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# Live, Model, Learn: Experiencing Information Systems Requirements through Simulation

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## Abstract

Information System professionals strive to determine requirements by interviewing clients, observing activities at the client's site, and studying existing system documentation. Still this often leads to vague and inaccurate requirements documentation. When teaching the skills needed to determine requirements, it is important to recreate a realistic environment to develop analytical thinking skills. To address this, we developed a simulation for students to learn requirements gathering and analysis where they experience the requirements by operating a fictitious manufacturing firm. The students manage and operate the company, taking on a variety of employee roles from the physical "manufacturing" to the order-taking to the purchasing of component parts. With this pedagogical approach, students deal with the messiness of the problem by drawing on their own experience working in the manufacturing firm, making assumptions, and having the opportunity to verify their assumptions and analyses by working with their classmates. The simulation was implemented across two courses in an undergraduate information systems program.

**Keywords:** simulation, requirements determination, pedagogy, modeling, active learning

## 1. INTRODUCTION

Requirements determination and documentation of business needs through modeling techniques, such as data flow, entity relationship, and UML diagrams, are critical skills for information system (IS) practitioners. In the field, a systems analyst or project team will determine requirements by interviewing clients and users, observing activities at the client's site, and studying existing system documentation. Often the information initially provided by the client is incomplete, not 100% accurate, and presented in an illogical sequence. If the analyst or project team fails to identify the missing and/or misrepresented needs of the client, the system will be flawed at implementation, as it will not be aligned with the true requirements and business needs. This potentially leads to failure of expectations and wasted resources.

One objective in teaching requirements determination and analysis is creating a problem domain that students can comprehend with a level of complexity that is neither too simple to present a genuine challenge nor too difficult to understand and model. The effort of creating effective learning material is amplified given the background of students varies both within and across universities. Some textbook scenarios, case studies, and assignments that are used to

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educate and train IS undergraduate students describe the problem domain by providing a list of requirements. These lists come in a variety of forms, such as bulleted lists, paragraphs, and videos. This effectively provides students with an opportunity to practice the syntax of the specified modeling approach, but the opportunity to actually analyze the business situation is limited.

When students find, however, that the exercises are too vague or complicated, due to their limited business background, students may perceive there is no mechanism to clarify their own assumptions, making them hesitant to state those assumptions, draw models, and formulate decisions based on the information provided. When the students find the exercises are too neatly packaged or too simple, the modeling exercises may become overly repetitive and routine as it is not necessary for students to make their own assumptions or draw conclusions. Understanding when one needs to make an assumption, making the assumption, and determining how to verify its appropriateness are critical skills to develop as part of requirements determination. When using traditional textbook exercises, it is difficult to create realistic experiences for students because static text is not interactive and cannot respond to specific questions as they emerge during the problem solving phase of the exercise. To be successful in the information systems profession, a systems analyst must be able to identify the weaknesses inherent in information provided, analyze the situation, and devise a strategy to elicit the true requirements. This involves walking a fine line between both gathering information and questioning it at the same time.

To better prepare students for the industry, we developed an in-class simulation that provides students with exposure to a requirements determination process that incorporates vagueness, incomplete information, and the opportunity to acquire incorrect information and/or perspectives. This, as a result, forces students to make assumptions and seek to verify them, bringing together the gathering and questioning of information. We sought to create an experience where students would be motivated to dive into the messiness of the problem in an environment where information gathering and requirements development would be required before modeling, instead of having requirements simply listed. With this pedagogical approach, students deal with the messiness of the problem by drawing on their own experience working in a manufacturing firm, making assumptions, and verifying their assumptions and analyses by working with their classmates. The following sections of this paper describe prior literature, this didactic approach, and the implementation of the approach.

