LEARNING ENVIRONMENT FOR ORGANIZATIONS IT MANAGEMENT SUPPORTED BY A SIMULATION GAME

Olga Lucía Giraldo, Olga Lucero Vega
Universidad de los Andes, Carrera 1 Este No 19 A 40, Bogotá, Colombia

Juan Erasmo Gómez
Universidad de los Andes, Carrera 1 Este No 19 A 40, Bogotá, Colombia

Keywords: Business process, Business Process Management - BPM, Business Process Management System - BPMS, Business Process Modeling Notation - BPMN, Virtual learning environment, Serious games, IT Management.

Abstract: There is growing evidence about organizational need of aligning business and IT (Gartner, Inc., 2009). This alignment requires special IT managerial skills for understanding business and identifying core processes. Results show that IT governance frameworks can improve the alignment of IT and business. Companies aligning IT with the business and governing IT have higher profits than their competitors, experience shorter time to market, attain better value from their IT investment, have better access to shared data, have less risk of failure of mission-critical systems, have better top management satisfaction of IT -80%-, and have lower IT costs- 25% (Ross, et al., 2006).

Nowadays students are trained on general managerial skills in management programs but knowledge about IT governance and tool support is confined to the CxO level, and is not part of undergraduate education. Moreover education of IT governance tools is not feasible for undergraduate students because it involves working with real companies that are not willing to risk their IT investment, or their results on undergraduate student projects.

The MIT Sloan School of Management Center for Information Systems Research –CISR proposed a framework of IT Governance that begins by defining an Operating Model a company must implant. The key dimensions of this model are the *level of integration* and *standardization of business processes* (Ross, et al., 2006).

In this paper we present an ICT supported learning environment to train undergraduate students in IT managerial skills and IT governance tools. With this environment so student can experience how their decisions have an impact on the organizational life cycle and their effectiveness.

The main contribution of this work is proposing alternatives to surpass barriers for developing IT managerial skills in IT undergraduate students. Starting with the time barrier, strategic IT decisions have mostly long term impacts; trial and error decision making that is not possible for in real situations; and last, but not least, students bringing into play decisions that expose business continuity without catastrophic consequences.

1 INTRODUCTION

Developing organizational IT managerial skills in undergraduate students is challenging. Particularly for undergraduate IT students who are not aware of the importance of these skills; they frequently are confident about their technical skills and knowledge but lack managerial skills. These skills are difficult to instruct because they can only be deployed in real environments. Case studies are the most used and noteworthy tools to support training on these subjects. Nowadays ICT supported learning has been used to improve education of these types of skills (Casallas, et al., 2008 pp. 648-658). Virtual learning has many advantages that traditional classroom lecturing lacks. Particularly using serious games and

Lucía Giraldo O., Lucero Vega O. and Erasmo Gómez J..
LEARNING ENVIRONMENT FOR ORGANIZATIONS IT MANAGEMENT SUPPORTED BY A SIMULATION GAME.
DOI: 10.5220/0003297700150024
In *Proceedings of the 3rd International Conference on Computer Supported Education* (CSEDU-2011), pages 15-24
ISBN: 978-989-8425-49-2

virtual environments to train specialized skills can provide several advantages (Sterman, 2009), (Intel Corporation, 2009). For example simulating the passage of time much quicker can help illustrate the effect of actions and decisions on long-term consequences; feedback about outcomes of present-day decisions can be provided immediately; understanding the long-term impact of decisions can help students achieve their learning objectives. Virtual learning environments allow students to make erroneous decisions without having catastrophic consequences (Atiq, et al., 2008). Students might make the worst decisions possible, understand the behavior of their organization as a result, and even lead it to bankruptcy, without fear, but nevertheless learning. They can try out any decision, use resources, change goals, and learn. Acting this way in real life exposes and risks the continuity of any business (Kriz, 2003). Trial and error is not a way to manage a business, but it is an effective way to learn. Virtual learning spaces consent, even more, stimulate exploring many alternatives (Chua, 2005).

Simulation games present real situations that show the value of technical and managerial skills helping IT students understand the importance of complementing their curriculum with managerial skills. Training IT student in managerial IT skills is challenging. Instructors need innovative and rich tools to stimulate students so they become interested in the subject. The goal is linking organizational concepts and IT government elements to develop IT managerial skills so students, who become professional managers in the future, have a positive impact business performance.

Our main objective is developing IT managerial skills on undergraduate IT students from the very beginning of the curriculum (Cameron, 2008). We built a learning environment, supported by ICT to develop underlying concepts of IT governance. Specifically we focus on business processes comprehension, modeling and optimization.

