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Using active learning to enhance supply chain knowledge

Joe B. Hanna
Auburn University

Brian J. Gibson
Auburn University

Randall Chapman
LINKS Simulation Developer

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Joe B. Hanna
Auburn University

Brian J. Gibson
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ABSTRACT

The constantly evolving logistics discipline confronts practitioners with the challenge of keeping pace with the many advancements in the field. The authors examine ways in which logistics trainers may be able to improve their ability to effectively convey knowledge to logistics practitioners by supplementing the traditional lecture-based approaches with active learning exercises. The results of a recently conducted survey detailing current usage levels and approaches of active learning exercises, specifically simulations, by logistics educators is then presented. The paper also summarizes comments from individual simulation participants after they have completed a training experience designed to immerse them in a real world supply chain scenario. The article concludes by providing suggestions and managerial implications.

INTRODUCTION

The Internet revolution has helped to create many new business opportunities and challenges for logistics practitioners. Past research (Murphy and Poist, 1994, Fawcett, 1992) has found that the skills required of most logistics and supply chain practitioners are evolving rapidly as technology brings about constant change in the marketplace. As the tools necessary to practice effective logistics operations rapidly evolve and supply chain issues play an increasingly strategic role in business success, the importance of effective training and professional development will be heightened (Lancioni, Smith, and Forman, 1998).

The information age has impacted many areas of our lives including how we convey and receive information and turn it into knowledge. The technology barrage includes high tech computer and entertainment products, personal computers, palm pilots, cell phones, and other technological advances. As the information age impacts society, many individuals have discovered that they prefer to learn by doing and actually show a unique aptitude for mastering new tasks through activities that used to be

considered to be either entertainment-based or pure play (Duderstadt, 2002). While many now prefer to obtain information in a non-traditional way, research by Brown and Duguid (2000) shows that individuals repeatedly exposed to learning in the information age society multi-task very well. Furthermore, they are very adept at navigating complex information networks to acquire knowledge and build sophisticated learning resource networks. In fact, scientists have shown that individuals raised with a heavy dose of high technology learning opportunities actually process information in a different manner, leading to physiological differences between their brain structures and the brain structures of those previous generations not provided with high technology learning opportunities (Committee on Developments in the Science of Learning, 2000).

What does this mean for professional supply chain trainers? Is there an opportunity to capitalize on information age tools to assist our ability to convey knowledge? Past research (Gibson and Whitaker, 2004) suggests perhaps technology can play a vital role in the diffusion of supply chain knowledge to practitioners.

As our abilities and preferences for processing information evolve, the traditional lecture-based training experience may not fit very well with the technical skills and temperament of today's professionals. One alternative to the traditional passive method of conveying knowledge is the concept of active learning.

This article discusses the use of active learning, in the form of simulation models, as an alternative teaching tool for furthering the skills of logistics practitioners. Following a brief discussion of the merits of active learning and simulation, the results of a recent study on the use of simulations by logistics educators are presented. Many of the survey respondents are the individuals who will be responsible for training future logistics practitioners as the discipline grows. Comments from recent simulation participants are also summarized. Based on both the administrator and participant feedback, conclusions and managerial implications are offered.

BACKGROUND

Active Learning

Learning by participation is not a new concept. Early active learning can be traced back to Socrates, with modern application dating back to the early 1900's (Kellar, et al., 1995). While active learning has a long history, what is relatively new is the manner in which most trainers and educators assess learning effectiveness. Learning effectiveness has traditionally been evaluated by the learner's ability to recall information. However, trainers are now focusing on the learner's ability to find and use information effectively (Simon, 1995). With this change in focus, learning techniques like active learning are gaining renewed and increased attention.

Professional trainers have recently embraced active learning techniques as a way to engage individuals, foster cooperation, and enhance learning (Ravenscroft, 1997). Active learning is a broad term encompassing a variety of innovative approaches involving joint intellectual effort by learners, or by learners and their instructor together (Smith and MacGregor, 1992). Instead of an instructor delivering information in a lecture format, the instructor serves as a coach while individual learners collectively and actively dig for knowledge (Graham, 1992). The focus is on teaching the trainee how to access information and then perform a critical review of the information obtained. The focus of these types of active learning approaches is always on encouraging active participation in the learning process (Johnson, Johnson, and Holubec, 1998).

