0.030$), what they could learn ($U = 82.0$, $p = 0.046$), their perception that the game was not complex ($U = 84.0$, $p = 0.050$), and their perception that the game was worthwhile ($U = 54.0$, $p = 0.010$).

Team dynamics perceptions were also higher among participants with prior SAP courses concerning time spent helping team members understand the objectives ($U = 66.0$, $p = 0.020$), participation of team members providing task-related assistance ($U = 38.0$, $p = 0.003$), and perception of effective communication and interaction ($U = 70.0$, $p = 0.026$). However, prior SAP courses did not have any significant differences in learning outcomes except for the respondents' confidence in setting and changing prices in SAP ($U = 74.0$, $p = 0.033$), which is not surprising since altering prices is typically a skill learned in prior SAP courses.

While there were no significant differences in perceived team dynamics between male ($n = 53$) and female ($n = 50$) respondents, female respondents had significant higher levels of agreement regarding a fair chance of winning ($U = 928.0$, $p = 0.004$), interest in the game ($U = 957.5$, $p = 0.011$), enjoyment of the game ($U = 891.0$, $p = 0.003$), as well as how to improve profitability ($U = 1069.0$, $p = 0.048$) and sales revenue ($U = 1053.0$, $p = 0.036$).

These results indicate that students who have previous business experience tend to have higher positive perceptions regarding team dynamics and engagement in learning activities, validating that this type of learning activity is valued by business students. Regarding the differences of prior experience between the two universities, while statistically significant, the median differences were within the agree to strongly agree levels and therefore have a negligible effect on the outcomes.

4.2 Construct Validity

To test the hypotheses, an analysis of the associations between engagement, team dynamics, and learning outcomes from respondents' participation using ERPsim proceeded in four steps. First, the level of agreement respondents expressed associated with the 11 questions for engagement, 19 questions for team dynamics, and 21 questions for learning outcomes were measured using a 5-point Likert scale, in which 1 indicated "strongly disagree" and 5 indicated "strongly agree." Next, internal consistency was examined for each set of questions used to measure engagement, team dynamics, and learning outcomes. In the third step, factor analyses were performed to determine if the markers for engagement, team dynamics, and learning outcomes converged and discriminated where expected. This was necessary to verify the framework measures. In the fourth step, associations were identified in support of the three hypotheses: (H1) student engagement and learning outcomes, (H2) team dynamics and learning outcomes, and (H3) student engagement and team dynamics. Kendall's tau-b (τ_b) correlation coefficient was used to measure the strength and direction of association between each of these.

4.2.1 Student Engagement. Regarding the 11 questions used to measure Engagement, the Cronbach's alpha was 0.865, indicating a good level of internal consistency in the engagement survey questions. Further analysis of the communalities of these 11 items indicate they have a shared variance, and the removal of any question would result in a lower Cronbach's Alpha, except for measuring the passage of time which would lead to a small improvement with the corrected item-total correlation value of 0.076. Therefore, this question was not removed. To proceed with factor analysis, the Kaiser-Meyer-Olkin (KMO) measure was deployed to determine the sampling adequacy (Kaiser, 1974). The KMO measure for engagement is 0.838, indicating the degree of common variance among the 11 variables is meritorious and a factor analysis will account for a good amount of variance (Cerny and Kaiser, 1977). Furthermore, the Bartlett's test is less than 0.5 ($p < 0.001$) significance level indicating responses collected for this study are valid and factor analysis is suitable.

A confirmatory factor analysis using varimax rotation was administered to determine the convergent and discriminant validity of the measures describing engagement (Table 4). Three factors emerged from the 11 questions used to measure engagement with an eigenvalue greater than 1.0, explaining that 67.051% of the common variance is accounted for by these three factors. A rotated factor loading was conducted to reveal the grouping of questions to factors. Each factor loading aligns well with the three aspects of flow theory (Csikszentmihalyi, Abuhamdeh, and Nakamura, 2014): action and awareness; control; and sense of time. This is evidence of high convergent validity. In addition, there was minimal cross-loading on other factors, which is evidence of high discriminant validity.

4.2.2 Team Dynamics. Regarding the 19 questions used to measure Team Dynamics, the internal consistency is good ($\alpha = 0.927$), and communalities analysis indicates a shared variance. The removal of any question would not result in a lower Cronbach's Alpha except for the question referring to goals-were-clear ($\alpha = 0.930$). However, the removal of this question would only lead to small improvements with corrected item-total correlation values of 0.322, representing low values, leading to the consideration of whether removal would be beneficial. A factor analysis was found to account for a good amount of variance (KMO = 0.873) and to be suitable ($p < 0.001$).