## 2. LITERATURE REVIEW

### Requirements Determination

Requirements determination starts with the scope statement and leads to a list of specific functional and non-functional requirements that must be met to create the deliverable described in the scope statements (Dennis et al., 2012). Also called requirements discovery, requirements determination is a process of fact finding where a variety of tools and techniques can be used, such as stakeholder interviews, observation and document analysis (Whitten and Bentley, 2007). By studying existing procedures, reports and forms, an analyst can uncover both problems with the existing system and also opportunities to enhance system capabilities in a new system (Hoffer et al., 2014). Studies have shown that a flaw found in a system after it has been released to users can cost from 10 to 100 times more than if it had been identified and resolved when the requirements were being determined (McConnell, 2004). This suggests that learning how to determine system requirements is a critical component in educating information systems students, and successful learning activities may lead to improved systems quality and reduced costs.

Although there is substantial research on requirements elicitation, knowledge acquisition and requirements analysis (Byrd et al., 1992), little research is available on the pedagogy of preparing a student to know to apply the theory they have learned in the classroom (Hanchey, 2002). Prototyping tools are one technology that has been used in the classroom to develop students' requirements determination skills. Dalal (2012) used "rapid game prototyping" in an assignment requiring students to build a game using one of their personal friends or a family member to provide the game requirements.

### Inquiry-Based Learning

Another successful approach is inquiry-based learning, which is a student centered approach to learning where, given a scenario or goal, the student acts as a detective, asking questions and performing research (Hu et al., 2008). It has been demonstrated that inquiry-based learning not only contributes to improved learning in specific contexts, but it is also associated with intellectual development (Hu et al., 2008). Simulations present the opportunity for inquiry-based learning as participants interact and explore possibilities. Using simulations in the classroom is an instructional strategy where students are engaged in the discovery of knowledge rather than the recipient of static information (Queen, 1984). A simulation is a model of a real-world phenomenon. As such, the simulation is an abstraction or simplification of the real thing that includes only the aspects of the target that are necessary to achieve the learning goals.

**Simulation Types**

There are four types of educational simulations: physical, iterative, procedural, and situational (Lunce, 2006). In a physical simulation, a student has the opportunity to change a system characteristic, such as level of production or routing pattern, and then watch the result. In the iterative simulation, a student develops hypotheses regarding a system parameter, and then observes the results after altering the parameter to test the various hypotheses. The results are observed and then the alteration-observation pattern is repeated until the learner develops a thorough understanding of how the altered parameter affects the construct of interest. In a procedural simulation, a student learns how to operate by observing processes and steps, such as a flight simulator. Finally, a situational simulation involves a goal-directed role playing exercises.

Furthermore, simulations can be individual or group activities. Studies have shown that groups consistently outperform individuals in many types of activities, and team-based projects in academic settings, such as information systems courses, lend themselves well to a constructivist approach to learning (Keys, 2003; Derrick & Haggerty, 2001; Cronan & Douglas, 2012). The group simulation provides a shared experience for the participants, and both common intellectual experiences and collaborative projects are considered high-impact educational practices (Kuh, 2008).

**Classroom Simulations and Active Learning**

Classroom simulations require active student involvement which leads to a deeper understanding of the issues (Montgomery et al., 1997). Active learning, experiential learning, and constructivism are essentially synonymous terms for a student learning by doing or engaging. Kolb (1984) described experiential learning theory as “a holistic integrative perspective on learning that combines experience, perception, and behavior.” Thus learning is not viewed as a final state where knowledge has been acquired, rather it is viewed as a process where the learner interacts with the environment. On the other hand, in the traditional classroom lecture, an instructivistic approach, the student is viewed as a passive receptacle. Leemkuil et al. (2003) describe instructivism as “characterized by the explicit presentation of non-arbitrary relationships between pieces of information to learners” (p. 100). Thus the lecture may be an effective way for a student to acquire knowledge of facts and procedures. Lectures alone, however, fail to communicate how challenging it is to apply that knowledge in a professional setting (Jeffries, 2005). This suggests that utilizing multiple educational strategies can be useful in the classroom.

