Introduction

Since the early 1900s simulations of one form or another have been used as method for training. Simulations are being used in education by number of different names. Interactions between people such as role-playing can be defined as simulations. Virtual and constructive simulations are being used more and more due to decreasing cost of computing tools. The web based tools have an advantage in performance based training; simulations are used in e-learning environments. Even though this field is dominated by engineers and computer scientists, the non-experts are involved in designing simulation.

Instructional Simulation is playing a very important role on society. It focuses on real life facts, concepts of system and its applications. It is imitation of reality which helps students to explore and experiment with
system, which is generally not possible with real system. The model of system is generally created with simulation and the behavior of the system is studied.

In every area of knowledge simulation addresses the conceptual framework differently. Computer systems can be used to simulate complex processes and social interactions. The computer program can help student to perform experimentation with simulation which allows students to explore deep learning. The instruction simulation helps understanding the phenomenon and process which is not possible in real system. It helps to adopt scientific approach to real learning phenomenon.

Now a days government are exploring the potential of simulation apart from Industrial sector. The new pedagogies are using simulations extensively.

For learning, a new approach was adopted by developing advanced pedagogical process which works very successfully with learning and instructional process. The thought process can be evaluated and improved with the help of simulation and experimentations. It is observed that instructional simulation helps in reducing time for learning and improving decisions.

It is a very important tool for students as it gives chance for if-then analysis to improve critical approach. The instructional simulation requires a instructor preparation approach with a lot of participation from students followed by discussion. The simulation covers two areas

A. A Replacement Model
B. A tweaking Simulation Model

Many universities are adopting to provide virtual learning environment, helping students for lifelong learning approach at their convenience at any time and giving opportunity to get involved them without physically moving. This new approach has given new direction to Teaching and Learning pedagogy.

In medicines, the simulation have given new dimensions in understanding medical phenomenon with no of benefits like

• Patient safety
• Diagnostic Accelerating
• Therapeutic Procedures
• Medical Cost Reduction
• Lowering of medical errors

The above parameters have reduced the amount of loss of life and cost associated with it.

Instructional Simulations

The simulations are designed and developed for learner or learning simulations for students to explore learning through instructions. The students can get more insight into facts, concepts and applications of particular area.

Figure 3.1 Instructional Simulation

The model of system behavior is very important for good understanding as it helps student to explore and experiment individually and personally.

• The student can study the trends of buyers and sellers with simulation or the market study.
• The simulation can also be used for election process and political forecasting, which helps in understanding future trends.
• The simulation also help student in experimenting with electric circuit with the web and learning about physical phenomenon without actual lab set up.
• The economic, social and natural world predictions can also be very well understood and analyzed with simulation.

Method of Teaching

Formal specification of a conceptual structure is the key element that differentiates instructional simulation from other pedagogies with which students interact to learn about relationships between concepts.

Different Simulations for Different Disciplines

The conceptual structure of the simulation is treated differently by every discipline. The conceptual structure to economists is typically mathematical which involves the specification of a mathematical model solved with different parameters several times to illustrate concepts and reveal relationships. The conceptual structure to sociologists is typically sets of social interactions. The conceptual structure to political scientists is often institutional.
Variation of simulations in Complexity and Style

Computer programs may be used by simulations which require only a portion of a single class period. Taking significant time, computer models require that students complete several assignments. Range of simulations is from attempts to duplicate complex social processes (such as a legislature), to very simple social interactions (such as making eye contact). Pencil-and-paper, physical models of some natural phenomenon or computers may be used to conduct these simulations. Some simulations works with all class sizes and some works with only small classes.

As opposed to “surface learning” that requires only memorization; instructional simulations have the potential to engage students in “deep learning” that empowers understanding.