While several variations of active learning exist, effective active learning exercises tend to have six key attributes included in their design (See Table 1).

TABLE 1
KEY ATTRIBUTES OF ACTIVE LEARNING EXERCISES

Key Attribute	Example of Application to Learning Activity
Face-to-face peer interaction	Dedicate course time to group interaction Instructor guided instruction to each group
Intentional group formation	Instructor formation of groups to enhance heterogeneity Control size and balance group member qualifications to encourage interaction
Promote positive interdependence	Assign complementary roles to different group members All group members must feel they contribute When multiple groups are involved, assign complementary roles to different groups
Require application of knowledge	Include issues that can actively be discussed Require decisions to be debated and finalized
Instructor serves as a facilitator	Instructor guides exercises Instructor interjects knowledge and provides input when necessary
In-depth learning assessment	De-briefing at the conclusion of the exercise Written and/or oral assessment requirement

Simulations as an Active Learning Tool

Simulations have recently gained the attention of training professionals as the shift from the traditional instructor to learner model gives way to the more active learning model. Specifically, simulation games are gaining popularity in professional training as evidence begins to establish a possible link between instructional strategies, motivational processes, and positive learning outcomes (Cordova and Lepper, 1996; Ricci, Salas, and Cannon-Bowers, 1996). For purposes of this research, a simulation is broadly defined as "a useful heuristic device designed to: 1) provide the user with a realistic picture of a real world scenario or 2) imitate a real world scenario and/or event." A simulation can be computer based and/or can take the form of an instructional game or model of realistic events.

Recent research has examined cost effectiveness, time efficiency, and skill enhancement via technology based training aids. While results are not conclusive regarding the use of technology based training, employee skill enhancement via technology based methods received relatively high marks (Gibson and Whitaker, 2004). It appears that support is beginning to emerge for the use of technology to effectively convey supply chain knowledge. One popular form of technology-based training is computer based simulations.

Simulations and role-playing exercises give today's trainees the hands-on experiences they crave in order to learn and retain information (Farrington, 1998). However, not all simulations and games provide equal educational value. Research shows the higher the level of realism or fidelity included in the simulation, the more effective simulation is as a learning aid (Feinstein and Cannon, 2002). As a result, much work has been done over the last 10 to 20 years to enhance the robustness of simulations and improve their level of realism (Perotti and Pray, 2002).

In management training settings, management simulations support learning in a non-threatening but competitive environment of the kind that real managers face every day. As a training activity, there is nothing quite like

taking over the management of a real company. Unfortunately, real life has real costs and consequences associated with it. As a result, few companies would permit novices to run part or all of their business in real time.

Even if management turned their company over to novices for the sake of learning, it would take quite a while for management initiatives to be developed and implemented. Feedback from real-life business decisions is often slow in coming and can be difficult or impossible to interpret. While operating a real company would be an excellent training opportunity, it is hardly realistic in most instances.

Simulation models and tools overcome these issues and potential problems while providing a dose of reality-oriented learning. Simulations allow rapid time compression and quick feedback to the learner, in a low-risk process where jobs and company survival are not on the line. A well-designed simulator can provide the learner with a realistic training experience in the relative safety of a controlled operating environment provided by the simulation. Perhaps most importantly, the lessons learned in the simulation environment occur within hours or days, not the months, quarters, or years associated with real life.

Given these benefits, it is not surprising that simulation tools are employed in a wide variety of training environments. Following the lead of the airline industry's longstanding use of flight simulators to train pilots, medical schools are using computer simulations to educate future doctors and the U.S. military is using combat simulation games to prepare future commanders in low risk environments (Noonan, 2002; Chuang, 2003). Likewise, manufacturers are employing computer simulation tools to improve employee skills and engineering schools are being encouraged to expand the use of simulation in the classroom (Robb, 2002; Babicz, 2003).