The work presented in this paper focuses on how we developed this learning environment. In next section we present the background, and the theoretical framework that includes IT managerial concepts, IT tools used in this work, virtual learning environments, and the LIDIE methodology (Aldana, et al., 2003). Afterward we present the learning environment supported with ICT to train students in business processes management. Finally we suggest some future work and present our main conclusions.

2 BACKGROUND

Undergraduate IT programs must adapt curricula that include managerial skills for XXI century IT professionals (Brown, et al., 1999). It is also mandatory using ICT tools to solve logistical difficulties that hinder student progress. Particularly, these tools are useful to help students apply organizational concepts. By mastering these concepts IT professional in their future work will be able to focus on generating Business Value from IT-BVIT.

An important element to generate BVIT is IT governance. Ross, Weill & Robertson propose an IT governance framework based on the operational model –OM, *the necessary level of business processes standardization and integration for delivering goods and services to customers* (Ross, et al., 2006). Cruz, Gómez & Giraldo designed a serious game to simulate OM deployment (Cruz, et al., 2010). Its focus is organizational effects of applying a particularly OM, Diversification, Coordination, Replication, or Unification, in a particularly company (Ross, et al., 2006). For a period of time the student becomes the CIO of this company in a specific scenario; she has IT resources and makes decisions related to the OM implanted in the company spending IT resources and generating incomes. The game simulates the passage of time; year after year the student obtains results as a consequence of her decisions. This way the student learns how IT decisions -OM, have an impact on organizational performance.

The results show that students understand this concept, but do not grasp how processes behave in real business, how to identify them, what are the main differences from one business to another or from an organization to the next one. We perceive they need more support to understand the cornerstone of OM: business processes.

3 THEORETICAL FRAMEWORK

Organizational analysis requires knowledge of its environment and identification of its competitive forces (Porter, 2008), its value chain and its business processes (Porter, 2004). When this analysis is supported by tools, such as Business Process Management- BPM- tools, professional performance is improved. Before presenting our work we now introduce these concepts and tools.

3.1 IT Management

3.1.1 Competitive Forces

Porter's five competitive forces analysis helps strategist understand the structure and interactions within an industry. The five forces are existing competitors, buyers, suppliers, new entrants, and substitute. Understanding competitive forces allows a strategist to propose appropriate plans for achieving company objectives (Porter, 2008).

3.1.2 Value Chain

The value chain describes activities of enterprise processes, illustrating the way an enterprise generates value to its clients (Porter, 2004). The value chain has activities directly involved with transforming raw materials into final products, and others activities pervasive to the entire organization. The former are called primary activities, the latter support activities. Value chain activities not only add value by themselves, but also by the way they are articulated amongst each other. Identifying an organization's value chain helps improve profit by allowing application of best practices to increase efficiency, to reduce costs, or to increase production.

3.1.3 Business Processes

The international standard ISO-9001 defines a process as "an activity that uses resources that is managed to transform input in outputs" (ICONTEC, 2005 p. 6). Complementing this definition (Hammer, 1990) says that business process contains activities with specific goals, it is carried out collaboratively by workers with different specialties, often crossing borders of functional areas, and is always triggered by external agents or customers.

Business processes have goals, owners, inputs, outputs, threads, decisions and activities. Goals are the raison d'être of a process; processes are developed to achieve them. Owners are the ones accountable for the behavior of the process and frequently the owner is the person more affected or benefited by its results. Inputs are resources necessary for executing process activities. Outputs are results obtained from process execution. Threads are parts of higher level processes. Decisions are points in a process where its behavior changes according to specific conditions, points where there are several possible routes within the process. Activities are parts of a business process that do not include decision-making. Modeling a process includes identifying its activities, decisions, and break in the order they are executed. Modeling a process helps understand it, explain it, and identify opportunities for its improvement.

3.2 IT Tools

Business Process Modeling (BPM) is a methodology for improving process efficiency through it holistic management by modeling, automating, integrating, monitoring and optimizing it continuously. BPM reduces costs and errors, ensures process behavior and informs its status, and supports continuous process improvement.

Business Process Management Systems (BPMS) are systems that provide functionalities described before, delivered as a single package, frequently by a single provider.

