IMPLEMENTING SYSTEM THINKING IN HIGHER EDUCATION TO TEACH BUSINESS COURSES

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ABSTRACT

Students in classrooms construct their own knowledge through experiences gained by observing, exploring and performing in the real world. The constructivist approach to education centers on this claim. This paper explore the use of system thinking tools to enhance the learning process in universities courses, which through testing different scenarios "enrich and broaden both the scope of activity and the scope of thinking of the student". Through computer-based instructional simulations, we can provide a wide variety of learning experiences to the students in classrooms. The simulation environment provides them with the observations and experiences that they must attempt to explain, assimilate and combine with their existing knowledge. The present paper describes the role of computer-based instructional simulations as a system thinking approach in teaching-learning process.

The students' achievements were measured using a test. A pre-test was given before simulation to know their performance level and pre-knowledge and a post test was administered after simulation to examine whether they showed a progress or not. Their achievement results were analyzed by using a t-test. The analysis of the result indicates that, students who were taught using computer simulations as a teaching aid showed a good progress.

Keywords: System Thinking, Education, Business Courses, University Students.

Note: This paper was conducted during the author's sabbatical leave from al-zaytoonah university of Jordan

1. Introduction

The purpose of teaching at any level is to bring fundamental changes in the learner. Such changes may be in the form of acquiring intellectual skills, solving problems and inculcation of desirable attitudes and values. Teachers adopt different approaches to help students to acquire knowledge, skills and experiences. Classroom use of Information and Communication Technology (ICT) for teaching science and technology has increased dramatically in recent years and has proven to be a very effective tool in variety of situations (Ambelu, 2011)

One of the challenges the society is facing in the modern world is the growing discrepancy, which exists between the rising demand of highly qualified manpower in the fields of finance and the low number of talented graduates in this fields. Since this is the concern of the people in the society, governments and professionals have to make unreserved efforts to change the situation. Now, almost everyone has realized that, in order students to have interest in science fields, it is necessary for universities to consider more carefully the problems at all levels of the educational pyramid. The way students are trained to understand science of finance and the environment they grew up may have an impact on their future options and affinities (Hake, 1998)

Many university lectures are dedicated in teaching activities and in some cases, they have a special focus on the improvement of technology teaching in classrooms by using different teaching methods like the computer simulated programs called Virtual Simulations (VS) (lakin, 2000). Advances in computer technology have led to various high-quality educational tools including interactive programs, multimedia presentations and more recently virtual simulations. Virtual simulation is a computer interface characterized by a high degree of immersion and interaction making the user believe that he/she is actually inside the artificial environment.

The development of information technology has played a great role in supporting many educational fields in a way that the user must be supported in a computer-assisted method of teaching. Using computer simulation as a teaching aid in science fields enables students to acquire all the benefits mentioned above, that is, to develop an interest, make them to interact and exchange ideas with their friends, and achieve more in their examination results. Virtual simulation can also be used circumvent the physical, safety and cost constraints that limit schools in the types of environments they can provide for learning by doing (Kampourakis et al, 2011)

The effect of replacing traditional teaching methods by using computer-based simulations have been published and shown that, the students who learn Physics instruction using simulated programs perform conceptual mastery than their counter parts who were trained by the traditional method of teaching.

According to previous papers, when a traditional university teacher-centered method is used in teaching finance at bachelor level, students expect everything from the teacher where he/she is the source of every concept and they are a mere receivers of knowledge. After the lecture is covered by one-way teaching method, that is, from the teacher to the students, students are fighting to solve problems and miscellaneous exercises (yaleu, 2005: Steinberg ,2000).

Therefore, this paper examined the effect of using system thinking tools to support student to gain better insight into the main problem, and test different solutions.

