Teaching and Learning with Computer Simulations

Computer simulations can be very effective tools for teaching about complex systems. Simulations can teach concepts, relationships, and vocabulary. Play-based simulations are also excellent for generating interest in a topic and multiplying a teacher's effort. Unlike text books, most students will independently spend hours and hours "studying" a simulation game.

Computer simulations are generally poor for teaching "facts". Usually the detail suffers in order to model the big picture. Facts in complex systems tend to be very situational. When a simulation focuses on a specific situation, it begins to loose it's value to teach the "big" picture.

Simulation designers attempt to distill a system down to a manageable set of the most significant subsystems and variables. They then try to create as accurate as possible interaction model between the subsystems. As more subsystems and variables are added, the simulation becomes more realistic. More detail is good to a point. Too much detail can overwhelm the computing machinery and overwhelm the user. The most sophisticated weather simulations are amazingly accurate, jokes about weathermen not withstanding. However, you need a supercomputer to run them and a Ph.D. in meteorology to begin to understand them.

Consider the audience and learning objectives when considering simulations as a teaching tool. SimFarm (a farming simulation from Maxis) will add very little to the knowledge base of someone who has spent their life on a farm and studied farming. SimFarm has nothing to offer if you want to know yesterday's Chicago price of beans. However, 20 hrs on SimFarm will increase by orders of magnitude the appreciation and knowledge about farming for individuals whose base knowledge of farming was gleaned from the fields as they sped by on the interstate.

I see simulations as moving the starting point. We as educators build on the concepts, vocabulary and interest that is generated by playing the game. We talk about what was in the simulation and even more about what was left out. It's also fun! Because it's fun it's stimulating. Simulations can lay a foundation so we don't have to start on a topic at ground zero. The game builds a common frame of reference that is needed to create a community of learners. For example, veteran SimFarmers all have a basic idea about the futures market. We can talk about the Chicago Board of Trade without covering the basics.

Teaching with computer simulations is totally different than a traditional classroom model. Teaching with computers, especially simulations, is maddeningly learner directed. Each learner proceeds in the direction and at the pace best suited for them. At times teaching with computers is like herding cats. It can be disconcerting to someone who is most comfortable in a well sequenced classroom. I've found that simulations tend to fit best in less formal settings; gifted, special-ed, after-school and summer enrichment programs. The non-formal, experiential model used by 4-H is an excellent place for simulations.

There is tremendous value in just "playing the game", especially when the time comes from hours usually allocated to Reality TV or First Person Shooters. Research strongly suggests that kids will trade TV time for computer time. And given a choice between negative computer games and educational games many youth prefer the educational if the games are fun. I've found

that the value of computer games is increased exponentially when the game time is combined with related off-computer activities. Some value-added activities for SimFarmers are growing a garden, raising an animal, visiting a real farm, following the markets, almost any agricultural related project or field trip. Educational activities enrich and are enriched by the parallel playing of related computer simulations. I've had good experiences with business Sims, community Sims, history Sims, and aerospace Sims.

Even the very best teachers do not know automatically how to teach with computer simulations. However, all the teachers that I know who have taken the time to learn, report that it was well worth the effort.

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Organizing a 4-H Computer Simulation Event

What are Computer Simulations?
One of the most powerful tools for analysis and learning with a computer is simulations. A computer simulation is a mathematical model of the significant variables and relationships of an activity or system. The variables and relationships that represent the system tend to be very complex. Through the processing power of the computer the variables can be manipulated and the relationships explored. In the best simulations the systems are represented graphically so the user can see the system change. Many of the more popular computer games are simulations. The best simulations for education model real-life activities such as communities and businesses. Computer simulations allow youth to control and explore complex activities. Many activities, like flying an airplane or managing a city, are cost/time prohibitive or even impossible for most youth. A good simulation is the next best option to the real activity.

Why a Contest?
Many popular simulation games also have tremendous educational content. However, most youth play the games at a very low level. A contest format creates an opportunity and incentive to enhance the experiential value of computer play-time. The contest provides the motivation to play the game better. The best way to play the game better is by understanding the model and the system being modeled. Pizza Tycoon is a restaurant business simulation game. The best Pizza Tycoon players are the ones who understand the dynamics of the restaurant business as it is modeled by the game. Preparing for a contest is a good way to share, process, generalize, and apply what is being learned in the simulation experience.

Possible Simulation Topics and Titles
There are a wide range of simulation topics and software titles that are easily adaptable for contests. Some of the factors for selecting a topic include the interest of the youth and leaders, educational value of the topic and fit with overall educational objectives. Another important criterion should be the play value of the software. For example, flight simulators are fun and tend to be of high interest to both youth and adults. An aerospace project can use computer flight simulators to explore and emphasizes the educational objectives of the project. In addition to flight simulators, there are business, community, farming, genetics, geological, historical, and environmental simulations. With a few exceptions; sports, fighting and war simulation games generally have narrow or very little educational value. Most have negative educational value.