Business Process Management Notation (BPMN) is a graphic language that portrays the sequences of activities, actors and rules involved in a business process. There are many implementations, some of which only depict the process, while others generate applications directly from the process specification. BPMN Level 1 is the most frequently used tool to interact with business people. (Silver, 2010)

3.3 Virtual Learning Environment

Virtual learning environments –VLE- use ICT to "ease interaction and arbitrate relationships amongst people, knowledge, and the world" (Ospina, 2008). Learning Management Systems –LMS- incorporate ICT to articulate components of specific learning scenarios with their own target population, environmental elements and execution conditions. Typical components of a VLE are virtual learning objects –VLO, wikis, asynchronous forums and simulation games. VLOs are structures that store knowledge about a specific subject with an educational purpose that are distributed and accessed through the Internet (MEN, 2005). Wikis are websites that allow editing contents by those that access them. The best known example is Wikipedia, www.wikipedia.com. Forums are virtual spaces that allow asynchronous participation of people in discussions and debates. Simulation games are educational computer games simulating the real world to develop skills by "learning to do" and "learning to be". Two examples are the Beer Game of MIT, for teaching principles and management of supply chains (Sterman, 2009); and Intel IT Manager III to develop skills to manage and implement IT technologies in enterprises (Intel Corporation, 2009).

3.4 Methodology

We decide to use the LIDIE methodology, Figure 1, because it focuses on developing learning environments supported by ICT, and it is linked to Software Engineering Education (Galvis, 2000).

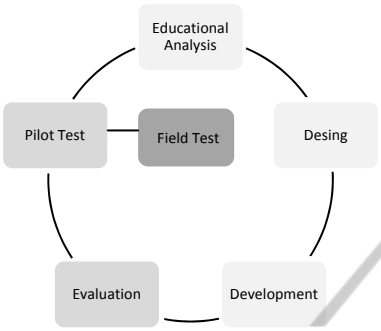

Figure 1: LIDIE Methodology (Galvis, 2000).

The LIDIE methodology defines six stages; its application includes stages iteration for continuous improvement. The analysis identifies educational needs; the design stage focuses on satisfying these needs; in the development stage we use ICT to implant the designed solution. Finally the evaluation, pilot and field test stages assess the quality of the solution and infrastructure, and its deployment.

4 WORK DEVELOPMENT

We now present the application of the first three stages of the LIDIE methodology to develop IT managerial skills in undergraduate students.

4.1 Educational Analysis

To identify the main educational needs we examined an IT organization undergraduate course; analyzed student course evaluations and surveys; performed teacher interviews; and studied the OM simulation game (Cruz, et al., 2010).

The course we selected is an organizational design using ICT course. Figure 2 shows its learning sequence; case study is the preferred learning technique. This course was selected because it covers IT governance topics and helps develop foundations to understand how generate value using IT.

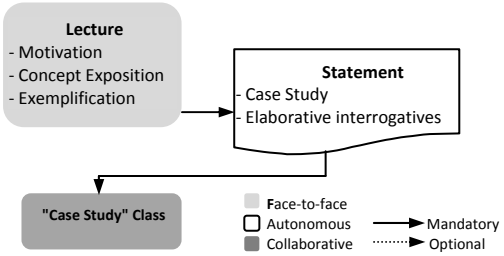

Figure 2: Current sequence learning.

We obtained student course evaluation and surveys over four semesters from 2008 and 2009; figure 3 shows student perception of significant learning topics. According to the surveys, the least significant learning topic for students is “Strategic IT; Business alignment”.

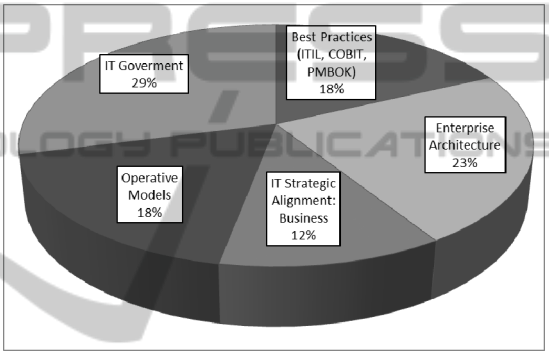

Figure 3: Students perception of significant topics in Organizational Design with ICT.

We interviewed former lecturers of the course for these same periods. Their perception was similar to student insights from the surveys: students are not able to bridge IT strategic topics. Students do not understand how the OM is the base for enterprise architecture, nor they are able to recognize that enterprise architecture is sustained using an IT governance framework, and that IT governance is entrenched via best practices, which helps achieve strategic use of IT: Business alignment.

Cruz developed the OM simulation game (Cruz, et al., 2010). Our future works will focus on executing a whole iteration of this game and performing pilot and field tests. To play this game, students must have basic organizational concepts, but not all do. Therefore we turn our attention to organizational analysis and business processes mastering, considering that using ICT could solve educational needs related to those concerns. This objective drives the design phase (Barbera, et al., 2005).