2. Why using systems thinking?

> "*Systems Thinking. A cloud masses, the sky darkens, leaves twist upwards, and we know that it will rain. We also know that after the storm, the runoff will feed into groundwater miles away, and the sky will grow by tomorrow. All these events are distant in time and space, and yet they all connected within the same*

> *pattern. Each has an influence on the rest, an influence that is usually hidden from view. You can only understand the system of a rainstorm by contemplating the whole, not only individual part of the pattern. Business and other human endeavors are also systems. They, too, are bound by invisible fabrics of interrelated actions, which often take years to fully play out their effects on each other. Since we are part of that lacework ourselves, it is doubly hard to see the whole pattern of change. Instead, we tend to focus on snapshots of isolated parts of the system, and wonder why our deepest problems never seem to get solved. Systems thinking is a conceptual framework, a body of knowledge and tools that has been developed over the past fifty years, to make the full patterns clearer, and to help us see how to change them effectively"* (Senge, 1990).

Such a worldview accentuates the need for a new ways of thinking. Systems thinking is an emerging discipline, or a language that has a subtle, yet powerful effect on the way we view the world (Kim, 1994), it offers a new way to communicate and understand dynamic complexities and interdependencies. It is based on the idea that the system's part will act differently when isolated from other parts of the system or from the environment since the whole is greater than the sum of its parts. Systems thinking offer a framework and a set of tools, which are discussed below that looks at certain issues as systemic wholes. Some of these tools will be embedded in teaching finance to students.

2.1 Features of Systems Thinking

2.1.1 Dynamic and Non-Linear Thinking

As discussed before, the static thinking assumes that causality runs only one way and any system's factors are independent which is quite primitive. Dynamic thinking offers effective alternatives to see and understand systems or problems. This creative thinking allows viewing the world with ongoing, interdependent relations, dynamic process. Each of the causes in the dynamic thinking is linked in a circular process to both the effect and to each of other causes. These circular processes are the feedback loops which enables us to better understand what is going on in the system, these circular loops represent a non-linear and dynamic thinking (Richmond, 1993).

Taking into consideration this type of thinking, the bank's credit officer can understand the borrowers in a better way as the feedback process inside a firm clarifies the dynamic relations inside a firm, analyzing the causes and effects and their interconnection and allows for observing the behavior over time.

For example, if a firm decreases its product's price, this decision has an effect on the sales as it increases the sales, but on the other hand the firm's profits will be less than usual, which affects the firm's pricing policy and push the firm to increase the prices.

2.1.2 Holistic Thinking

Holistic thinking is one of the most significant features of systems thinking as it allows us to see the "Big Picture". So instead of examining each part of the system, the whole system is examined. Whatever the problem we are experiencing and searching for its source, we must always widen our focus to include that bigger system. Dealing with the wholes rather than parts is a very effective idea in the field of credit analysis. Each part or department in a firm is not isolated from other department, so trying to solve a problem in one process; we must first look the whole firm and the interconnections inside it to understand the nature and the reasons for such problem.

This research illustrated how systems thinking tools provides the manager and the bank's analyst with a creative holism.

2.1.3 Systemic Thinking

In recent years, systems thinking has provided new effective methods for tackling issues in a systemic than a reductionist way. Systems thinking allow us to look for various patterns of behavior, to seek underlying systemic interrelationships, which are responsible for these types of behavior, and events. A recent study defines systemic thinking as a technique that provides a deeper insight into complex situation very quickly.

3. Optimal system thinking tools.

In this section, a detail of the most powerful systems thinking approaches is introduced. It aims to improve goal seeking and viability, and improving the student's capabilities to understand different problems.

3.1 System Dynamics as a Simulation Tool.

"*The field of system dynamics is thriving, over the past decades, many top companies, consulting firms, and governmental organizations have used system dynamics to address critical issues. Tools and methods for system dynamics modelling, the library of successful applications, and insights into the effective use of tools with executives and organizations are all expanding rapidly" (Sterman, 2000).*

System Dynamics simulation uses a perspective based on information feedback and delays to understand the dynamic behaviour of complex physical, biological, and social systems. It also helps the decision maker untangle the complexity of the connections between various policy variables by providing a new language and set of tools to describe. Then it does this by modelling the cause and effect relationships among these variables.

Furthermore, System Dynamics simulation enables the decision makers or the modeler via its tools in any system to identify the underlying structure of their system or issue, and how this structure determines the system's behaviour. System Dynamics can also be used to study the changes in one part of a system in order to observe its effect on the behaviour of the system as a whole (Martin, 1997).

