Learning and Team Attributes in an Enterprise Systems Simulation

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ABSTRACT

A team-based enterprise systems simulation is used in an MBA class to enhance students' knowledge of business processes and enterprise systems' capabilities. Before the simulation begins, and after each distinct phase of the simulation exercise, student perceptions regarding individual learning and team attributes are assessed. The authors then investigate the relationship between team performance, individual knowledge, team attributes, and the simulation phase. All teams showed a similar increase in business process knowledge and enterprise systems skill as the simulation progressed to more advanced phases, while some behavioral attributes – such as team potency and individual satisfaction – appeared relatively constant across simulation phases but differ significantly depending on the team's performance. Other attributes, such as role clarity and the number of within-team interactions, appeared to change more over time for certain types of teams than for others.

Keywords

Enterprise systems, simulation, team learning

INTRODUCTION

Enterprise systems, also referred to as enterprise resource planning (ERP) systems, are complex integrated software systems that are used to manage all aspects of an organization. A key aspect of enterprise systems is their cross-functional nature. When an organization uses an enterprise system, the data associated with all organizational functions (e.g., sales, manufacturing, human resource management, etc.) are stored in and accessed from a common database. The use of an enterprise system facilitates better management and execution of cross-functional "business processes" (i.e., processes or procedures necessary for the running of the business which span several different functional areas).

Traditional business education is minimally integrative and focuses on functional specialization. For example, business students tend to focus solely on courses in their concentration area (e.g., marketing, operations, human resources, etc.). Little emphasis is placed on understanding how functions such as sales, operations, distribution, and purchasing need to interact on a daily basis. While the integrative nature of "business processes" existed long before computerization and enterprise systems, the advent of enterprise systems has made it even more important for students to gain a solid knowledge of how business processes work (Johnson et al., 2004; Seethamraju, 2007). Educating students on the nature of these integrative processes, as well as how they are implemented and executed in an enterprise system, is at the core of formal university-level enterprise systems education.

ENTERPRISE SYSTEMS EDUCATION

Most universities offering enterprise systems courses have access to one or more enterprise system software packages for classroom use. For a number of years, lab exercises, in which the students learn to configure the system and execute transactions, have been a common element of enterprise systems classes (Esteves & Bohorquez, 2007). However, given the complexity of enterprise systems, there has been some concern that this standard procedural approach is not sufficient in providing students with a broader conceptual knowledge of the system as a whole (Rienzo & Han, 2011). In a step-by-step exercise, students may be able to follow a business process from beginning to end, but may not appreciate how the interaction of multiple cross-functional business processes contribute to the success or failure of the organization.

In response to these concerns a cross-functional team of faculty at HEC University in Montreal, Canada, recently developed a team-based enterprise systems simulation (Leger et al., 2011). Using commercial enterprise software coupled with a simulation engine, student teams compete to maximize profit over the length of the simulation. The use of enterprise software to make decisions, as opposed to simply following a script, is intended to bolster students' knowledge of the system and of the business processes being supported (Cronan et al., 2011). In addition, when such simulations are done with a team, students have an opportunity to learn how to effectively coordinate their interactions with others and gain experience

with group-related issues such as role clarity and team satisfaction within the context of working with an integrated information system (Leger et al., 2011).

This paper reports on an exploratory study that was undertaken to investigate factors that may influence the development of enterprise system and business process knowledge and team performance in an enterprise systems simulation. Specific team attributes examined include team potency, role clarity, and group satisfaction. In addition, the study examined student perceptions regarding the "ease of use" of the enterprise system. Particular attention was paid to changes in the impact of these elements over time.

RESEARCH DESIGN

In the fall of 2009, one of the authors was scheduled to teach an interdisciplinary enterprise systems MBA class. Key objectives of the course were to help students gain a better understanding of a) business processes, b) the integrative nature of enterprise systems, and c) how to use enterprise software in a team environment. The instructor had used a team-based enterprise systems simulation exercise in this class in previous years. Based on observations of student performance in the class, the instructor felt that the simulation helped achieve both of these objectives; in addition, however, the instructor noted that team characteristics appeared to have a large impact on team performance. These observations raised several questions in the authors' minds. Does student knowledge related to the key learning objectives increase over the length of the simulation? Are some phases of the simulation more important than others in increasing student knowledge? What are the relationships between team attributes and team performance? These questions led the authors to develop a longitudinal study which assessed individual and team characteristics at six different instances over the course of the simulation.