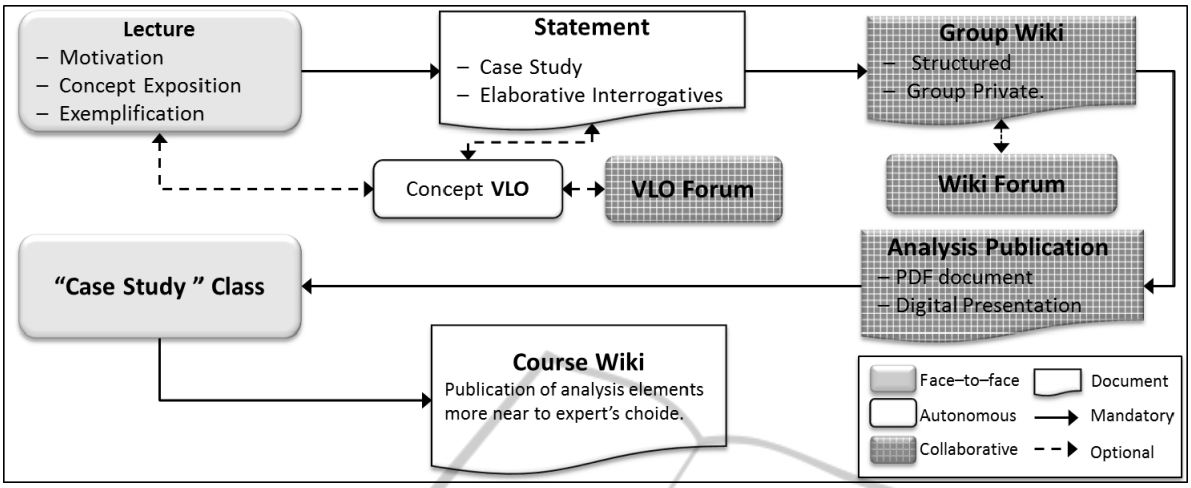

Figure 4: Learning sequence for basic concepts.

4.2 Design

In the Design stage we focus on developing students skills to set organization industry characteristics, Porter's Forces actors, organizational value chain processes, and business processes. We propose two learning sequences, one for basic concepts and another for business process. Both learning sequences begin with the lecturer presenting rules and support tools for the course, and achieving commitment from students in virtual and face-to-face spaces. The learning sequences are supported in a Learning Management Systems- LMS.

4.2.1 Learning Sequence for Basic Concepts

Figure 4 shows the proposed learning sequence. Details Students work in groups of three to five students. The first step is the lecture, a face-to-face moment. During class, the lecturer presents core concepts, origin, importance, and application in a case. We recommend lecturers support this activity with elaborative interrogations and digital presentations. Elaborative interrogations encourage students to find more information about the organization in the case and its industry to better comprehend organizational concepts, industry behavior, Porter's Forces, value chain, and business processes (Hill, 1994).

The second step is the Statement, a virtual moment. Using the LMS students have access to a case study, elaborative interrogatives, a wiki for each group, Virtual Learning Objects -VLO, and two forums. The objective is for them to work on a case study similar to the one presented during lectures. Elaborative interrogatives motivate students to analyze the organization and publish results in their wiki. Elaborative interrogatives motivate students to analyze the organization and publish results in their wiki. Group wikis are private group spaces to construct knowledge and publish results. VLOs are private student space to reinforce learning. Forums are meeting spaces for students to develop discussions.

Group wikis, with a pre-defined structure, include spaces that groups should use to store results of organizational analysis. At the very beginning wikis are empty, but have a template to guide their organization. As the course progresses, students must develop their wikis to include new topics.

VLO are grasping spaces about specific concepts that have other smaller case studies and questions to increase student understanding of specific aspects by applying concepts. The students interact with the VLO by recoding their answers to elaborative interrogatives. As a result the VLO will present a comparison between their answers and those made by a team of experts. The students must analyze differences and similarities. These VLO are similar to the trainers of the Cupi2 project (Villalobos, et al., 2009).

Each group also has two forums available: VLO forum and wiki forum. Students can share their concerns and questions in these spaces. The lecturer or her assistant are invited to participate in forums, but this is not mandatory.

The last step is the Case Study Class, the 2nd face-to-face moment. The lecturer begins this class addressing the concerns of students. Afterward she argues the concepts related to the case study to