Sterman (2000) gives an insight that the real value of an SD model should be to eliminate problems by changing the underlying structure of the system rather than anticipating and reacting to the environment. This allows the model to interact with the environment and gives/alerts feedback for structure changes. This is what the term (Dynamics) refers to the changes in the system's variables while interacting which stimulate changes over time?

Feedback is one of the core concepts of System Dynamics. Yet our mental models often fail to include the critical feedbacks determining the dynamics of our systems (Sterman, 2000). Much of the art of system dynamics modelling is to discover and represent the range of different feedback processes in any complex systems that enable the modeller to understand the dynamics of these systems because all complex behaviour arise from the interactions (feedbacks) among the variables of the system. It is not only dynamics that rise from feedback, but all learning too depends on feedback. As Sterman (2000) states "we make decisions that alter the real world; we gather information about the real world, and using the new information we revise our understanding of the world and the decisions we make to bring our perception of the state of the system closer to our goals"

4. System Dynamics Model.

We have applied system dynamics methodology to address the firm value problem which is a common financial problems usually tought to financial magement courses. I have developed a system dynamics simulation model using Powersim Studio 2005 for a hypothetical textile firm that produces yarn and cloth.

Strategic planning is the process of translating corporate objectives into the policies and resource allocations that will help achieve those objectives. SWOT analysis (Strengths, Weaknesses, Opportunities, Threats; for more explanation please see glossary), helps managers design their policies, based on which they allocate resources for policy implementation. However, the planning tools generally used by the planners are particularly inadequate for present day environment of complexity and rapid change. The variable performance of many firms is usually a consequence of dynamic interaction of endogenous corporate system and exogenous environment surrounding it, wherein these systems are overwhelmed by delays and non-linearities. Unfortunately, human mind is observed to be incapable of evaluating more than a few such interactions. The developed policies are usually rendered to be inconsistent and allocated resources inadequate due to these complex dynamic interactions, resulting into fluctuating corporate performance (Lyneis-1980). System dynamics model, in such situations, will help students to formulate best possible policies by simulating possible behavior of system structure, if they prefer to adopt certain policies.

4.1 Model Description

In this section, I will describe major System Dynamics causal relationships underlying the model built for this study. First, the firm's optimistic expectations about its product market will push up its desired investment that will stimulate its financing needs and consequently financing decision will not only identify the financing sources, debt and equity, but also their mix in capital structure. The implementation of financing decision will make the resources available for investment. The investment decision will define the utilization of these resources in capacity building reducing the capacity gap, thus making the demand ignited causal link of capacity and debt as balancing (B1) and causal link of capacity and equity (R1) as re-enforcing. The re-enforcing loop R1 is the endogenous growth loop that will help the firm for sustainable development. In addition, debt and equity levels will balance themselves.

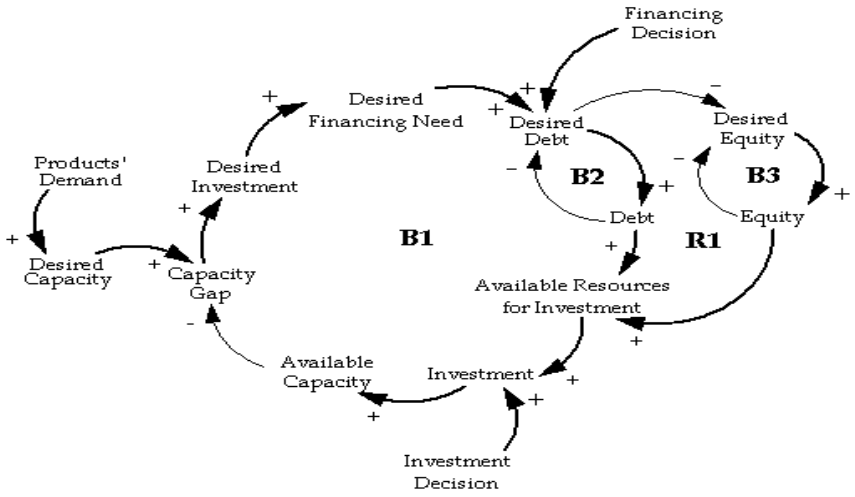

Figure 1: Causal Links of Investment and Financing Decisions

Debt and equity in the capital structure of the firm will affect its long-term financial risk, represented as *Debt Capital Ratio*. This long-term financial risk will perform a balancing role in future financing decisions, depicted as balancing loop B4.

