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# COMPUTER-BASED SIMULATIONS

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***Abstract:*** *A computer-based* simulation *replicates an environment through a computer program designed to consider multiple variables, interactions, and system constraints. Computer-based* simulation *is used in organization studies to model human social systems to better understand the dynamics between individual and group behaviours.*
*These methods advance organization studies research in many ways. They can be used for extrapolating theory, validating hypotheses, or revealing emergent behaviour.* Simulations *can extrapolate theory into another scale or level of analysis.*

***Key words:*** *computer-based simulation, learning, individual and group behaviours.*

## 1. Introduction

While the delivery of material is an important component of teaching, course design can be a much more important component of learning. To be successful as a facilitator of learning, a teacher must be competent in both material delivery and course structure.

Whetten (2007) acknowledges that 30 years of teaching experience has taught him that the most important component of the facilitation of learning lies in the choice of reading material, assignments, activities and learning objectives and not in the personal delivery of those materials.

A business course should be designed not with the needs and preferences of the professor in mind, but instead, focused on students' needs and preferences.

## 2. Contents

Computer-based simulation was originally developed to process data in biology, physics, and astronomy.

The names of the simulation techniques indicate their origins in natural sciences. The simulation techniques found in organization studies research include cellular automata, stochastic processes, genetic algorithms, NK fitness, and system dynamics.

The stochastic method provides solutions using probabilities as opposed to a deterministic method that uses precise solutions. The system dynamics describes the relationship between objects in causal loops and feedback loops. Each simulation method is designed to provide certain types of answers. The choice of the simulation method is determined by the nature of the research question.

The creation of the model is a central aspect of computer-based simulation. The model must accurately describe the human social system. In 2003, Richard Burton described five types of simulation models: procedural, agent-based, equation-based, rule-based, and intelligent models.

Procedural models describe events over time. Agent models describe individual

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entities, which are called agents. Each agent receives simple actions and interaction rules. Equation models illustrate mathematical equivalences. Rule-based models show changes to the system state through a sequence of decisions.

Commonly, rule-based models are described in a series of if-then statements that form a decision tree. Finally, intelligent models are task-oriented, machine-learning algorithms, like a software robot. Overall, each model is designed to bring out characteristics of a system.

The simulation technique complements the model. The simulation technique is based on the research goals. The model is based on the properties of the underlying human system that is being investigated.

Researchers studying the change process in organizations have consistently suggested that people will resist change. Often people will not consider new ideas or activities simply because they are quite comfortable with the old way of doing things and do not want to disturb the status quo. From this paradigm came the old adages: "That is the way I have always done it" or "If it ain't broke don't fix it." Nowhere is this paradigm more salient than in the academic environment.

It has been suggested that professors develop a style of teaching early in their careers and often, they do not deviate far from that style [Greenberg, et. al, 2007; Whetten, 2007]. Researchers state that this lack of style change is a result of the professors managing their priorities.

When we attempt to create high quality classes we ask the following questions:

*What do I want to teach?*

*How can I best cover the designated course material?*

*How can I deliver the material in a quality way?*

Simulations provide quick feedback and allow students to see the consequences of their decisions. The entire dynamics of the classroom changes when the student is given immediate feedback [Yourstone, et. al., 2008].

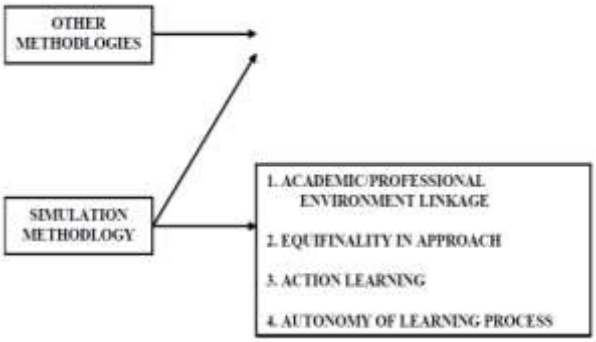


Fig. 1. *Methodology Learning Objectives*

Simulations, different from other methodologies, are "reciprocal in nature", meaning that past decision results are both an end of a process and the beginning of future actions.

The purpose of simulations is to have users revisit past actions and commit to changing those past actions in an attempt to create positive future outcomes [Vega, 2007]. In this way, assessments of past decisions stimulate further learning, this is referred to as "action learning"

Simulation methodology is focused on the process of student learning and not on the students' individual decisions.