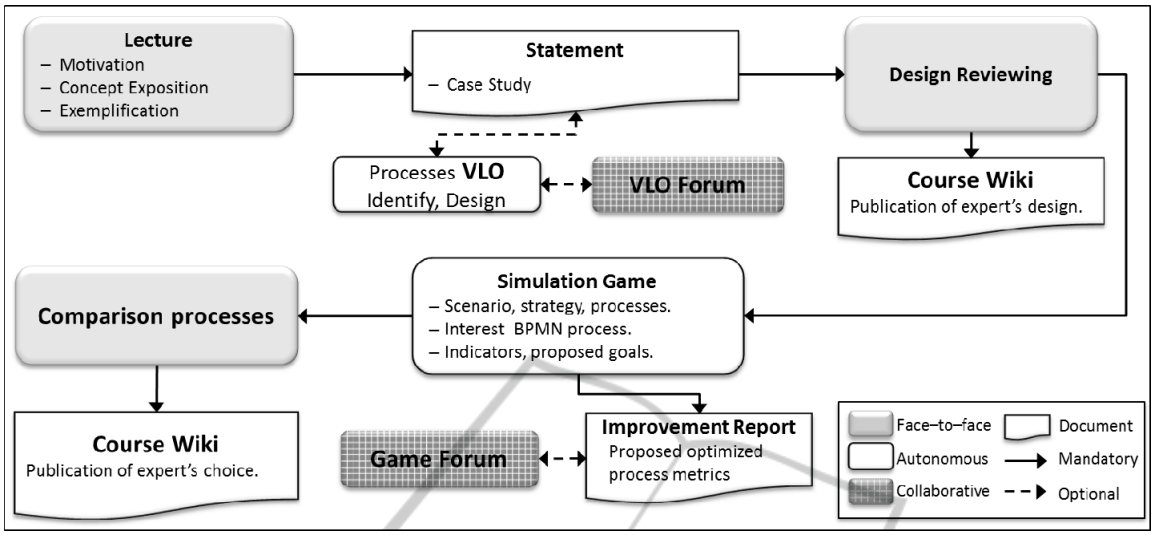

Figure 5: Learning Sequence for Business Process with the simulation game.

discuss, in plenary, their application. She must also bring into discussion the results and ideas the groups published in their wikis. Then lecturer must publish in the course wiki selected group results, particularly those closer or divergent from the proposed solution. Then students can consult these solutions when pertinent.

The lecturer evaluates student using the documents published in the group wikis. In this way students are externally motivated to review the case before group discussions and participate in the construction of the group wikis. As a collateral result students develop collaborative work skills. We expect the VLE to help increase student involvement because their objective is to increase student preparation and review of concepts and subjects before class.

4.2.2 Learning Sequence for Business Process

One of the main objectives of IT management in organizations is strategic alignment between business and IT. During the analysis stage strategic alignment was rated by students as the least significant topic, Figure 3. For this reason we decided to focus on improving education of process skills management.

The main skills we want to develop are:

- Business Processes identification and description.
- Process actors, activities and events identification
- Process design with BPMN.
- Process optimization concepts.

To train students in the first three skills we defined a learning sequence similar to the sequence proposed for basic concept, Figure 4. To develop process optimization skills, we propose including it in the Cruz simulation game (Cruz, et al., 2010).

The learning sequence, Figure 5, begins with a class where lecturer introduces business processes concepts. Afterward the student must solve a problem from a case study- define a statement about an organization and how it does its job- using the VLE. Students must identify and describe the main organizational business processes. In the next step the lecturer defines and describes a process. The students must identify its components and depict them using BPMN as shown in Figure 6.

Students will find a VLO and a forum supporting their learning activities; after they answer teacher' question the VLO displays a business processes defined by experts. We suggest the lecturer uses a widely known business process such as "internet shopping", "credit study", or "billing". Students are familiar with these kinds of processes, and are usually included in the knowledge base of BPM tools (Vision Software, 2010). Development and deployment of these VLOs is similar to those proposed in previous sections.

Actually Cruz simulation game focuses on organizational impact of operational model- OM. The game elements are staff, infrastructures and software, and change; its costs and benefits determine the impact of OM in organizational performance. During the game students choose the appropriate OM, so they must determine the