Rotated Component Matrix[a]			
Engagement	**Factor Grouping**		
	Action and Awareness	**Control**	**Passage of Time**
Cared if win or lose	0.835		
Game not boring	0.737		
Excited during game	0.722		
Enjoyed the game	0.655		
Had fair chance of winning	0.637		
Game not complex		0.853	
Effects of my actions known		0.817	
Learning was clear		0.693	
Game was worthwhile		0.658	
Knew what to do		0.541	
Time went fast			0.879
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.			
a. Rotation converged in 4 iterations.			

Table 4. Factor Groupings for Engagement

A confirmatory factor analysis using varimax rotation was administered to determine the convergent and discriminant validity of the measures describing Team Dynamics (Table 5). First, a factor analysis was done without removing the question "goals-were-clear." A factor analysis of the 19 questions used to measure team dynamics in the survey revealed 4 factors with an eigenvalue greater than 1.0, explaining that 66.653% of the common variance shared using these 19 Team Dynamics questions can be accounted for by these 4 factors. A second factor analysis with the removal of the question "goals-were-clear" revealed a very small increase in the common variance (68.345%) with similar factor groupings, however with a few cross-loadings; therefore, this question was included in the factor analysis. Each of these factors aligns well with previous studies (Wageman, 2001; Anderson, 2005; Johnson et al., 2007; Fisher et al., 2012; Bhagwatwar, Bala, and Barlow, 2017).

Rotated Component Matrix[a]				
	Perceived Team Effectiveness and Performance	**Shared Mental Model**	**Implicit Co-ordination**	**Team Inter-dependence**
Team got better over time	0.798			
Would work with members again	0.760			
Team met requirements	0.759			
Good Team Communication	0.710			
No undermining in team	0.703			
All members made decisions	0.675			
Satisfied with performance	0.674			
Team Adapted	0.612			
Team understood roles		0.784		
Common understanding		0.767		
Time spent to help understand		0.737		
Clear goals		0.705		
Reliance		0.632		
Communicate problems		0.537		
Members were productive			0.830	
Skills valued			0.686	
Good teamwork			0.527	
Members assisted others			0.515	
Reliable members				0.815
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.				
a. Rotation converged in 6 iterations.				

Table 5. Factor Groupings for Team Dynamics

4.2.3 Learning Outcomes. Regarding the 21 questions used to measure Learning Outcomes in the survey, the Cronbach's Alpha was 0.951, indicating a good level of internal consistency in the survey. Further analysis indicated the communalities of these 21 items have a shared variance and removal of any question would result in a lower Cronbach's Alpha. The KMO measure for Learning Outcomes is 0.877, indicating a meritorious degree of common variance among the 21 variables. Furthermore, the Bartlett's test is less than 0.5 ($p < 0.001$), indicating responses collected for this study are valid and factor analysis is suitable.

The factor analysis of the 21 questions used to measure Learning Outcomes in the survey produced three factors with eigenvalues greater than 1.0, explaining that 67.756% of the common variance shared is by the use of these 21 questions can be accounted for by these three factors (Table 6). Each factor loading aligns well, similar to the previous learning outcomes scales designed by Cronan and Douglas (2012) and Seethamraju (2011). This is evidence of high convergent validity. In addition, there was minimal cross-loading on other factors, evidence of high discriminant validity.

Rotated Component Matrix[a]			
	Business Process Knowledge	SAP Transaction Skills	Problem-Solving / Decision-Making
Cross-Functional Dependencies	0.798		
How Decisions Affect Future	0.795		
Standardization and Efficiency	0.788		
Value of Sharing Data	0.734		
Value of Real-Time Business Data	0.679		
Business Process Concepts	0.678		
Cross-Functional Collaboration	0.643		
Value of Data Visualization	0.616		
Value of Real-Time Integration	0.596		
Value of Customer Preferences	0.563		
Purchase Inventory		0.865	
Create Forecast		0.853	
Allocate Stock		0.762	
Create Reports		0.600	
Understand Push and Pull		0.597	
Create and Change Pricing		0.555	
Product Performance			0.842
Sales and Profitability			0.781
Valuation and Profitability			0.764
Explain Procurement Process			0.670
Decision-Making with Dashboard			0.588
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.			
a. Rotation converged in 6 iterations.			