Subject Pool

Thirty-eight students were enrolled in the Fall 2009 MBA class; all agreed to take part in the study voluntarily. Individuals were randomly assigned to eight teams. Six teams had five members each and two teams each had four students.

The ERPSim Simulation

The simulation used in this study, ERPSim, was developed by a team of researchers at HEC-Montreal (Leger et al., 2011). During the simulation, student teams use commercial enterprise software (SAP ERP) to make a variety of short- and long-term business decisions. Each team represents a separate company manufacturing muesli cereal for the German market. In order to sell muesli, each team must forecast demand, plan and execute production, and purchase raw materials on the open market. All of these transactions must be executed via the SAP enterprise system. The simulation runs in simulated real time; after students use the enterprise system for planning their activities for the upcoming period, the thirty days of the upcoming period are simulated in less than two hours. Thus, students need to use the system to execute all necessary standard business processes. Team success or failure depends upon the team's understanding of the muesli company business case; their understanding of the requisite business processes; and their ability to execute those business processes in a specific enterprise system.

A separate simulation engine takes these team decisions into consideration when determining customer orders, production and purchasing receipts for each company. Since all teams are selling in the same market (Germany), the actions of one team will impact the sales of other teams. Detailed financial statements are automatically generated for each team on a periodic basis, and teams strive to maximize profit over the length of the simulation.

Instructors have control over the length of simulated time and the types of decisions required of each team. For example, it is possible to run the simulation so that teams begin with large amounts of finished product and need only to adjust prices and advertising expense to manipulate demand. At the other extreme, teams may be given control not only over the precise recipes of their products, but may also be given the option of investing in process improvements. Given the complexity of enterprise systems, a recommended teaching strategy is to begin with a simple scenario requiring few decisions from team members, and then to increase the complexity in subsequent simulation games. The approach taken in the author's MBA enterprise systems class was to engage the students in three progressively more realistic and complex simulations.

The Introductory Simulation

The objective of the introductory simulation is to provide a quick hands-on experience of an integrated business process in order to provide students with an overview of both the ERPSim simulation and of the SAP system. Each company is responsible for selling six pre-defined products through two different distribution channels (hypermarkets and grocery chains). All teams start with the same amount of inventory of each product. In addition, the introductory simulation is, itself,

broken into three thirty-day "quarters" of increasing complexity. In the first quarter, the only possible decisions are to determine product pricing and advertising expense. These quantities may be changed in "real time" at any moment during the simulation. Teams have access to sales reports, inventory reports, and financial data to help them make these decisions. In the second quarter, teams are provided with a large amount of raw materials, but must plan and execute production orders as well as maintain prices and advertising. Finally, in the third quarter, teams are responsible for purchasing raw materials as well as production and sales. This simulation was the class's first exposure to ERPSIM and SAP ERP, and two two-hour class sessions were devoted to reviewing the rules and performing the simulation. At the end of the two sessions, students have been provided with a common frame of reference and have been introduced to the importance of the "cash-to-cash" cycle.

The Short Extended Simulation

As its name suggests, the extended simulation has greater decision-making options for team members and is intended to run for a longer period of simulated time than the introductory simulation. There are also new constraints and external factors that teams must consider in the extended simulation: raw material prices fluctuate; teams low on cash must borrow money (at interest) to operate; production capacity is limited; and an additional distribution channel is available. Additional decisions available to team members include product recipe changes, loan payoffs, capacity investment, and lean process improvement.

In addition to the additional constraints and decisions, however, the extended simulation also has the option of being conducted in "turn-based" mode rather than "real-time" mode. Running the simulation in turn-based mode removes the element of time pressure and enables team members to more fully grasp the underlying business processes that the transactions support. Consequently, the "short" extended simulation was broken down into three distinct phases. First, teams stepped through several mandated transactions in period 1; the emphasis in period 1 was therefore not decision-making, since those were pre-determined for each team, but on understanding the different transactions and the business processes that the transactions supported. Period 2 was also conducted in turn-based mode, and therefore without time pressure, but the students were allowed to make their own decisions. Finally, after period 2's decisions were completed, two full quarters of the extended simulation were run in real-time. Discussion and execution of the short extended simulation took place over a length of time covering four class periods.