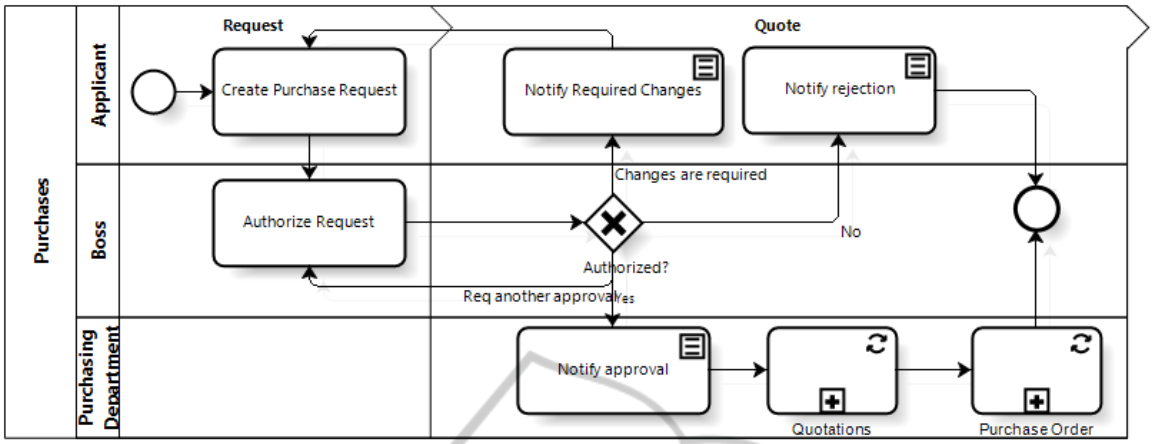

Figure 6: Purchases v1.0 (Vision Software, 2010).

necessary level of business processes standardization and integration. Then they require abilities to identify, describe, design, and optimize processes.

We propose that the game manage business process and feedback about processes optimization; the game would simulate changes students propose and shows their impact. This includes simulating the execution of the process over long periods of time and generating indicators. We propose the wholesaler industry as a game scenario (Rubio, 2009) because it is a global and enough documented example. Main activities in the wholesaler/retail are designing product and process, buying, making, selling, and managing a business (MIT, 2003). Wholesaler industry is a good selection for a serious game: arguments, knowledge and pedagogic element are easily built using in this example (Aldrich, 2009).

For designing the business process, Bizagi (Vision Software, 2010) provides a design tool with a business process repository and examples such as the purchase process documented, Figure 6, and we decide using it, as a pedagogic element in our simulation game (Aldrich, 2009). When changed, the simulation game will present students this process and will ask them accomplish a strategic objective, and present metrics described later. Students must propose process improvements and the simulation game shows the results of this improvement.

Improving a process requires an investment. The student must keep in mind the benefits expected of this investment, i.e. the return of the project, so they can compare it with other possible investments. For example, the student analyses an inefficient purchase process; each time an order is authorized, the Purchasing Department must request quotes from suppliers and wait for their responses to select the best proposal and then complete the Order. The game presents strategies pointed by the business, available resources, Porter's forces and value chain and current metrics of this process. If the student understands the organizational analysis, she can choose to implement an automatic request for purchase, eliminating the quotes step each time an order is authorized. This automatic request needs a supplier registration, qualifications and pre-approved prices. Her initiative must be inspired in the narrative of suppliers' force of the Porter's Forces provided by the game. The simulation will show her that process executed in this way reduce time. If she does not understand the Porter's Forces she could erroneously think that doing online purchase request would improve the process. Contrary to her expectations, the simulation shows that process resulted in worst indicators because adding online implementation costs, without improvement in time, has a negative impact on her organization.To incorporate in the simulation game a business process performance measurement, we propose to use (Mogollon, et al., 2004) formula to calculate the ROI of a process improvement:

$$ROI = \frac{CurrentProcessCost - NewProcessCost + OtherBenefits}{Cost\ to\ Implement\ the\ Project}$$

Formula 1: ROI for a process (Mogollon, et al., 2004).

Current Process Cost, New Process Cost and Cost to Implement the Project are calculated according indicators already in use in the simulation game. The Other Benefits must be calculated adding tangible and intangible benefits. The former refers to benefits for which monetary value can be easily assigned; the latter refers to those which monetary value is difficult to assign. From (Mogollon, et al.,

2004) we use, for tangibles: sales increase, production increase and reduction of operating cost; and for intangibles: managerial know-how and improved employee morale. These cost calculation rules must be presented to students so they can understand the simulation process results.

4.3 Development and Evaluation

During development stage we implemented the basic concepts sequence learning on the Moodle LMS environment (Dougiamas, 1991). This project is available with user est001/isis1401* from http://backus.uniandes.edu.co/~ol.vegam/ moodle.

We selected as example a construction company. We developed a Concept VLO with interrogations to help students reinforce concept comprehension related to value chain and competitive forces. The Group Wiki of this learning sequence has the structure and elements presented in Figure 7.

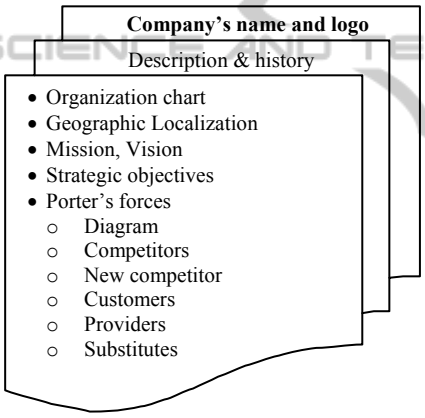

Figure 7: Wiki Structure.