Choosing a Software Title for a Contest
The primary barriers to developing a computer simulation contest are - 1) potential participants do not have access to the software, 2) the contest organizers are unfamiliar with the software, 3) finding a computer lab that will host the event. The easiest way to get started is to create a contest for an inexpensive computer game that is readily available and popular with your audience. To create an original simulation contest the organizers must have a very good working knowledge of whatever software is used. If a contest format already exists, the contest organizers only need a cursory knowledge of the title. The software selection should be based on potential educational value, cost and availability of software, play value of the software, and the availability of related content materials. Having a leader who is already familiar with the software can also be a big factor.

General Contest Format and Rules

Depending on topic, software, local resources, and purpose each contest will be unique. Below are some features which will help maximize the educational value of computer simulation contests:

- have the youth work as teams on a single computer,
- provide a set of objectives and constraints for the simulation,
- set a limited amount of time for the simulation and
- require a team presentation of the results.

Generally, operating a computer is an individual activity. However, managing a complex activity is seldom an individual activity. Working together on teams emphasizes the social nature of computing, allows for greater participation, and also adds teamwork into the educational mix. In addition to learning the software from each other, teams allow the participants an opportunity for discussion and group problem solving. Three to five person teams work best. More team members generally increase the importance of team work but can limit individual participation. For most youth, an activity is more fun if they are actively involved. Room layout and the ability to see the computer screen tends to be the limiting factor for team size.

There are computer simulation games are children as young as preschool. Games with significant educational value are more appropriate for youth ages eight and above. Many simulations may be too complex for the younger end of that range. Youth from about 10 to 15 years of age appear to have the greatest interest. Depending on the level of competition, topic and the software used; age classes may be needed. In general, older youth will have better presentation skills and have a significant advantage in the contest. Content skills are usually not a matter of age. Game play expertise depend more on time spent with the software and the content value added to that play. A ten year old who has been playing environmental simulation for three years will do better than a 14 year old that just picked up the game last month. This is especially true if the ten year old has a project leader who helps relate the simulation to real-life ecological systems and environmental issues.

One of the fun aspects of simulations is how open-ended and self-directed they are. Each player takes off in their own direction at their own speed. Each simulation can be totally different. For the purpose of a contest it is frequently desirable to have some comparability among the participants' work. Requiring a specific focus, attributes or constraints that all simulations must include can do this. The required common elements create a certain amount of comparability yet each simulation still allows participant creativity. For example, SimFarm, a farming simulation, allows the participants to select their crops and livestock. The contest may require that the participants must include soybeans and sheep in their product mix. Another idea is for each team to load the same saved game. The saved game could be set up with specific problems that must be solved.

Approximately 1.5 to 2 hrs works well for a contest and is usually enough time to develop most simulations. Presentations should be 5 to 8 minutes long with a couple minutes between presentations. It will take almost an hour for presentations for a contest with six teams. Listening to each other's presentations will have the greatest educational value for the

participants, but that may not be appropriate if the competition is more serious. If the competition is more serious, start times should be staggered so all teams have the same prep time prior to their presentations. If at all possible a computer projector should be used for the presentations. The projector allows and encourages the participants to make the connection between their game and their presentation. It also adds educational value by helping the participants to develop multimedia presentation skills.

Judging the Contests

The judges evaluate the results of the simulation and presentation of the team. A judging sheet can be devised by listing the significant concepts being modeled by the simulation. The point allocations can reflect the relative value placed on each part of the content. The judging sheet should emphasis team work along with an understanding of the system being modeled. The presentation should always include a discussion of what is missing from the model. The score sheet creates a standard presentation format and a teaching guide for the coach. Although the contests can be quite competitive, education should always be the first priority.

The Contest Should Be a Part of a Larger Educational Program

To make the event successful and maximize the educational impact the contest should be a part of a larger educational program. The program should provide:

- the youth with plenty of time to practice the simulation before the contest,
- instruction about the content of the simulation.
- instruction on presentation format and delivery and
- support with organizing teams.

School enrichment, after-school activities, and 4-H clubs are all excellent models for creating an educational program that includes a computer simulation contest. The key to developing a program is getting youth access to computers so they can play the game. Group settings can be very productive. The participants will teach each other how to play the game. The game learning can and will happen independent of adult leadership. Once the youth have a grasp of the game the leaders can add content. This also makes for better use of "content experts". After playing the games, most participants develop a good understanding of the basics of the model so the teaching can begin at a much higher level. Probably, the best teaching strategy is to "teach to the test" or in our case the contest presentation format. By helping the participants prepare presentations, the leaders can build on the interest, concepts, and vocabulary that the youths are learning by playing the game.

Finding a Contest Location

The most significant barrier and limiting factor for organizing a computer simulation contest is a location with computers. You will need at least one computer system for each team and enough room for the number of participants. It is very important the organizers verify that the contest software will run on the available computers! In many locations, a school computer lab is the only appropriate place for a contest. Other possible locations may include libraries and community computer labs. If the facility is included in the overall educational program through 4-H club work, school enrichment and/or after-school activities, using the lab for a contest should be an easy sell.