Studies across disciplines consistently find that experiential learning is deeper and more enduring than the rote memorization which often accompanies the classroom lecture. Kolb (1984) identified four specific stages learners proceed through to develop understanding: 1-concrete experience, 2-reflective observation, 3-abstract conceptualization, and 4-active experimentation. In other words, Kolb said the learner must interact with the learning target, think about the experience, generalize their understanding of the experience, and then test their generalized theory. Montgomery et al. (1997) applied Kolb’s four step experiential learning process in an introductory education class. To gain concrete experience, the students attended a local school board meeting. Then the students engaged in reflective observation by discussing their experience in the classroom. The third phase, abstract conceptualization, required students to assume the role of a board member and “prepare for the simulation through researching the stakeholder’s role and writing a grant proposal to present during the simulation” (p. 223). They found that because the students participated in the simulated board meeting, they had a deep understanding of the

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responsibility and influence of the U.S. educational system. Leemkuil et al. (2003) used a physical simulation to train people in the area of knowledge management, and demonstrated the importance of both providing domain instruction to prepare students for the simulation and also debriefing the students afterwards. These finding are consistent with Kolb's four abilities model.

The nursing education literature also suggests that educational simulations, particularly physical clinical simulations, lead to longer retention of knowledge, development of skills that are directly applicable in patient care, and increased confidence (Jeffries, 2005). Simulations are commonly used in business schools, particularly in operations and supply chain management. Perhaps the most well-recognized supply-chain simulation is the "Beer Game," a physical simulation, which was developed at MIT. The game demonstrates how small changes in downstream demand (e.g. consumer purchases) can lead to big changes in upstream order quantities (e.g. manufacturer / work orders), a phenomenon call the bullwhip effect. What is compelling about the "Beer Game" is how clearly participants can see the bullwhip effect and that the manifestation of the bullwhip effect occurs regardless of who is participating (Goodwin & Franking, 1994). Klassen and Willoughby (2003) developed a similar simulation, but their version included the costs associated with over-ordering and shortages. They found that those participating in the simulation not only increased their general knowledge of inventory management, but also gained an appreciation for the complexity of the problem. Bandy (2005) also used an in-class simulation to demonstrate the benefits of pooling safety stock across decentralized locations. Subsequent student performance on a quiz and the results of a survey given to the students after the simulation both indicated that the simulation was instrumental in students understanding the benefits of pooling safety stock.

Engaging students in an active learning process by employing a physical simulation creates an opportunity for greater understanding of the theory taught in the classroom. This technique can enable students to better understand how to effectively discover the needs of the client and develop better solutions to the business problems.

## 3. PEDAGOGICAL APPROACH

To encourage inquiry-based and active learning in a group experience, a simulation was developed situated around a company called Fetch, Inc., a fictional manufacturing firm. This is a physical simulation where the students manipulate production levels and the purchasing pattern of raw goods inventory. To develop a learning experience where the learner interacts with the environment, it was required to create such an environment.
To understand and gather the requirements, the students manage and operate the company, taking on a variety of employee roles from the physical "manufacturing" to order-taking to purchasing of component parts. While working at Fetch, students experience the manufacturing process grind to a halt as component parts become unavailable, which is based on their chosen production levels and purchasing patterns. Neither management nor the purchasing department are in a position to correct the problem because they are all working with bad information, whether it be stale or simply inaccurate. The experience of working at Fetch provides students with both a low-level detailed experience based on their role and a high-level overview of how the departments operate and experience failure. To control the complexity of the simulation, we opted to not include any financial information. The key focus is on inventory quantities as accurate inventory management is necessary for consistent, timely production of finished goods.

Although the context of this simulation is operations management, the learning objective is not related to operations management. Our objective is to develop and refine requirements determination and modeling skills. All information systems projects are embedded in some business context. We chose the manufacturing context because we were able to model the business context using tinker toys. We believe this physical simulation made the business context more understandable to the students in comparison to other less tangible contexts, like accounting or marketing.