Evaluation of the VLE was done including education quality, usability and viability using the evaluation guidelines proposed in (Galvis, 2000).

For educational issues the results showed that learning objectives are adequately covered by the learning environment sequence implemented; that learning strategies are pertinent; and that students sometimes choose not to use VLO. During evaluation we realized that we can gather information about student behavior regarding difficulties and achievements. This information would be useful for the lecturer to guide her lessons.

Concerning usability results showed that our VLE is easy to use, instructions are clear, roles (student, lecturer, and assistant) are clearly differentiable, and maintenance is easy. Viability was assessed using the VLE in an undergraduate class laboratory, results were satisfactory.

The implementation was evaluated by peers who were selected to evaluate proposals for learning environments supported by ICT, in a project competition. They used the LMS platform as a student and give us comments, suggestions and questions. Their opinions were that the interfaces are attractive and the implementation is consistent with the proposed design. Several pairs made questions about time elapsed between virtual and face to face moments, because it seen that students must do a lot of work from one to another moment. This should require more time than was used in the traditional classroom.

5 FUTURE WORK

Currently pilot evaluations and field testing has not been done. We must complete the examples on the basic concept learning sequence, and develop the business process learning sequence. The former requires TIGER rubric specification to assess the wiki groups of organizational analysis (Galvis, 2007). The business process learning sequence must be developed. The biggest challenge is to adapt the simulation game incorporating the proposed business process issue. We must use experience in the field of serious game generation (Casallas, et al., 2008 pp. 648-658). We must also decide on how to use the results of the simulation game as part of student evaluation.

Other future work includes recollecting results of our work, to provide students with a summarized exercise. Each semester students develop a project. We recommend that students choose a target enterprise from a list offered by the lecturer or an enterprise of particular interest to them. In both cases the enterprise must be a successful business, preferably with local presence, and for which extensive information is available.

Additionally we must gather information from the VLE about student concerns for the lecturer and help him use this feedback to.

Finally, we want other IT undergraduate schools and IT management programs to use our VLE in their courses; therefore other future work is adapting the environment to these target users.

6 CONCLUSIONS

IT management is critical to achieve improved results in any business. Development of IT

managerial skills in undergraduate IT students is mandatory to create a management force capable of achieving this. Using a traditional learning environment it is very difficult to achieve this learning objective. Students nowadays are digital natives; our initiative is an opportunity to take advantage of this.

We have presented an integrated learning environment that uses LMS, VLO, forums, wikis and a simulation game to support the development of IT managerial skills in undergraduate IT students. The LMS incorporates ICT in a natural and controlled way. Each ICT has a specific educational objective; VLO reinforce basic organizational and business process management concepts; thematic forums provide a meeting place for students to express concerns, successes and to share their learning experiences; Wikis make possible collaborative work; the simulation game develops managerial skills to optimize business processes.

A collateral benefit of LMS implementation is the gathering information about student behavior of their autonomous work. With this information we can identify challenges and achievements of students.

The incorporation of ICT tools in learning environment proposed in this work is aligned with developments in the real world. Students using our learning environment will be better skilled to exploit these tools in their future work and help organizations improve their usage of these tools.

REFERENCES

Aldana, María F., Arango, Martha L.; Leal, Diego E.; López, Esperanza; Osorio, Luz A.; Salazar, Ana M.. 2003. Metodología para la Construcción de Ambientes Virtuales como Soporte para la Educación Presencial de la Universidad de los Andes. *Revista de Ingeniería, Univ.de los Andes,Bogotá.* 2003, 18.

Aldrich, Clark. 2009. *The Complete Guide to Simulations and Serious Games: How the Most Valuable Content Will be Created in the Age Beyond Gutenberg to Google.* San Francisco, Pfeiffer, 2009.

Atiq, Siddiqui, Mehmood, Khan and Sohail, Akhtar. 2008. Supply chain simulator: A scenario-based educational tool to enhance student learning. [ed.] Elsevier Science Ltd. *Computers & Education.* 2008, Vol. 51, 1, pp. 252-261.

Barbera, Elena and Badia, Antoni. 2005**.** *Educar con Aulas Virtuales, Orientaciones para la innovación en el proceso de enseñanza y aprendizaje.* Madrid: Antonio Machado Libros, 2005.

Brown, Carol and Ross, Jeanne W. 1999. *The IT Organization of the 21st Century: Moving to a Process- Based Orientation.* Massachusetts: s.n., 1999.

Cameron, Brian H. 2008. Enterprise systems education: new directions & challenges for the future. [ed.] ACM. *Special Interest Group on Computer Personnel Research Annual Conference.* 2008.

Casallas, Rubby and López, Nicolás F. 2008. An environment to help develop professional software engineering skills for undergraduate students. *International Journal Of Engineering Education.* 2008, Vol. 24, 4.