The Final Extended Simulation

After automatically generating the same initial transactions for each team in period 1, the final simulation was conducted in real-time for six additional quarters. Two real-time quarters were simulated per class session. Teams were allowed to execute the full range of decisions beginning with quarter 2.

The Configuration Exercise

In between the short and final extended simulations, teams were assigned the task of partially configuring an empty client for their muesli companies. Setting up the organizational structure of the company and entering the necessary master data was intended to strengthen individuals' familiarity with the data and the business processes that the data supported.

Assessing Individual Knowledge and Team Characteristics

There were four distinct enterprise system phases that took place during the class: the introductory simulation, the short extended simulation, the configuration exercise, and the final extended simulation. After each of these phases, a survey instrument was administered to each student. Each of these four surveys assessed seven different constructs: the individual's self-perceived knowledge of business processes; the individual's self-perceived knowledge of SAP ERP transactions; the individual's assessment of the potency of her team; the individual's assessment of the clarity of the roles of team members; the individual's satisfaction with his team; the ease of use experienced by the individual with the enterprise software; and the extent of the interactions between the individual and other team members.

In addition, two surveys were administered before the introductory simulation. The first survey, which included only an assessment of the individual's knowledge of business processes and SAP ERP transactions, was administered on the first day of class. The second survey was administered after teams had been formed and had time to interact; it assessed team potency, role clarity, satisfaction, ease of use, and within-team interactions.

Instruments to measure the seven constructs were adapted from previous studies. The self-assessment of business process and SAP knowledge instruments were taken from Cronan et al. (2009). The eight-item measure of team potency, meant to

assess the individual's belief in her team's ability to accomplish its goals, was adapted from Guzzo et al. (1993). The five-item construct measuring satisfaction with the team was taken from Dennis (1996), while the four-item measure of role clarity was adapted from Kayworth and Liedner (2002). Finally, ease of use was measured by the TAM construct as presented in Venkatesh et al. (2000). A complete list of survey questions is provided in the appendix.

In addition to the survey instruments, team performance, as measured by cumulative net income, was recorded for each of the three simulations.

PRELIMINARY RESULTS

For all of the participants, the authors calculated the mean construct scores by averaging the value of all of the items within the construct. Each individual therefore had a single summary score for each of the seven constructs assessed in the survey.

Classifying the Teams

For purposes of analysis, we divided teams into groups defined by their performance, i.e. by their profitability at the end of each of the three simulations. From reviewing the profitability of the teams, it became clear that there were three groups, with one of the "groups" consisting of a single team. The team in the single team group consistently outperformed all other groups by a wide margin. In the final simulation, the team in this "Super Group" outperformed the next best team by a factor of two. The second group consisted of four teams which had roughly the same level of profitability in the final simulation and generally did equally well in the earlier two simulations. This group was dubbed the "High Performers." Finally there was a third group, the "Low Performers," that was comprised of three teams that were marginally profitable: in the final simulation, the best team in the "Low Performers" had a profit that was less than half that of the worst team in the "High Performers." A formal hierarchical cluster analysis confirmed that these three groupings were the most logical if team profitability were used as the clustering criteria.

Business Process Knowledge and Enterprise Systems Skill

Self-perceived business process knowledge and SAP skill were two constructs that behaved similarly over time for all three team categories: all types of teams experienced an increase in both knowledge and skill over the course of the class (See Figures 1 and 2). The possible range of responses for each item in these two constructs was from one to seven. It should also be noted that the range of values shown on the vertical axes of all graphs in this paper are allowed to vary between graphs to best match the data being plotted. Using first business process knowledge and then SAP skill as response variables, and group membership and survey number as independent factors, group membership was not a significant factor affecting either business process knowledge ($p=0.137$) or SAP skill ($p=0.667$). Survey number, however, was significant for both ($p=0.000$ and $p=0.000$, respectively). Examining the graphs, it appears that all team members felt that their SAP skill "leveled out" after the fourth survey, i.e. after the short extended simulation. Neither the configuration exercise nor the final extended simulation seemed to increase their self-perceived skill with SAP. In contrast, most teams felt that their business process knowledge increased throughout the quarter, although Figure 1 suggests that the Low Performer group experienced a decrease in knowledge after the final simulation (Survey 6).