It has been discovered that players who made bad decisions and performed poorly at the beginning of the simulation, became very skilled and knowledgeable of successful business practices as they

conscientiously played the game and worked to correct their earlier bad decisions. This would not be a possible outcome for teaching methodologies that did not allow the student to work through their decision errors.

Simulation methodology totally changes the roles of the actors in the learning process. The learners are now given a very high degree of autonomy. Students are now in control of their self-directed learning experience and the instructors act solely as facilitators for that learning process.

Once again, the learning objectives of the simulation methodology, autonomy in this case, are objectives that are essential in today's business environment. Thus, what is learned in the academic environment can be linked to the future activities of the student in the professional environment.

Simulations are a good practice in critical thinking techniques. However, some courses, especially core courses where the students are first learning the terminology and theories associated with that subject matter, require a different type of learning objective.

Bloom's (1956) taxonomy of learning objectives refers to this as the early stages of learning. He states at this point, the learning objective should be comprehension and simple application.

Whetten (2007) states that students cannot apply something they do not understand, therefore, the educator should find means in which to help the student comprehend the subject matter as soon as possible so they can begin the critical thinking part of the learning process.

In this instance, simulations could possibly be used as part of the simple application learning objective referred to by Bloom, but, a caveat must be given in relying too heavily on simulations at this stage of the student learning process.

Most application of knowledge at this early stage of learning requires careful guidance by the instructor. This is in stark contrast to the autonomous nature of simulations.

Applying Boom's taxonomy, instructors should seek a strategic fit between the course design and their students' stage of learning. This design may or may not include simulation methodology.

Another caveat given to instructors is to remember that all simulations are not the same. Educators should examine the content of each simulation carefully.

Even though simulations have improved dramatically, there are usually still some missing elements.

One of the most common elements missing from simulations is ethical training.

Finally, the linking of the academic environment to the professional environment is almost always lacking in the hands on experience of the actual implementation of a strategy, idea, or theory.

In academic courses, as well in academic research, the transfer of knowledge is intangible. In different types of methodology, students make decisions and design strategies; however, in reality the implementation of those changes and strategies involve more people than simply the members of a project work team.

The strategist or change agents must use "change leadership" in order to get the members of the organization to "buy into" a new change or strategy otherwise the change will not happen.

Even when using simulations where the linkage between the academic and professional environments is strong, this implementation element is missing.

While other methodologies (e.g., specific reading assignments, video documentaries, cooperative programs) are not perfect in teaching the needs and requirements for the implementation of organizational change, they can be used to supplement the void within the simulation only methodology.

Computer-based simulation has made an impact on the development of organization

studies theory. The method involves programming a computer with a model of a human social system. Simulations have been used to extend theory, test hypotheses, and reveal emergent behaviour.

The development of computer-based simulation is closely aligned with developments in technology. Computer science research in machine intelligence greatly impacts the range of simulation tools available. As computing power increases, simulations will have the ability to model reality better.

However, even with the most powerful computers imaginable, many researchers question the goal of exactly replicating human social systems. On the other hand, Kathleen Carley in 2001 suggested that organizations are in fact computational objects.

Organizations observe, react, decide, communicate, and have input, output, and storage mechanisms. Computers are now accumulating large data sets about individuals and organizations automatically through the course of normal business.

More importantly, these data replicate the network structure of how the people and organizations are connected. Simulations in the future could replicate the technology networks that inform and connect knowledge workers in organizations.

Despite these concerns, computer-based simulation is useful in nonlinear, process-oriented research or in research with a large number of variables. It has the ability to augment understanding of behavior in organizations without the risks and costs of testing human subjects.

## 3. Conclusions

When attempting to teach, an educator should make a determination as to what would best facilitate the learning process for the individuals in which you wish to teach. Bloom's (1956) taxonomy suggests that individuals are at different levels of learning maturity. Educators can successfully facilitate the learning experience if they use this theoretical foundation as a means to understand the needs of the students they wish to teach.

Obviously, simulations are not the panacea that will change every business course taught into the perfect learning environment. If business courses, however, are designed with the primary focus of strategically fitting the course methodology with the needs of the student learners, simulations can be a very important part of the learning process.

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