Throughout the remainder of the semester, students model the processes they experienced in the simulation, identify the problems and requirements necessary to fix the problems, and model the solution that can be supported by a new information system. With this didactic approach, students deal with the messiness of the problem by drawing on their own experience working at Fetch, review the documentation generated during the simulation, make assumptions, and have the opportunity to verify their assumptions and analyses by working with other Fetch employees - their classmates.

**Simulation Administrative Details**

The simulation takes approximately 1 hour to conduct. However, the students utilize the experience gained during the 1 hour for many weeks in the semester, including during class, group meetings, and the creation of deliverables. For the simulation, students are assigned roles in one of the various departments and issued job descriptions, which included what their responsibilities are and any artifacts needed to complete their work. These departments are: manufacturing, quality control, shipping, order entry, operations management, purchasing, and general management. Four to six students are assigned to manufacturing, shipping, order entry, and purchasing. One to two students are assigned to quality control, operations management, and general management. In addition to the instructor and students, the simulation requires two additional assistants to run. One assistant is responsible for feeding orders (via dropping paper slips in an inbox) to the order entry department, and the other assistant is responsible for receiving and fulfilling orders placed by the purchasing department. In order to fulfill the orders for component parts, this second assistant should also accumulate product shipped by Fetch so that he/she can disassemble them and use those pieces for fulfillment. It is recommended that this person has a station external to the main simulation room. See Appendix A for other steps necessary to conduct the simulation.

**Supporting Materials**

Over twenty artifacts were developed to support the operation of Fetch, Inc., including job descriptions for each role, forms, and report templates. These are available by request from the authors. For example, Appendix B describes the procedures that the purchase order clerk is to follow, which is included in the job description for the role. In order to complete these instructions, the Purchase Order (PO) clerk needs to work with the following documents: Reorder Point Memo, Raw Goods Inventory on Hand Report., Suppliers List, Price List, Purchase Orders, and the Purchase Order Ledger. Each of these was prepared prior to the simulation.

**Simulation Execution**

The "manufacturing" was performed by students in the role of shop floor employee. Students "built" products using Tinker Toys as raw materials and a bill of materials that described the component parts and assembly of each product (see Figure 1 for sample portion of the BOM). The simulation was driven by fictional email messages containing customer orders. The operations of the company includes everything from recording customer orders, manufacturing products, purchasing raw materials, building, inspecting, and shipping products. Communication regarding work performed is conducted within and across departments using the forms and report templates provided for the department. Departments can send these forms, as specified in the instructions, to each other using the department mailboxes.

The work procedures given to the participants are logically sound. The overlapping and loosely coordinated activities of the functional areas, however, inevitably lead to a work stoppage as raw materials are consumed, not adequately replaced, and customer orders consequently cannot be manufactured and shipped. Thus, within one hour of "operating" Fetch, the system breaks down.

| | | |
|---|---|---|
| **Portable Scanner**<br>1 Red Bulb<br>1 Pink Clip<br>1 Green Flipper<br>1 Orange Rod<br>1 8 Hole Disk |  | First join the Orange Rod with 8 Hole Disk. Be sure to secure firmly. Then attach the other end of the Orange Rod to its … |

**Figure 1. Excerpt from Bill of Materials**

**Debriefing and Classroom Application**

At the end of the simulation, the number of orders and the order metrics (customer orders, work orders, purchase orders and open, closed, waiting to ship orders) are counted as a mechanism for measuring performance of the session. Immediately following the simulation, a debrief should be held to elicit ideas from the students as to why the system breaks and what can be done to fix it. The order metrics are also presented at the debrief. The specific cause of the failure and subsequent low metrics is a delay

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in communicating both the consumption of raw material and the shipment of finished goods inventory – an information problem. In other words, demand is realized too late in the process. It is the system's failure that becomes the main focus of the exercises and assignments following the simulation. Throughout the remainder of the semester, students create diagrams modeling the user requirements, data structures, and processes for an information system that could correct the inherent data timing and quality problems in the operations of Fetch, Inc. To create these models, students use their own simulation experience, interview their classmates, and study documentation and forms used in the simulation. See Appendix A for a listing of the forms and reports used in the simulation.