Meaning of deep learning is that students:

- Learns scientific methods which include
  • the model building importance. Scientists do their work by the way of simulations and experiments. Students get concrete formats using instructional simulations of what it means to think like a scientist and do scientific work.
  • the relationships among variables in models or a model. With the help of simulation, students can see what happens by changing parameter values. Students understand the significance of changing of magnitude in parameters and develop a feel for what variables are important.
  • probability, data issues and sampling theory. With the help of simulations, students easily understand sampling theory and probability. It is proved that Instructional simulations worth many times over in the statistics based fields. In the beginning classes where students often struggle with sampling theory, the ability to match an analytically derived conclusion with simulation results is especially valuable. On teaching with data simulation, the SERC has an existing module, given the utility of data simulation.
  • the use of a model for outcomes prediction. With the help of simulations, students understand that the scientific knowledge depends on the testable hypotheses foundation.

- Learn to extend and reflect on knowledge by
  • engaging actively in instructor-student or student-student conversations required to conduct a simulation. By their very nature, Instructional simulations cannot be passive learning. Students actively participate in formulating new questions to ask, anticipating outcomes and selecting parameter values.
  • transferring knowledge to new situations and problems. To include an extension to a new set of parameters or new problem, a well done simulation is constructed that needs students to extend what they have learned in an earlier context.
  • refining and understanding their own thought processes. A strong reflection summary that requires students to think about why and how they behaved as they did during the simulation is included in a well done simulation.
  • seeing social interactions and social processes in action. In social science disciplines such as political science and sociology, this is one of the most significant outcomes of simulation.

Working of Simulation

Among the most often used pedagogies in government and industry are simulations.

- Airlines require pilots to log simulator hours, electrical engineers conduct simulations on a daily basis to check load requirements; the pentagon simulates potential conflicts, and so on.
- Given the success in industry and government, it is not surprising that simulation is found in professional schools in universities. Medical students, for example, learn on plastic patients that are programmed to exhibit all manner of symptoms in rapid succession. A few select business schools have a resource like the Hughey Center for Financial Services at Bentley University, where former alum donated money to recreate a Wall Street trading room, complete with the ability to simulate any market event. Health educators are using entertainment style games and simulations and social networking tools to construct effective learning environments in the classroom and online.

While cost constraints limit the large scale simulations found in the corporate environment, Hertel and Millis argue that much of what is successful outside of the academy can be extended to undergraduate instruction with careful curriculum development. Their extensive work with simulation in the Department of Defense suggests a series of steps to ensure simulations bridge the gap between theory and reality in ways that are meaningful to students. While much of their evidence for the success of simulations is generated by matching
simulation curriculum with deep and active leaning features, their suggestion that successful simulations force instructors to have refined curricular goals that are made clear to students in writing is clearly a necessary condition for the student learning goals given in the preceding section.

More directly focused on learning theory, general pedagogical prescriptions was developed that work well with instructional simulations. Changing routine experts into adaptive experts requires that students learn how to transfer knowledge to new problems and situations. Simulations also can make students aware of their own thought processes and how they arrive at conclusions.

Finally, Porter summarizes what is known about the learning effectiveness of simulations in economics principles courses. Their general conclusion is that simulation either makes no difference or a small amount of positive difference. There are suggestions in the various economics studies, however, that instructional simulations may be more effective for some students than the general results suggest.

• There is some evidence that students who think in a scientific manner apply this thinking to a simulation and benefit, while other students do not.
• There is some evidence that students in a class that used simulations learned a set of concepts in less time that students in a traditional, lecture based class.

Given these findings, an instructor thinking about how to improve the critical thinking of his or her students should find instructional simulations a valuable tool. The findings also suggest that upper-division courses that structure the curriculum in terms of scientific inquiry are tailor made for instructional simulations.

Teaching with Simulations
Effectiveness instructional simulations require:
A. Instructor preparation. The good news is that instructional simulations can be very effective in stimulating student understanding. The bad news is that many simulations require intensive pre-simulation lesson preparation.
B. Active student participation. The learning effectiveness of instructional simulation rests on actively engaging students in problem solving.
C. Post-simulation discussion. Students need sufficient time to reflect on the simulation results.