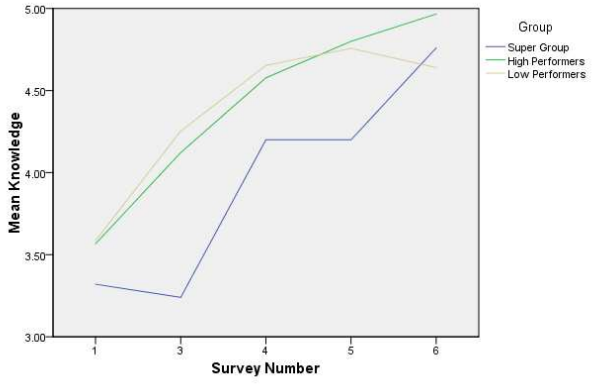

Figure 1. Business Process Knowledge Over Time

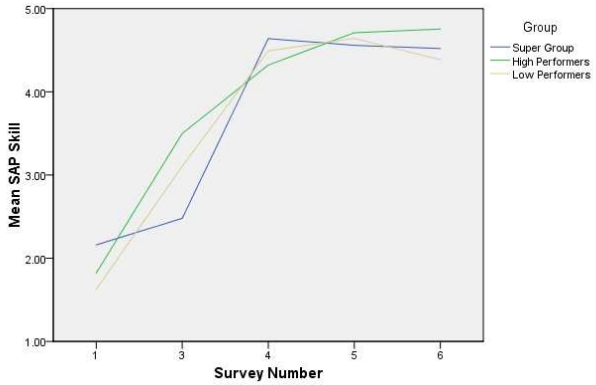

Figure 2. SAP Skill Over Time

Potency and Satisfaction

In contrast to knowledge and SAP skill, the team potency and personal satisfaction perceived by team members did vary significantly by team category. Potency was assessed using a five-point scale, while a seven-point scale was used to measure personal satisfaction. Figure 3 shows the mean potency for each group after each survey: group category was significant (p=0.000) while, when all three groups were considered together, survey number was not significant (p=0.995). The graph, however, suggests that the Low Performer teams experienced a significant degradation in perceived team potency as the quarter progressed; this is borne out by examining just the Low Performer teams and using survey number as the single factor. In that analysis, survey number is significant at a p-value of 0.100 (p=0.051).

Figure 4 shows that personal satisfaction did not significantly change over time (p=0.000), but there is a clear difference between groups borne out by the analysis (p=0.021). Most of this difference is attributable to the higher satisfaction of the members of the Super Group: leaving the Super Group out of the analysis results in no significant differences between the High Performer and Low Performer teams (p=0.556). Note that a lower numeric value indicates a higher level of satisfaction; we have reversed the scale on the graph to reflect this fact.