We have explained this financial issue to students with the traditional learning process in class, and we noticed that it was difficult for them to analyze the situation and make decisions
The following causal loop diagrams are the foundations for building the model for this study.

4.2 Implementing the System Dynamics model in class:

We have performed the formal model validation under reference mode. Therefore, we defined reference mode for this study before we start formal model validation. Sterman (2000) defines reference mode as a pattern of behavior showing the development of problem over time and the modelers refer back to this throughout the modeling process. As the model pertains to a hypothetical textile firm, we have hypothetically developed reference mode for this study based on generally accepted notions and relevant common knowledge.
Students started to run the simulation model several times, exploring many different scenarios to improve their decisions.

Corporate management usually takes three types of decisions to manage the firm value; i.e. investment decisions, financing decisions, and dividend decisions. We have assumed that the firm is not exposed to operating risk, and therefore students make right investment decisions at right time. However, profitability of current operations dictates level of current investment. The investment policy, employed in their simulation and their decisions, assumes that the firm is willing to invest 100% of the desired investment level, subject to financing availability, if the *Return on Invested Capital* is 15% per annum or more (Gitman, 2003)

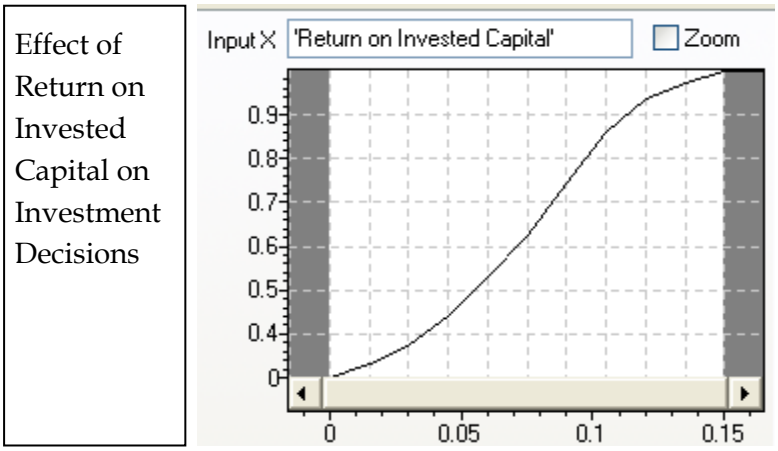

Figure 2: Investment Policy

While, the two graphs on the following page depict the Aggressive and Conservative Investment Policy respectively.