Chua, Alton Y. K. 2005. The design and implementation of a simulation game for teaching knowledge management: Special Topic Section on Knowledge Management in Asia. *Journal of the American Society for Information Science & Technology.* 2005, Vol. 56, 11, págs. 1207-1216.

Cruz, César F., Gómez, Juan E. and Giraldo, Olga L. 2010**.** Enseñanza de Sistemas de Información con ambientes simulados: El caso de los Modelos Operativos en la Universidad de los Andes. *2010 International Conference on Information Resources Management.* Montego Bay, Jamaica: s.n., 2010.

Dougiamas, Martin. 1991. Moodle. [Online] 1991. http://moodle.org/.

Galvis, Alvaro H. 2007. Criterios y rúbrica tigre para autocontrolar calidad de aportes en discusiones. [Online] 06 03, 2007. [Cited: 05 03, 2010.] http://aportetigre.blogspot.com/.

Galvis, Alvaro H. 2000. *Ingeniería de Software Educativo.* Bogotá: Ed. Universidad de los Andes, 2000.

Gartner, Inc. 2009. Predicts 2010: CIOs and IT Executives Brace for a Tough Year, Even as Economic Indicators Improve. [Online] Gartner Group, 12 15, 2009. [Cited: 04 05, 2010.] http://www.gartner.com/DisplayDocument?ref=prd2010&doc_cd=173506&ref=g_noreg..

Hammer, Michael M. 1990. Re-engineering Work: Don't Automate, Obliterate. Harvard Business Review, July-August 1990, pp. 104-119

Hill, Lee. 1994. West Virginia University Insitutional Repository. [Online] 1994. http://wvuscholar.wvu.edu:8881/exlibris/dtl/d3_1/apache_media/20629.PDF.

ICONTEC. 2005. *Directrices para la aplicación de la NTC-ISO 9001:2000.* Bogotá: ICONTEC, 2005.

Intel Corporation. 2009. IT Manager III. [Online] 2009. [Cited: 11 2, 2009.] http://itmanager3.intel.com.

Kriz, Willy C. 2003. Creating Effective Learning Environments and Learning Organizations through Gaming Simulation Design. *Simulation and Gaming.* 2003, Vol. 34, 4.

MEN. 2005. Ministerio de Educación Nacional. [Online] 2005. http://www.colombiaaprende.edu.co/html/directivos/1598/articles-75230_archivo.pdf.

MIT. 2003. The MIT Process Handbook . *Massachusetts Institute of Technology.* [Online] 2003. [Cited: 08 12, 2010.] http://ccs.mit.edu/ph/.

Mogollon, Manuel and Raisinghani, Mahesh S. 2004**.** Measuring ROI in e-commerce Applications: Analysis

to Action. [book auth.] W Van Grembergen. *Strategies for Information Technology Governance.* Hershey: Idea Group Publishing, 2004, pp. 187 - 215.

Ospina, Diana P. 2008. Univ. de Antioquia. *¿Qué es un ambiente virtual de aprendizaje?* [Online] Programa Integración de Tecnologías a la Docencia, Vic. de Docencia, 2008. [Cited: 06 24, 2010.] http://aprendeenlinea.udea.edu.co/banco/html/ambiente_virtual_de_aprendizaje/.

Porter, Michael E. 2004. *Competitive advantage: creating and sustaining superior performance.* New York: Free Press, 2004.

Porter, Michael E. 2008. *On Competition.* Cambridge: Harvard Business Press, 2008.

Ross, Jeanne W., Weill, Peter and Robertson, David. 2006. *Enterprise Architecture as Strategy.* Massachusetts: Harvard Business School Press Boston, 2006.

Rubio, Pedro. 2009. ¿Cómo llegar a ser un experto en Marketing? *Biblioteca Virtual Univ. de Málaga.* [Online] 2009. www.eumed.net/libros/2009a/506/.

Silver, Bruce. 2010. BPMS Watch. [Online] 08 23, 2010. [Cited: 08 30, 2010.] http://www.brsilver.com/ bruce-silver-associates/.

Sterman, Jhon D. 2009. The MIT Beer Game. [Online] The MIT Forum for Supply Chain Innovatio, 2009. [Cited: 11 2, 2009.] http://beergame.mit.edu/.

Villalobos, Jorge and Calderon, Nadya. 2009. Proyecto Cupi2: Un enfoque Multidimensional frente al problema de Enseñar y Aprender a Programar. 2009, Vol. 8, 2.

Vision Software. 2010. Bizagi. [Online] 2010. [Cited: 08 12, 2010.] http://www.bizagi.com.