A. Instructor Preparation
Lesson preparation varies with the type and complexity of the simulation. However, most expert users argue that instructional simulation work best when:
• Instructors have a clear written statement in the course syllabus about the goals of the simulation and an explanation of how the simulation is tied to the course goals.
• Instructors read ALL the supporting material for the simulation.
• Instructors do a trial run of the simulation before assigning the simulation to students, when possible.
• Instructors make sure that university laboratory facilities support the simulation when laboratory facilities are needed.
• Instructors integrate instructional simulations with other pedagogies such as Cooperative Learning or Interactive Lecture Demonstration.

B. Active Student Participation
Students learn through instructional simulations when they are actively engaged.
• Students should predict and explain the outcome they expect the simulation to generate.
• Every effort should be made to make it difficult for students to become passive during the simulation. Students must submit timely input and not rely on classmates to play for them.
• Instructors should anticipate ways the simulation can go wrong and include this in their pre-simulation discussion with the class.

C. Post-Simulation Discussion
Post-simulation discussion with students leads to deeper learning. The instructor should:
• Provide sufficient time for students to reflect on and discuss what they learned from the simulation.
• Integrate the course goals into the post-simulation discussion.
• Ask students explicitly asked how the simulation helped them understand the course goals or how it may have made the goals more confusing.

Uses of Simulation in Education
Simulation use in education has potential in two areas. The first being a replacement model for real world
experiences. The article “A Model Patient” by “Jerome Groopman” reflects this usage and has many advantages including not putting humans at risk. The other being a tweaking simulation model in which a student can learn underlying theories based on exploration. Of course this method is more suitable for a classroom environment but has its limitations.

Replacing real world models
The obvious usage for simulated models in a medical school is so they can replace real human subjects and take them out of the hands of the inexperienced. By doing this medical students have the opportunity to practice a certain procedure or general diagnosis dozens or even hundreds of times. The vast number of runs and data that can be gathered by simulations is a quality that has been hailed about them.

Replacing humans for safety reasons is not the only advantage of these simulations though. In the Groopman’s article there is a fascinating statistic claiming that students who learned by simulations completed their real operations 29 percent faster and hesitated less during the process. I have two theories that may account for this.

First the simulation represents a simplified model and contains only essential elements to the task at hand, while all other non-essential variables, elements, etc. are removed so the students can focus on what is important. When operation time comes around, simulation students focus on the simulation model they have learned and are able to ignore the rest of the elements that are around them. Non-Simulation students are dealing with a more complicated situation in their model. They have supervisors looking over them as well as a more complicated model of the human. They have also not experienced independent operations dozens of times before. Their confidence is lower and their fear of failure is much higher. This leads to the second theory.

There is an issue of de-sensitizing experiences through simulations. Upon actually flying a small plane with an instructor I had no fear in mimicking my simulation experiences of hard turning and the instructor was more than impressed. The same is true of the medical students who had learned off of simulation. The traditional fears that come with operating are no longer there. Simulation students have experienced these situations dozens of times before and are thus de-sensitized.

Tweaking and Exploring Simulation Models
This method is touted as a way for students to learn underlying theories through exploration. They can have fun while enforcing knowledge at their own pace. But as the Squire paper explains the instructor must goes over what the student has learned. The simulation is programmed in such a way that basic concepts can be learned through attaining a goal.

In early stage I would play simulator games that involved plants. The game required tweaking of variables to attain goals of plant growth. I can say that I learned basic concepts about trying to attain the goal but nothing telling me why these variables made the model work differently. The Squire paper explains that this is where the instructor would come in to teach the kids why.

The simulation only provides a way to view patterns with cause and effects relationships. In the way of factual learning I believe it would be faster to teach the students the material, and perhaps have these simulations as a way to reinforce what they have learned and not an initial learning tool.

Virtual worlds in instructional simulation
A virtual world is an interactive 3-D environment where users are immersed in the environment. Users can manipulate the environment and interact with other users. Depending on the degree of immersion, users can begin playing a game, interact with other users, attend seminars, or complete course work for an online class.

Online discussion groups and social networks such as Myspace and Facebook are already being used to supplement interaction within coursework.

Sparkle is poised to become the first virtual world for the iPhone. What’s more, it’s being developed completely from scratch, exclusively as an MMO for the iPhone/iPod Touch. This will bring more mobility to the learner. They will no longer need to be at a desktop.