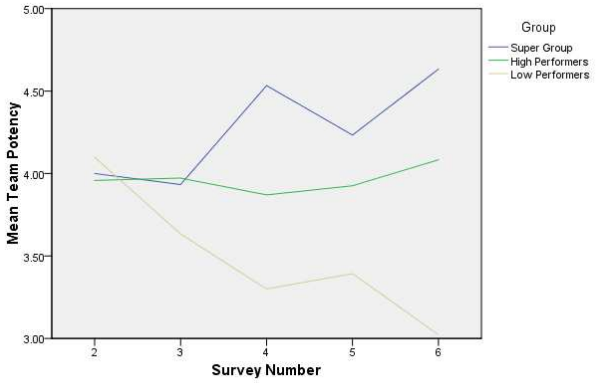

Figure 3. Team Potency Over Time

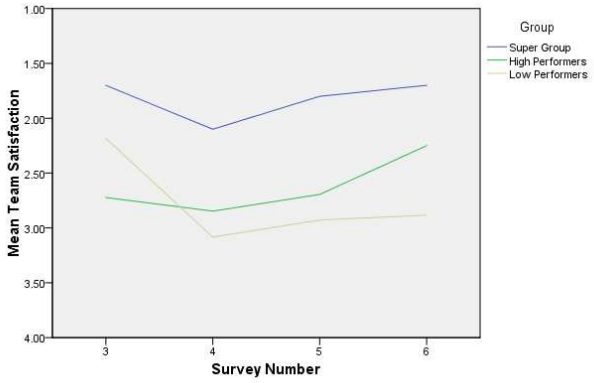

Figure 4. Satisfaction with Team Over Time

Clarity and Interactions

Figure 5 shows the average role clarity for each team category over time. Role clarity was measured using a scale that ranged from one to five. The impact of role clarity and survey number is not significant (p=0.151), i.e., no significant differences between teams and no significant changes throughout the quarter for each team were detected. However, the graph seems to show a modest difference between the Super Group and the remaining teams, and indeed leaving the Super Group out of the analysis shows that there was a change in role clarity among the remaining teams as the quarter progressed (p=0.085). Interestingly, Figure 5 shows that the Super Group established role clarity early on – after the short extended simulation – while remaining teams did not reach that level of role clarity until the end of the final simulation.

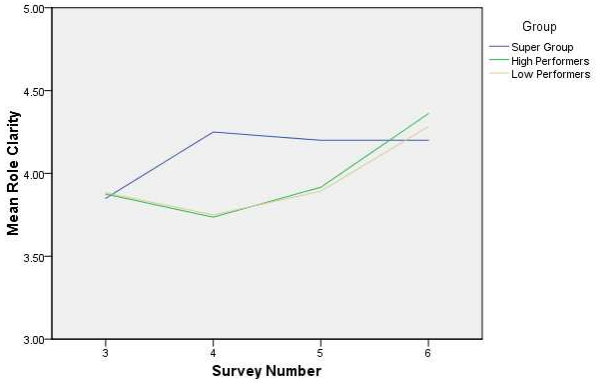

Figure 5. Role Clarity Over Time

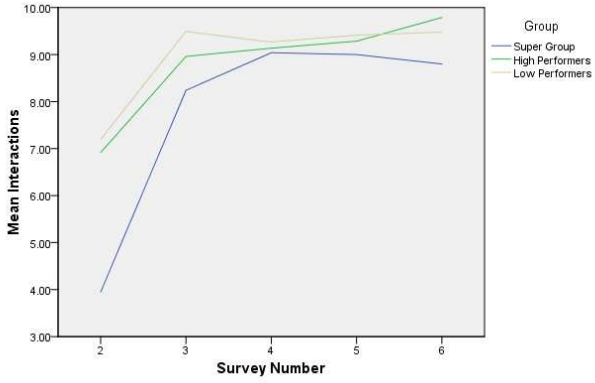

Figure 6. Team Interactions Over Time

The mean level of interactions between team members, which team members were asked to rate on a scale from zero to ten, is shown in Figure 6. As the figure suggests, both team category (p=0.032) and survey number (p=0.000) are significant factors for predicting interactions between team members. Once again, most of the differences between teams are derived from differences between the Super Group and the remaining teams; if the Super Group is removed from the analysis, the differences across team categories is not significant (p=0.611). Somewhat surprisingly, however, the Super Group appears to have had fewer within-team interactions than other teams early in the quarter.

Ease of Use

Interestingly, ease of use, as measured by TAM, does not appear to exhibit a consistent pattern across time or team categories. The initial model including all teams and surveys is not significant (p=0.192). What nonetheless appears striking from Figure 7 is that the Low Performer teams consistently rated SAP easy to use after the Short Extended Simulation.