What about the use of simulations in supply chain management (SCM) training? The next section provides insight into the current use of supply chain simulation tools. The discussion is based upon a recent survey of supply chain and logistics educators. These individuals from leading academic institutions were selected to participate for three reasons:

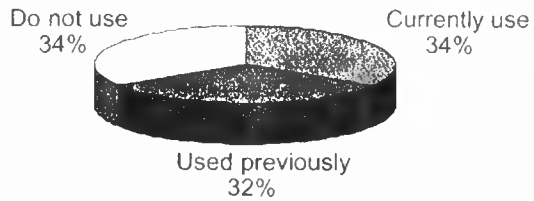
1. They will be helping to train future supply chain practitioners
2. They have significant experience with industry training activities
3. They are well versed in SCM concepts and the use of innovative educational tools.

SURVEY RESULTS AND DISCUSSION

To gain insight into the use of simulations in SCM education, an iterative design-critique-revise survey development process was used to create an eight-question survey. The survey was attached to an e-mail request explaining the purpose of the study and sent to 150 attendees of the 2003 Council of Supply Chain Management Professionals (formerly Council of Logistics Management) Educators Conference. The original request and a reminder e-mail generated feedback from 47 supply chain educators, a participation rate of 31.3 percent.

The results suggest that simulation tools are commonly used by supply chain educators. Figure 1 reveals a fairly even split between the numbers of instructors who currently use simulations, have used them in the past, and have never used them.

FIGURE 1
SUPPLY CHAIN SIMULATIONS



Of the 31 instructors with simulation teaching experience, 20 provided detailed insights regarding their use of simulation tools across 43 different courses. Those who use simulations tend to embrace them regardless of the level or focus of the course where the simulation is being applied. Respondents identified 14 simulations by name, with the Beer Game, LOGA, and LOGEX listed most frequently by the respondents. Additionally, several home grown or proprietary simulations were mentioned as being used by the respondents.

Respondents indicated that simulations are used for a variety of reasons. Most frequently, simulations (51.2 percent of the courses identified) are used to illustrate specific principles in a course (e.g., using the Beer Game to demonstrate the Bullwhip Effect). Simulations are also frequently integrated into the course (32.6 percent) to supplement large portions of the course content. Rarely do instructors indicate that they use these types of active learning tools as the focal point of the course (14 percent).

Teams are typically assembled for simulation assignments. Over 70 percent of the courses identified by respondents are organized by having teams compete against each other or by trying to attain a specific goal over the duration of the simulation. According to survey participants, teams run from two to twenty people in size, with four team members as the median number per team. The size and make-up of the team varies depending on the training situation faced by the instructor.

As Table 2 highlights, the participants strongly believe that simulations are of value to the individuals participating in them and are an effective teaching tool. However, their opinions were not as strong regarding the ability of current tools to model SCM. These respondents see room for improvement in supply chain simulations.

Given these opinions, it should be no surprise that 81.5 percent of the survey respondents (including all current simulation users, all but one former user, and three current nonusers) indicated that their future plans are to expand the use of simulations in their courses or keep them at the same level of use. The remaining 18.5 percent suggest that they have no plans to use simulations in future supply chain training activities. Clearly, supply chain educators see an ongoing need for active learning via simulation in the curriculum.

Simulation Participant Feedback

Based on the previous section, it is clear that a significant portion of logistics educators see value in using simulations to augment traditional course content. While the educator perspective is useful, it only provides information from the perspective of the instructor. The researchers also wished to gain insight into the receptiveness of participants to using a simulation and their perceptions of simulation effectiveness.