Table 6. Factor Groupings for Learning Outcomes

5. RESULTS

5.1 Association between Engagement and Learning Outcomes

Kendall's tau-b (τ_b) correlation coefficient was used to measure the strength and direction of association between perceived Engagement and perceived Learning Outcomes of individuals. Kendall's tau-b (τ_b) correlation coefficient is used when data is nonparametric and the two variables measured are at least on an ordinal scale. Based on the factor groupings of engagement and learning outcomes, Table 7 provides support for H1, demonstrating that there is a significant positive association between learning outcomes and engagement, except for the measure for time passing quickly, which was asked with a single question. Previous studies on measuring perceptions of time during gaming have mixed outcomes (Luthman, Bliesener, and Staude-Muller, 2009), and recalling the passage of time retrospectively is often challenging (Sanders and Cairns, 2010). There is a positive association between all of the learning outcomes combined groupings and two of the engagement groupings: action and awareness, and control. Overall H1 is supported: as the level of student engagement increases, student learning outcomes will also increase. Because there was no significance between student perception of time during the simulation and learning outcomes, this measure could be re-evaluated and tested again in a future study.

5.2 Association between Team Dynamics and Learning Outcomes

Kendall's tau-b (τ_b) correlation coefficient was deployed with the factor groupings of Team Dynamics and Learning Outcomes. The results (shown in Table 8) reveal there is a significant positive association between three of the four team dynamics groupings (perceived team effectiveness and performance, shared mental model, and implicit coordination) and learning outcomes, providing partial support for H2. Team interdependence is only significantly associated with the combined learning outcome for Evaluate (problem solving and decision making). Team interdependence is not associated with the combined SAP transactions skills (Remember and Understand) nor the combined business process knowledge (Apply and Analyze) learning outcomes, suggesting that it becomes more important with higher levels of learning.

5.3 Association between Team Dynamics and Engagement

Kendall's tau-b (τ_b) correlation coefficient was used to test whether Team Dynamics was positively related to Student Engagement (H3). The factor groupings of Team Dynamics and Engagement were used in the analysis as shown in Table 9. The results indicate there is a significant positive association between two of the three Engagement groupings (action and awareness, and control) and team dynamics. As before, perception of time is not significantly associated with Team Dynamics, except for implicit coordination. This single time question was a limitation to this study and more research regarding the passage of time associated in team coordination would be needed in the future to clarify this relationship.

		ENGAGEMENT		
Learning Outcomes		Action and Awareness	Control	Passage of Time
SAP Transaction Skills (remember; understand)	Correlation Coefficient	0.439**	0.535**	0.122
	Sig. (2-tailed)	0.000	0.000	0.163
	N	103	103	103
Business Process Knowledge (apply; analyze)	Correlation Coefficient	0.425**	0.404**	0.224*
	Sig. (2-tailed)	0.000	0.000	0.012
	N	103	103	103
Problem-solving/ Decision-making (evaluate)	Correlation Coefficient	0.397**	0.440**	0.099
	Sig. (2-tailed)	0.000	0.000	0.269
	N	103	103	103

Note: Correlation Coefficient *p < 0.05, **p < 0.01

Table 7. Association between Combined Factor Groupings of Learning Outcomes and Engagement

		TEAM DYNAMICS			
Learning Outcomes Combined		Perceived Team Effectiveness and Performance	Shared Mental Model	Implicit Co-ordination	Team Inter-dependence
SAP Transaction Skills (remember; understand)	Correlation Coefficient	0.227**	0.392**	0.315**	0.086
	Sig. (2-tailed)	0.007	0.000	0.000	0.319
	N	102	103	102	102
Business Process Knowledge (apply; analyze)	Correlation Coefficient	0.292**	0.335**	0.394**	0.129
	Sig. (2-tailed)	0.001	0.000	0.000	0.145
	N	102	103	102	102
Problem-solving/ Decision-making (evaluate)	Correlation Coefficient	0.223**	0.352**	0.325**	0.199*
	Sig. (2-tailed)	0.010	0.000	0.000	0.025
	N	102	103	102	102

Note: Correlation Coefficient *p < 0.05, **p < 0.01

Table 8. Association between Combined Factor Groupings of Learning Outcomes and Team Dynamics

		ENGAGEMENT		
TEAM DYNAMICS		Action and Awareness	Control	Passage of Time
Perceived Team effectiveness and Performance	Correlation Coefficient	0.272**	0.285**	0.051
	Sig. (2-tailed)	0.001	0.001	0.564
	N	101	101	101
Shared Mental Model	Correlation Coefficient	0.394**	0.474**	0.005
	Sig. (2-tailed)	0.000	0.000	0.957
	N	102	102	102
Implicit Coordination	Correlation Coefficient	0.339**	0.304**	0.252**
	Sig. (2-tailed)	0.000	0.000	0.003
	N	101	101	101
Team Interdependence	Correlation Coefficient	0.191*	0.191*	0.043
	Sig. (2-tailed)	0.030	0.030	0.634
	N	101	101	101