Second Life is a virtual world where users create avatars. An avatar is a virtual representation of the user to other users. These avatars then interact with any other user within the Second Life world. Avatars can purchase virtual land, own buildings, and travel, interact, conduct business, and even attend lectures by professors. Second Life is running 24 hours a day and is tied into the Internet, so there are always other avatars to interact with.
Virtual learning environment (VLE)

Today, most universities make lifelong learning possible by offering a virtual learning environment (VLE). Not only can users access learning at different times in their lives, but they can also immerse themselves in learning without physically moving to a learning facility, or interact face to face with an instructor in real time. Such VLEs vary widely in interactivity and scope. For example, there are virtual classes, virtual labs, virtual programs, virtual library, virtual training, etc.

Figure 3.3 Classification of VLE

Researchers have classified VLE in 4 types:

• 1st generation VLE: They originated in 1992, and provided the first on line course opportunities. They consisted of a collection of learning materials, discussion forums, testing, and e-mail systems all accessible online. This type of virtual environment was static, and did not allow for interaction among the different components of the system.

• 2nd generation VLE: Originated in 1996, these VLE are more powerful, both in data base integration and functions – planning and administrating, creating and supporting teaching materials, testing and analyzing results. Over 80 forms exist, including Learning Space, WebCT, Top Class, COSE, Blackboard, etc.

• 3rd generation VLE: The novelty of 3rd generation VLE is that they incorporate the newest technologies, accessible in real and non-real time (synchronous and asynchronous communications), such as audio and video conferences through the internet – ‘one to one’ and ‘one to many’, collaboration features for work in groups, seminars, labs, forums, and of course the learning, development, planning, library and administrative functions. Stanford On-line, InterLabs, Classroom 2000 and the system “Virtual University” (VU) are examples of this VLE.

• 4th generation VLE: These are the environments of the future, and represent new learning paradigms, at the center of which are the user and the ‘global resources,’ as opposed to the teacher and the ‘local resources.’ Their main advantage is that learning materials can be created, adapted, and personalized to the specific needs and function of each user. Few 4th generation VLE exist, most of them still being in the planning and developing phases. One example of supportive technology is called the ‘multi-agent technology,’ which allows the interface of data among different systems.

Uses of VLE in education

In education, virtual learning environments are simulated experiences which utilize the pedagogical strategies of instructional modeling and role playing for the teaching of new concepts. The environment in which the experiences are presented is a virtual one often accessed via a computer or other video projection interface. Immersive virtual environment headsets have been used with younger children and students with special needs. The advantages of using instructional simulators via VLEs include:

a. Students are motivated when they are able to use computers and other technology.

b. VLEs allow for interaction, exploration, and experimentation with locations, objects, and environments that would otherwise be unavailable in the absence of the VLE.

c. Instructors can adapt programs and parameters of the virtual learning experience to meet individual learner needs.

d. When multi-user virtual environments are used collaborative and cooperative learning is encouraged.

e. VLEs relate to students the real-world relevance of their learning by extending concepts and skills to application in the simulated environment.

f. Learning can occur in an emotionally and physically safe environment without detrimental consequence.

Distance learning

1. The importance of a physical classroom is being reduced as the technology of distance learning develops. Students may do well in distance learning environments; however they need to have engaging moments within the course.

2. The virtual learning environment needs to simulate the learning process, using goals and objectives to measure the learners’ achievement.

3. 3D virtual laboratory can be used as a tool to familiarize distance learning chemistry students with an actual chemistry laboratory. While it was not incorporated into the initial study, the researchers suggest including instructional scaffolding experiences to help alleviate students’ anxieties with applying mathematics and chemistry concepts in the actual laboratory setting.
4. The virtual laboratory does not replace the real-world experience, rather it helps to enhance the student's schema of a chemistry laboratory and prepare them for performance expectations in the actual environment.

5. Web-based virtual science laboratories are also used with elementary school students. Students who used a web-based virtual science laboratory in conjunction with traditional teaching methods not only found the learning experience more enjoyable, they also performed better academically and received higher grades.