## 4. IMPLEMENTATION OF THE PEDAGOGY

The pedagogical approach was implemented across two courses, bringing together related concepts from a Systems Analysis and Design course and a Data and Information Management course. These two courses are the first two taken by Information Systems Management majors in the Palumbo-Donahue School of Business at Duquesne University. As these courses are typically taken by first semester juniors, 85 to 90 percent of the students are registered in both courses simultaneously. This implementation was innovative in its own right because it allowed the instructors to demonstrate cross-course concepts - determining and documenting requirements to serve as the basis for information system design. This process is a critical skill for students studying information systems and is directly related to both courses. The Systems Analysis and Design course focuses on how to determine the requirements of an application (e.g., what actions must be accomplished by the users of the system), while Data and Information Management course focuses on the requirements for data storage (e.g., what information needs to be stored and accessed). Further, both courses provide students with skills necessary for creating diagrams and other artifacts to document requirements using industry-standard modeling methodologies. The simulation could be used in either course independently, however.

Prior to the day of the simulation, students were briefed in the classroom to ensure their familiarity with the business context. The briefing reviewed a manufacture-to-stock scenario where (1) customer orders deplete finished good inventory, (2) a reduction in finished goods triggers work orders to manufacture more product, (3) the manufacturing process consumes raw goods inventory, (4) and reductions in raw goods triggers purchase orders for the component parts. Industry-standard modeling methodologies are covered throughout the courses.

In order to conduct the simulation in a classroom, the room was transformed into a "plant layout". The classroom furniture was arranged in a way that suggested there were seven different work areas (see Figure 2). Each area or department had a sign indicating the function performed there. Products in different stages of production were placed at different work areas to create the illusion of on-going operations at the start of the simulation.

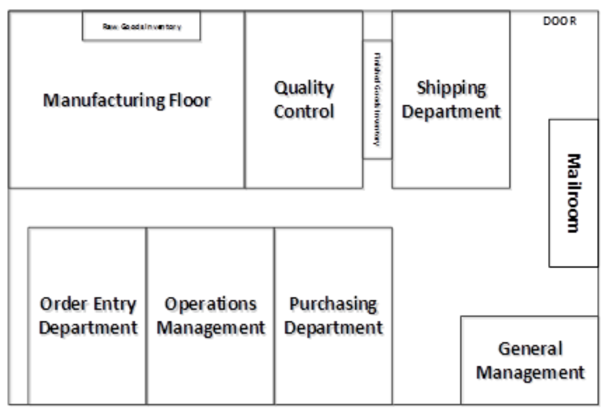


**Figure 2. Plant Layout**

## 5. Analysis

96 students participated in the simulation and were assigned to one of 4 sessions. Within 30 to 40 minutes, each of the sessions led to a system breakdown, as predicted. The order metrics (customer orders, work orders, purchase orders and open, closed, waiting to ship) were collected for each session (see Table 1).

| | Cos | | | WOs | | POs | |
|---|---|---|---|---|---|---|---|
| **Session** | **C** | **O** | **W** | **C** | **O** | **C** | **O** |
| A | 8 | 7 | 2 | 4 | 10 | 10 | 6 |
| B | 8 | 5 | 7 | 7 | 10 | 5 | 3 |
| C | 6 | 7 | 8 | 8 | 11 | 10 | 7 |
| D | 4 | 5 | 8 | 8 | 6 | 12 | 0 |
| *C-closed, O-opened, W-waiting to ship* | | | | | | | |

**Table 1. Final Order Statistics**

 

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**Debriefing**
The class session after the simulation, the students were debriefed on their experience. They were asked:

- With all the open orders and work-in-process, why weren't you, as employees, working?
- Why was everyone sitting around waiting when customers weren't receiving the product they ordered?