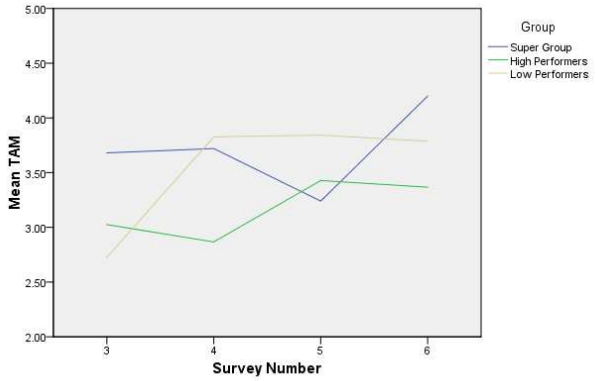

Figure 7. Ease of Use Over Time

CONCLUSIONS

Based on our preliminary analysis of the data, some tentative conclusions seem justified. First, both high- and low-performing teams perceive the same level of benefit from the enterprise systems simulation used in this study, and this benefit – both in terms of business process knowledge and SAP skill level – seems to plateau after the second of the three simulation exercises. More surprisingly, perhaps, students did not perceive the detailed configuration exercises as adding to their knowledge of business processes or SAP skill level. Second, if the single Super Group team is removed from the analysis, both high- and low-performing teams appear quite similar in their team satisfaction, role clarity, and level of interaction across time. The highest performing team appears to be distinguished by higher satisfaction and fewer initial team interactions, and is quicker to establish role clarity for its team members. By the second simulation exercise, the Super Group has established a level of role clarity that the remaining teams don't achieve until after the configuration exercise and the final simulation. Third, an additional distinction between team categories is perhaps less surprising: while teams start out with roughly equal assessments of team potency, the poorly performing teams' self-assessed potency drops rapidly as the simulation exercise progresses. Perceived team potency does not appear to have led to differences in team performance, but rather to have reflected individuals' awareness of their team performance. Finally, and somewhat surprisingly, the perceived ease of use of the enterprise system does not evince any readily identifiable pattern between teams or across time.

Given the relatively small number of subjects involved in this study, caution is warranted with respect to generalizing these conclusions. Furthermore, learning was measured by individual self-perception rather than by more objective stated learning outcomes, and there was no "control group" of MBA students in an enterprise systems class that did not use the simulation. Nonetheless, the above results suggest that an intermediate-level of exposure to a simulation tool can be effective for teaching business process and SAP skills, and that establishing early role clarity can be a key element of success for team engaged in a complex technical task.

REFERENCES

1. Cronan, T.P., Douglas, D.E., Alnuaimi, O., and Schmidt, P.J. (2009) Evaluating the impact of an ERP simulation game on student knowledge, skills, and attitudes, *Information Technology Research Institute Working Paper Series*, University of Arkansas, ITRI-WP123-1008.

2. Cronan, T.P., Douglas, D.E., Alnuaimi, O., and Schmidt, P.J. (2011) Decision making in an integrated business process context: Learning using an ERP simulation game, *Decision Sciences Journal of Innovative Education*, 9, 2, 227-234.
3. Davis, C. H., and Comeau, J. (2004) Enterprise integration in business education: Design and outcomes of a capstone ERP-based undergraduate E-business management course, *Journal of Information Systems Education*, 15, 3, 287-300.
4. Dennis, A.R. (1996) Information exchange and use in group decision making: You can lead a group to information, but you can't make it think, *MIS Quarterly*, 20, 4, 433-457.
5. Esteves, J. & Bohorquez, V. (2007) An updated ERP systems annotated bibliography: 2001-2005, *Communications of the AIS*, 19, 386-446.
6. Guzzo, R. A., Yost, P. R., Campbell, R. J., and Shea, G. P. (1993) Potency in groups: Articulating a construct, *British Journal of Social Psychology*, 32, 87–106.
7. Johnson, T., Lorents, A.,. Morgan, J. Ozmun, J. (2004) A customized ERP/SAP model for business curriculum integration, *Journal of Information Systems Education*, 15, 3, 245-253.
8. Kayworth, T.R. & Liedner, D. (2002). Leadership effectiveness in global virtual teams, *Journal of MIS*, 18, 3, 7-40.
9. Leger, P.M., Charland, P., Feldstein, H.D., Robert, J., Babin, G., and Lyle, D. (2011) Business simulation training in information technology education: Guidelines for new approaches in IT training, *Journal of Information Technology Education,* 10, 39-53.
10. Rienzo, T. and Han, B. (2011) Does ERP hands-on experience help students learning business process concepts? *Decision Sciences Journal of Innovative Education*, 9, 2, 177-207.
11. Seethamraju, R. (2007) Enterprise systems (ES) software in business school curriculum -- Evaluation of design and delivery, *Journal of Information Systems Education*, 18, 1, 69-83.
12. Venkatesh, V. & Davis, F.D. (2000) A theoretical extension of the Technology Acceptance Model: Four longitudinal field studies, *Management Science*, 46, 2, 186-204.

APPENDIX: SURVEY QUESTIONS

1. Business Process Knowledge: "Business Process Knowledge" is the extent to which an individual has a general understanding of business terminology, key operations processes and their inter-relatedness. Business process knowledge includes understanding the delineation of key business activities within and between functional areas such as financial accounting, procurement, manufacturing and sales. With regard to your current knowledge of business processes, how would you assess your KNOWLEDGE of the following areas?" (7 point scale, Very Low - Very High).