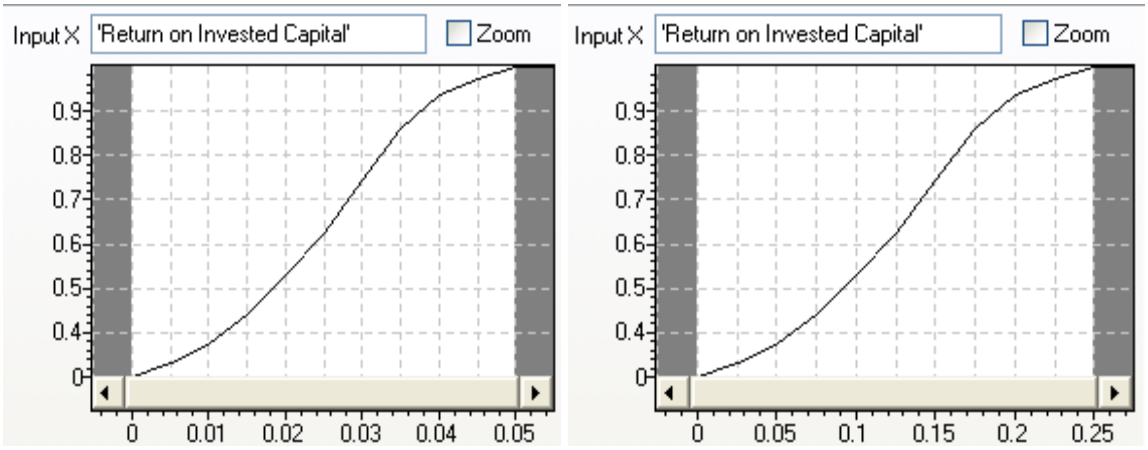

Figure 3: Aggressive and Conservative Investment Policy

The financing policy has two dimensions, borrowing and payment. While borrowing the long-term debt, the firm follows a long-term vision about its capital structure, represented as *Capital Structure Decision* in the model. This may assume three different values; 80% debt, 60% debt, 30% debt. However, the firms generally take debt dominant capital structure decisions due to two reasons. First, the regulations of the Banks, central bank responsible to regulate the credit flow in economy, allow credit with debt reaching a maximum of 60% in capital structure. Second, the firms usually shy away from the stock market due to its variability and uncertainty and their own poor operating results. Therefore, Capital Structure Policy of 60% debt will be assumed in the reference mode. While, the other two values will be helpful in policy analysis.

After several attempts from the student, they finally understood the financial dilemma proposed in the simulation, and they reached decisions that raises the return on the capital for the proposed firms as the next figure shows:

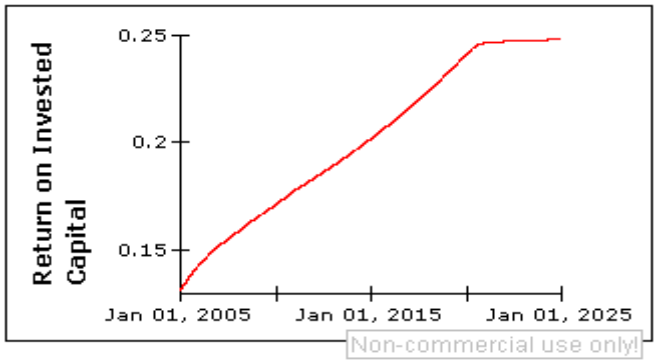

Figure 4: the effect of investment decisions on the return

They also managed to increase the firm's assets with maintaining a good level of the owner's equity as figure 5 shows.

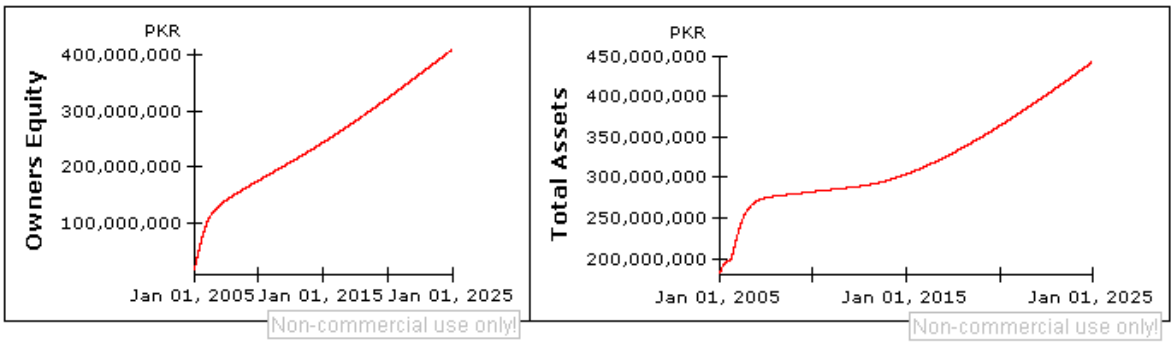

Figure 5: the effect of investment decisions on the owners' equity and total assets

5. Conclusion

After conducting the pre-test and the post-test, the result of students was analyzed by achieving good financial and investment decisions by using the SD simulation model. While there was no significant difference observed by teaching them traditional finance and investment principles in class. This indicates that, the both students before and after simulation experiments were on the same level of understanding on the concepts of finance factors forces. After the post-test was conducted, the experimental group (EG) who used computer simulations as a teaching aid in learning the concepts of electric fields showed a great progress. After the post-test was conducted, the score was found out to be great and their decisions were more effective. This is because system thinking simulation tool which is SD in learning the finance fields would provide the students the ability to gain better insights into the problem proposed by the author, which was by the was a simple investment decisions. The simulation helps the students to test different and infinite number of scenarios and see the effects visually.

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