TABLE 2
PERCEPTIONS REGARDING SUPPLY CHAIN SIMULATIONS

Statement	Mean Response	Standard Deviation
Active participation in a simulation helps individuals learn and retain key concepts	6.60	0.68
Simulations are an effective supplement to traditional teaching methods	6.45	0.68
Current simulation tools effectively capture the essence of SCM	5.05	0.89

Scale: 7 = Strongly Agree, 1 = Strongly Disagree

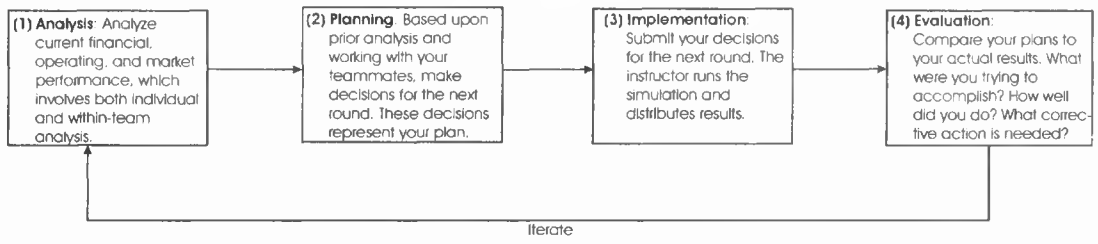
To obtain information feedback from the perspective of the learner, the researchers queried a select group of individuals who had recently been exposed to simulation based logistics training. During the training, a robust and realistic supply chain simulation was introduced to trainees. In order to prepare for participation in the simulation, the trainees were provided with a detailed manual describing the simulation. They were asked to read the manual and take a series of on-line quizzes and tutorials prior to beginning the simulation. Each team of four participants was then provided with detailed information about their company including financial and operating data on the following functional units: transportation, warehousing and distribution, suppliers, raw material and finished goods inventories, customer demand forecasting, and product configurations.

Students were asked to make a series of decisions and interface with the simulation through a web-based decision entry process. Students were asked to keep track of their decisions, and the reasons for their decisions, for each of the nine rounds of the simulation. Figure 2 illustrates the iterative process confronted by the simulation participants.

Roughly half way through simulation administration, each firm was asked to provide a short, 2-3 page executive summary (similar to an abbreviated SWOT analysis) of their performance to date and their strategy for the remainder of the simulation. At the conclusion of the simulation, each group was asked to provide a written annual report of their performance and provide a presentation to their stockholders. The annual report was to include the final financial and operating data for their simulated firm. In addition, an in-depth analysis of their firm's recent performance, an identification of management's strengths and weaknesses during the simulation period, and a comprehensive strategy for moving the firm forward in the future were required.

The simulation was designed to allow participants to maximize learning by participating in a realistic, group-based experience designed to simulate the decision-making processes faced by today's supply chain practitioners. Given this goal, the researchers were curious about participant feedback at the conclusion of the training.

FIGURE 2
SUPPLY CHAIN SIMULATION LEARNING PROCESS



At the conclusion of the training, each participant filled out an evaluation form. These semi-structured, open-ended evaluations were designed to provide the instructors with written feedback about the simulation experience and to provide suggestions on how to improve simulation administration for future courses. The feedback form used broad-based, general questions designed to allow students to use their own words to critique the simulation, the administration of the simulation, and the positives and/or negatives obtained from the simulation experience. Given the unrestricted nature of the feedback, Table 3 provides a general overview of participant impressions of the simulation experience.

CONCLUSIONS AND MANAGERIAL IMPLICATIONS

This research revealed three primary benefits of using a simulation to enhance supply chain training. First, similar to past research (Colbeck, Campbell, and Bjorklund, 2000), the active learning simulation resulted in improving participants' interactive skills and enhancing their abilities to deal with conflict, goal setting, and work delegation within their group. The exercise also forced participants to work through differences of opinion prior to submitting decisions for their firm.

Second, the simulation increased participant involvement in the learning environment by enhancing the interest level and level of discussion throughout the course. By having multiple firms compete against each other, participant involvement in the course was enhanced by creating a friendly environment of competition among group members of different firms. The positive byproduct of competition helps to confirm what prior researchers (Holcomb, Foggin, and Rinehart, 2002) have recently suggested; that it can be beneficial to participants to compete against each other in a truly competitive environment.