Listening to the students responses, it was clear to the them that (1) the shipping department was not shipping because the ordered parts were not in inventory, (2) the shop floor was not working because the component parts were not available in the raw goods inventory, and (3) the purchasing department was not ordering because the shop floor did not report the use of raw goods until after the work on the customer's order was done. At this point it was clear to all that the movement of parts needed to be reported as soon as the parts were pulled out of inventory. Carrying excess inventory would hide this problem, but not solve it. Better inventory practices such as just-in-time or lean would only exacerbate the problem. The above issues were independent of who was participating. They occurred in every session of the simulation.

There were additional problems that occurred as individuals made adjustments to the procedures to solve local issues without knowledge of how it would affect the overall process. For example, one of the purchasing clerks decided to order larger quantities of all parts so the shop floor would have everything they needed. The student was unaware that the availability of component parts was limited (this is realistic – scarcity or lead-time issues), and an assistant who helped run the simulation by receiving newly shipped customer orders was instructed not to "ship" partial orders for component parts (realistic – shipping costs). What physically happened was that the shop floor was waiting for component parts to enter raw goods inventory to finish building the product. New pieces, however, could only be made available when the assistant received finished products and could disassemble them to fill orders for component parts. No orders were leaving the plant because they were waiting on component parts. No parts were entering the plant because the assistant was waiting to disassemble shipped finish products, which would not be available because they were stalled in the manufacturing process.

**Attitudinal Survey**
An attitudinal survey was administered after the simulation was complete, but prior to the debriefing. Seven questions were used to assess the students' impressions of the simulation (see Appendix C) with a 7-point Likert scale from strongly disagree to strongly agree. Three areas were addressed. One, they were asked about the relative learning productivity of the simulation and should it be used again. Two, they were asked which was more enjoyable – the simulation or traditional lectures. Third, they were asked if they better understood the effort required to effectively work in teams.

We discarded 6 of the 96 participants responses because they answered both questions on enjoyment with the same response, and one item was reverse coded (response was not "4 = Neither Agree nor Disagree" in any of these cases). The results showed that no more than four students (out of the 90) responded negatively to the learning effectiveness or enjoyment of the activity. Over 84% of the respondents reported a greater appreciation for working in teams. Lastly, only two respondents would recommend we not use the simulation again.

**Post-simulation Learning Goals**
In addition to the one-hour simulation and the briefing and debriefing, students were given access to all the supporting documentation which includes job descriptions, work procedures, forms, report formats, and students were encouraged to interview one another about their experience and understanding of Fetch's operations. Thus the process of discovering and analyzing requirements continued throughout the remainder of the 15 week course.

The purpose of the simulation was to create an experience where students understood the complexity surrounding requirements determination and documentation, the purpose of the assignments was for the students to apply that understanding and for the instructors to assess the learning outcomes. Specific learning goals for the courses to measure learning are shown in Table 2.

For each of the learning goals in Table 2, student assignments completed post-simulation are specified as evidence that they have met the goal. The first three goals are part of the Systems Analysis and Design syllabus, whereas goals four and five are part of the Data and Information Management syllabus. The simulation allows students to experience the system through participation and discussion with classmates, and thus more fully understand the system and its weaknesses, which is strongly aligned to what they would experience in industry. This insight creates a basis on which students can create richer system development artifacts, even though the source of information is less clear than traditional written exercises in textbooks. Further, students are forced to make assumptions and attempt to verify their own assumptions by working with classmates.