Knowledge of PROCUREMENT Business Processes and Activities
Knowledge of FINANCIAL ACCOUNTING Business Processes and Activities
Knowledge of SALES AND DISTRIBUTION Business Processes and Activities
Knowledge of the INTERRELATIONSHIPS and INTERDEPENDENCIES between various functions (such as accounting, marketing, productions, etc.)
Knowledge of PRODUCTION MANAGEMENT Business Processes and Activities

2. SAP Transaction Skill: "SAP Transaction Skill" is the extent to which an individual has the user skills required to perform certain business transactions within SAP. With regard to your current skills, how would you assess your ABILTY to do each of the following tasks? (7 point scale, Very Low - Very High).

Ability to accomplish transactions to SET (and CHANGE) PRICES and SELL PRODUCTS in SAP.
Ability to accomplish transactions to PRODUCE/MANUFACTURE goods in SAP.
Ability to accomplish transactions to PAY VENDORS for purchases in SAP.
Ability to accomplish transactions to PROCURE INVENTORY in SAP.
Ability to accomplish transactions to COLLECT PAYMENT from customers.

3. Perceptions of your team: FOR THIS REPORTING PERIOD only, based on your experiences with the ERP simulation exercise, please indicate your perceptions of your TEAM with regard to the following questions. (5 point scale, To No Extent - To A Great Extent).

Believe it can be productive?
Expect to be known as a high performing team?

Feel it can address any problem it encounters?
Believe that no task is too tough for this team?
Expect to have a lot of influence?
Believe it can get a lot of work done when it works hard?
To what extent does your TEAM have confidence in itself?
Believe it can become unusually good at producing high quality work?

4. Role Clarity: For THIS REPORTING PERIOD only, to what extent do you agree with the following statements regarding your team experience involving the ERP simulation exercise? (5 point scale, Strongly Disagree – Strongly Agree).

I knew what was expected of ME on my team.
I felt that I had sufficient time to perform MY responsibilities on my team.
I knew what MY responsibilities were on my team.
I felt certain about how much authority I had on my team.

5. Perceptions of your team: FOR THIS REPORTING PERIOD only, with regard to the following set of questions, what are your perceptions regarding the team with respect to the ERP simulation exercise? Please indicate by answering each of the following questions. (7 point scale, Very Satisfied – Very Dissatisfied).

How do you feel about the interactions among team members during this portion of the exercise?
All in all, how do you feel about the team during this portion of the exercise?
How do you feel about the process by which your team worked toward completing the different components of this portion of the exercise?

6. Perceptions of your team: For THIS REPORTING PERIOD only, with regard to the following set of questions, what are your perceptions regarding the team with respect to the virtual team exercise? Please indicate by answering each of the following questions. (7 point scale, Very Much – Not At All).

How much fun has it been to be involved with your team?
To what extent have you enjoyed participating as a member of your team?

7. Perceptions of SAP software: FOR THIS REPORTING PERIOD only, please answer the following questions with regard to the SAP software system that you used for the simulation exercise. (7 point scale, Strongly Disagree – Strongly Agree).

I found it EASY to get SAP to do what I wanted it to do.
Interacting with SAP did NOT require a lot of my mental EFFORT.
My interaction with SAP was CLEAR and UNDERSTANDABLE.
I found SAP to be USEFUL for the course exercise.
I found SAP to be EASY TO USE.

8. Interaction Log: Members of ERP simulation teams can interact to a different extent with different team members. In the space below, please indicate the extent of your interaction with each of your other team members during THIS REPORTING PERIOD. Please use the drop-down boxes to indicate the extent of interaction. Use a 0 to 10 scale where 0 indicates no interaction and 10 indicates an extremely high degree of interaction.

9. Feedback about ERP simulation aspects of exercise (optional): The instructor is interested in your comments regarding the ERP simulation aspects of the exercise (e.g., SAP software usability, clarity of instructions, etc.). If you have comments, please type them in below.

10. Feedback about the team-related aspects of exercise (optional): The instructor is interested in your comments regarding the team-related aspects of the exercise (e.g., your interactions with team members, ability of team to work well together, etc.). If you have comments, please type them in below.