Note: Correlation Coefficient *p < 0.05, **p < 0.01

Table 9. Association between Combined Factor Groupings of Team Dynamics and Engagement

6. LIMITATIONS AND AREAS FOR FURTHER RESEARCH

The purpose of this study was to explore associations of student perceptions of their engagement, team dynamics, and learning outcomes. One limitation to this study was that in two of the constructs, there was a measure consisting of a single question. In measuring student engagement, a single question was used to ask about perceptions of time. In the measurement of team dynamics, a single question was used to evaluate perceptions of team interdependence. In both cases, it was difficult to use the resulting data from the single question because of a lack of statistical significance. While removing the questions did not affect the other results, the loss of this data did have a minor effect on the study because it reduced the number of usable factors to evaluate student perceptions of two important constructs in the model. That said, there was still an adequate representation of factors present for each construct. A future study should use multiple questions for these measures to further evaluate their potential impact in the model. Another limitation to this study is that learning outcomes were measured with scales that used self-reported data from students. Future research using objective measures, particularly for learning outcomes, would yield additional insight about the relationships among the constructs evaluated in this study.

This study evaluated the association of constructs in the model but not effect. This was by design, since a primary goal of this research was to create a validated survey instrument that could be generalized and used for more in-depth evaluation of student learning, particularly with ERPsim. With a validated survey instrument and significant associations between the constructs tested in this study, additional research can further examine the impact of student engagement factors and team dynamics factors on each other as well as on learning outcomes. Because teamwork is quite common in business curricula, it would be useful to understand what team factors are related to the depth and breadth of learning outcomes.

In addition to the model tested in this study, three distinct levels of learning outcomes associated with using ERPsim were defined and can be further examined in a future study. With the validated survey instrument, specific levels of ERP and business knowledge can be linked to the first five levels of the revised Bloom's Taxonomy. Further research can examine how the engagement and team dynamics factors validated in this study are associated with different levels of learning based on the adapted Bloom's Taxonomy of learning. Understanding what factors may contribute to deeper levels of student learning could provide valuable insight to teaching and learning outcomes.

7. DISCUSSION AND IMPLICATIONS

This study fills a gap in the literature about the use of the team-based simulation game, ERPsim, and learning outcomes. Prior research using ERPsim focused on learning outcomes based on team performance (company rankings) in the simulation game. This study provides new insight by evaluating factors associated with student engagement and team dynamics and their relationship to learning outcomes. A survey instrument to test these relationships was designed, tested, and validated so that can be used in future research. The results from this study provide initial insight about what factors may influence student engagement, positive team dynamics, and learning outcomes. Statistical support for all of the hypotheses was found, indicating that there is a significant positive relationship between student engagement and team dynamics, between student engagement and learning outcomes, and between team dynamics and learning outcomes.

There are several practical implications from this study. As more business schools continue to emphasize active learning and group work in their curricula, these findings can be usefully applied when teaching with team-based games and assessing learning outcomes. First, understanding the positive relationship between student engagement and team dynamics can provide insight about what contributes to successful teamwork. Second, the positive relationships between student engagement and learning outcomes, and between team dynamics and learning outcomes, demonstrate the importance of individual attitudes and perceptions when collaborating in teams. While prior ERPsim research evaluated team performance as a measure of learning outcomes, this study focuses on learning outcomes associated with individual perceptions and with collaborating in the team. This understanding can provide new insight to faculty when assessing the expected learning outcomes from using a competitive team-based simulation game like ERPsim.

The results from this research can be extended to business and other organizations facilitating learning with team-based simulation games. The use of business simulation games in industry is growing. Understanding engagement and team dynamics can be applied to workforce training as well, with the potential to result in higher quality learning, engagement, and team cohesion.

8. CONCLUSION

Simulation games like ERPsim are growing in popularity because of the real-world problem-solving opportunities that they can provide. The results from this study provide initial insight about the positive, interrelated associations between team dynamics, engagement, and learning outcomes. These affirmative results can be used to improve pedagogical practices utilizing ERPsim as well as other simulation games. Additional research in this area can provide more valuable insight that could enable university faculty as well as other instructors to improve team-based learning experiences as well as learning outcomes.

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