| **Learning Goal** | **Measure (Evidence)** |
|---|---|
| *Learning Goal 1 (381 W):* The student will be able to evaluate the current system and determine the requirements for creating an improved system. | • UML Model assignments<br>• Entity Relationship Model assignments<br>• Data Flow Model assignments<br>• Use Case assignments |
| *Learning Goal 2 (381 W):* The student will be able to model system requirements using object-oriented modeling techniques. | • UML Model assignments<br>○ Functional Models<br>○ Structural models<br>○ Behavioral Models |
| *Learning Goal 3 (381 W):* The student will be able to model system requirements using process-oriented techniques. | • Process Model assignment<br>• Multi-level Data Flow Diagram |
| *Learning Goal 4 (382):* The student will be able to model system requirements using data-oriented modeling techniques. | • Entity Relationship Diagrams incorporated into course project |
| *Learning Goal 5 (382):* The student will be able to build a functioning database to support their data model. | • Creation of a functional database using MS SQL Server as part of course project. |

**Table 2. Learning Goals**

Performance on the above assignments/project is the best way to assess student learning as a result of the simulation. Table 3 lists the major assignments/project in the courses, the learning goal(s) that each assignment/project support, and the average grade assigned to deliverable.

The scores earned on the assignments ranged from 85% to 94%, which suggests that the students were successful in reaching the learning goals. Assessing the direct contribution of the simulation to student learning, however, is difficult as it is only one week in a semester. All students participated in the simulation and, thus, there was no control group to compare performance against. Furthermore, we cannot make a direct comparison between the grades given to students in the term the simulation was used and previous terms because the assignments following the simulation were much more difficult. In previous terms, the students were given a clear set of requirements and only needed to create the models. The instructors did not observe any noticeable differences in the technical quality of student models, though the expert judgment of the faculty was that the simulation did lead to greater learning as assignments became more complex and a wider range of skills were necessary to complete those more rigorous assignments. For example, the students were more restricted in the assumptions they could make because more facts were presented in the simulations package. In future semesters, additional metrics will be collected so that the direct impact of the simulation on learning can be quantified.

| **Assignment/Project** | **Avg Score** | **Learning Goal Supported** |
|---|---|---|
| Assignment 1:Use Case Modeling | 91% | • Learning Goal 1 |
| Assignment 2: Structural Modeling (Class Diagrams) | 87% | • Learning Goal 2 |
| Assignment 3: Behavioral Modeling (Sequence Diagrams) | 94% | • Learning Goal 2<br>• Learning Goal 3 |
| Assignment 4: Behavioral Modeling (Sequence Diagrams & State Diagrams); Process Diagrams (Activity Diagrams) | 94% | • Learning Goal 2<br>• Learning Goal 3 |
| Assignment 5: Process Modeling (data flow diagrams to support their data model. | 85% | • Learning Goal 3 |
| Database Course Project | 94% | • Learning Goal 4<br>• Learning Goal 5 |

**Table 3. Learning Goals Assessment**

## 5. CONCLUSIONS

The simulation emerged out of our shared desire to create a problematic business context that the students, as a whole, could understand while

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experiencing some degree of vagueness and uncertainty. The simulation was prerequisite to creating an opportunity for students to more fully develop their requirements determination and modeling skills.

Providing a chance for the students to become part of the system they were modeling, presents an additional, complementary approach to understanding requirements determination techniques. A simulation like Fetch encourages a greater degree of student involvement in the assignment leading to more active involvement.

To the best of our knowledge, we know of no other program that has developed an IS simulation where (1) the students have a hands-on experience running a fictional business in order to "live" the requirements, (2) the experience is shared by two courses demonstrating the big picture of how the techniques learned in each class capture different, complementary aspects of systems definition, and (3) the experience is a focal point throughout the semester.