6. Multi-user virtual environments or MUVEs have the potential to engage students. Instructors can hold lectures; students can collaborate through chat. When compared to a discussion board, Second Life is a viable alternative for distance learning students to develop group work skills.

Uses in medicine

Medical simulations can be classified in 3 categories:
1. Simulators based on physical models, usually referred to as the Human Patient Simulator (HPS), of which several prototype exist for different purposes.
2. Virtual Reality training simulators based on computers – i.e. LapVR Surgical Simulator, and Suture Tutor.
3. A hybrid model of the first two kinds combines a realistic 3D computerized representation of an organ system, for example, with the ability to interface with it through haptic devices.

Figure 3.4 Human Patient Simulator

The use of simulation-based learning in the medical field has many benefits, including patient safety, accelerating diagnostic and therapeutic procedures, unfulfilled demand for medical personnel, medical cost reduction and lowering of medical errors that amount to loss of life and associated costs. The use of current technologies allows for very high fidelity simulations. These include Immersive Virtual Environments (IVEs)-computer based 3D environments known as serious games, and other very highly immersive virtual environments, such as Cave Automatic Virtual environment(CAVE), in which the student sits in a projection room wearing goggles and gloves equipped with sensors. This haptic technology activates the sense of touch, allowing the trainee to interface with a simulated patient, as well as to receive visual and auditory feedbacks, making the simulated learning experience very realistic.

According to research, the best instructional simulators, medical or otherwise, contain these elements:
1. Provide feedback
2. Involve repetitive practice
3. Integrate with the curricula
4. Possess a range of difficulty levels
5. Involve multiple learning strategies
6. Capture clinical variations
7. Occur in a control environment
8. Utilize individualized learning
9. Define expected outcomes

Immersive Virtual Environments (IVEs) in medical education range from teaching simple skills (taking a patient's blood) to complex skills (internal surgery). Different medical care providers use simulations for different purposes: emergency medical technicians, medics involved in combat environments, nurses, doctors, surgeons and medical First Responders in. IVEs simulates the human body so as to provide the student or trainee with the opportunity to realistically practice and thus become proficient as to the particular technique to be taught. IVEs is commonly used when teaching patient examination, surgical procedures and assessment (individual and collaborative). Students are relieved to know that these simulations are practice and appreciate the opportunity to make mistakes now rather than later. The use of IVEs provides a controlled, safe environment for students to learn and so the anxiety factor is reduced. Students can discuss the symptoms more openly than they could with an actual patient. At the same time, however, students use all the protocol they would with a real patient. That means they introduce themselves, address the patients by name and respect their privacy.

The use of the simulation saves lives and money by reducing medical errors, training time, operating room time and the need to replace expensive equipment. Simulation users may practice on a variety of patients, each of which has a different case history, exhibits unique symptoms, and responds to user actions with appropriate physiological responses. As in real life, patient anatomy moves with the beating of the heart and
the breathing of the lungs while tissues deform, bruise and bleed. The system generates a detailed evaluation after each session, enabling users and supervisors to measure the success of simulated procedures.

Conclusion
Simulations are not instructional. To make a simulation instructional, instructional elements are included which help expose the learner to key parts or concepts of the system or environment. An instructional simulation is also called an educational simulation. The key element that differentiates instructional simulation from other pedagogies is the formal specification of a conceptual structure with which students interact to learn about relationships between concepts. Every discipline treats the conceptual structure of the simulation differently.

Simulations range from attempts to duplicate complex social processes, to very simple social interactions. Simulations are among the most often used pedagogies in industry and government. There is some evidence that students who think in a scientific manner apply this thinking to a simulation and benefit, while other students do not. Also, students in a class that used simulations learned a set of concepts in less time than the students in a traditional, lecture based class. Online discussion groups and social networks such as Myspace and Facebook are already being used to supplement interaction within coursework. Virtual learning environments (VLEs) vary widely in interactivity and scope. The use of Immersive Virtual Environments (IVEs) provides a controlled, safe environment for medical students to learn and so the anxiety factor is reduced. The use of the simulation in medical science saves lives and money by reducing medical errors, training time, operating room time and the need to replace expensive equipment.

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