Third, participant energy and preparation throughout the project was generally enhanced due to participant perceptions that they were involved in an evolving supply chain simulation with "real-world" applicability. Real-world applicability was made possible since the simulation being used allowed the instructors to create a dynamic market environment by altering or adding one or more features during simulation administration. As suggested by prior researchers (Meyer and Rose, 1998), the instructors introduced a relatively simple version of the simulation and then increased its difficulty over time by adding additional features and complexities.

TABLE 3
EXAMPLES OF PARTICIPANT FEEDBACK ON SIMULATION PARTICIPATION

Category	Specific Participant Comments
Real-World Applicability	• "It was easier to become interested and involved since the project was a supply chain simulation with decisions relevant to what we have been confronted with in practice." • "I liked being involved in a project where I thought some of the things I was learning would be useful once I return to industry."
Class and Group Interaction/ Communication Skills	• "I liked having interactive discussion where I was free to discuss issues with my group members and obtain input from the instructor." • "It was good to see how different team members approach the same problem. It was a great learning experience to have to figure out how to work with other team members with different functional areas of expertise."
Active Preparation Skills	• "Actually seeing the interactions between different functions of the supply chain was fascinating. Using a simulation where not only your own decisions, but the decisions of other companies impact your results made for a challenge when managing the supply chain." • "I didn't realize how difficult and time-consuming the research and analysis portion of the project would be."

Simulations can be very powerful educational tools, especially given the background of individuals raised in the information age. While much work remains to be done to continue to improve the effectiveness of simulations as active learning tools for training purposes, the results experienced by the authors would certainly be described as positive. While participant feedback was generally positive, the educator survey respondents provided mixed reviews about the effectiveness of current simulations to capture and present key supply chain concepts to current and future practitioners. Future research should explore the identification of which key concepts and/or functional areas should be included in a supply chain simulation. Results of the research could help professional trainers and educators move towards a consensus about the content and complexity of effective supply chain simulations appropriate for various audiences.

Educator survey respondents also indicated that they believe active participation in a simulation helps participants to learn and retain key concepts. However, research on retention rates of supply chain trainees participating in simulation-based active learning projects compared to other types of learning is lacking and should be explored. The extent to which instructors should augment or replace their current instructional methods with simulation-based active learning exercises is unclear and needs to be examined further.

Simulation designers not only have to be cognizant of student learning processes, but also must understand instructor requirements of a simulation. Is the instructor adoption decision based on simulation complexity or perhaps the availability of instructor or participant support materials? Is cost a significant issue when considering simulation adoptions and, if so, what is the maximum acceptable cost per participant? How much time is an instructor willing to invest in training activities to help assure the simulation is executed properly? Increased understanding of these questions is paramount to enhancing simulation adoption by supply chain instructors.

Traditional training methods must evolve to effectively maximize the learning and retention of critical supply chain information. Our research suggests that simulations support these learning requirements. Thus, supply chain trainers and educators should seek out opportunities to supplement lecture based training with simulations and other active learning tools whenever possible.

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AUTHOR BIOGRAPHY

Joe B. Hanna is an associate professor of logistics in the Department of Aviation Management and Logistics, College of Business, Auburn University. He earned his Ph.D. from New Mexico State University. Dr. Hanna has published in numerous logistics and business journals and has co-authored or contributed to several logistics and supply chain textbooks.

AUTHOR BIOGRAPHY

Brian J. Gibson is an associate professor of logistics in the Department of Aviation Management and Logistics at Auburn University. He earned his Ph.D. from the University of Tennessee. Dr. Gibson is active in executive education and distance learning, supply chain research, and numerous professional organizations.

AUTHOR BIOGRAPHY

Randall Chapman has taught at several respected institutions of higher learning including Vanderbilt University and the University of Michigan. He earned his Ph.D. from Carnegie-Mellon University. Dr. Chapman has also held positions with Mercer Management Consulting and The Conference Board of Canada. He is currently active in executive education, having conducted more than 300 executive education programs globally.