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## Appendix A. Description of Preparation for Simulation

1) Form and analysis teams and assigned roles to students.
   a) General Manager
   b) Operations Manager
   c) OE Clerk
   d) PO Clerk
   e) Shop Floor Employee
   f) Shipping Clerk
   g) Quality Control Specialist
2) Prepare Rooms
   a) Move desks and chairs into plant configuration (see Figure 2)
   b) Post signs indicating department
   c) Setup bins and the appropriate number of raw goods and finished goods
3) Distribute job descriptions and procedures to each department
   a) Exhibit A – Customer Order
   b) Exhibit B – Finished Goods Inventory on Hand
   c) Exhibit C – Shipment Lot
   d) Exhibit D – Work Order
   e) Exhibit E – Finished Goods Shortage Memo
   f) Exhibit F – WO Quality Guidelines
   g) Exhibit H – Reorder Point Memo
   h) Exhibit I – Purchase Order Form
   i) Exhibit J – Raw Goods Inventory on Hand
   j) Exhibit K – Suppliers
   k) Exhibit L – Receipt Log
   l) Exhibit M – Contractual Price List
   m) Exhibit N – Product Price List
   n) Exhibit O – Customer Profile
   o) Exhibit P – Raw Goods Consumption Report
   p) Exhibit Q – Inventory Allocation Notice
   q) Exhibit R – Customer List
   r) Exhibit S – Finished Goods Replenishment Notice
   s) Bill of Materials
4) Run 30 minutes exercise
5) Collect number of customer orders shipped
6) Breakdown Room

## Appendix B. Purchase Order Clerk Procedures

1. Retrieve updated Raw Goods Inventory on Hand from mailbox.
2. Use Raw Goods Inventory on Hand and Reorder Point Memo to determine which items must be ordered.
3. Create a Purchase Order for the appropriate supplier to order the needed raw goods. The supplier address is on the Suppliers list, and the prices are on the Contractual Price List. Repeat until all needed raw goods are ordered. Make two copies of each Purchase Order. Record the Purchase Order in the Purchase Order Ledger for each one created.
4. Put one copy of the Purchase Order in the Outgoing Mailbox, and send one to the Shipping Dept.
5. When Purchase Orders are returned from the Shipping Department and marked received, update the Purchase Order Ledger.

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## Appendix C. Survey Results

| Item | Area of Interest | Frequency | | | | | | | Mean | St. Dev. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | | |
| As a learning experience, this simulation was more productive than listening to a lecture. | Productive | 1 | 1 | 2 | 7 | 19 | 35 | 25 | 5.74 | 1.19 |
| As a learning experience, this simulation was more enjoyable than listening to a lecture. | Enjoyment | 1 | 0 | 0 | 3 | 8 | 27 | 51 | 6.36 | 0.98 |
| Compared to group projects in other business-related courses, this simulation was more productive. | Productive / Teams | 1 | 0 | 2 | 6 | 19 | 38 | 24 | 5.80 | 1.09 |
| Compared to group projects in other business-related courses, this simulation was less enjoyable. | Enjoyment / Teams | 30 | 39 | 12 | 5 | 2 | 1 | 1 | 2.08 | 1.16 |
| As a result of completing this simulation, I have a greater appreciation for what it takes to work in a group. | Teams | 2 | 3 | 1 | 8 | 18 | 44 | 14 | 5.50 | 1.29 |
| This simulation should not be used in future classes. | General | 43 | 32 | 6 | 7 | 1 | 0 | 1 | 1.83 | 1.10 |
| This simulation was one of the best parts of the systems analysis and database courses so far. | General | 1 | 0 | 2 | 11 | 13 | 36 | 27 | 5.79 | 1.18 |
| 1= Strongly Disagree, 2=Disagree, 3=Somewhat Disagree, 4=Neither Agree nor Disagree, 5=Somewhat Agree, 6=Agree, 7=Strongly Agree | | | | | | | | | | |

Areas of interest:

Productive — They were asked about the relative learning productivity of the simulation and should it be used again.

Enjoyment — They were asked which was more enjoyable – the simulation or traditional lectures.

Teams — They were asked if they better understood the effort required to effectively work in teams.