SimCity 4: Using simulations to learn principles of geometry and civil engineering

by

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Part I -

Why video games in the classroom?

A few years ago I was a hard-core traditionalist when it came to the art of teaching. I was thoroughly baptized in the lecture approach to education and did not think that any other method was worth the try. But the developments of the last ten years have made me to take a new direction. Research has shown that it is games, not education that is teaching students to think. The digital natives, as this new generation is called, learn differently. They are more geared toward digital media as opposed to the traditional text. (I have had first-hand experience with my five-year-old son.) Somehow and in some way computer and video games have a way of getting to students in a non-threatening, engaging, and discovery-orienting manner. In the past century, learning grew out of an intense belief in text. As such, it required someone well versed in the text to expound on it, hence the traditional lecture in the classroom. Today things are vastly different. We have the Web and other digital media that support multiple forms of intelligence --- abstract, textual, visual, musical, social, and kinesthetic. Evidence gathered on digital natives supports the notion that the underlining principles of video and computer games greatly foster student learning. Listed below are some observable outcomes of using video games in the classroom:

- Students are challenged to use creativity and imagination
- Students take control of what they learn and how they learn it
- Problem solving becomes a way of life in the classroom
- Critical and analytical thinking is nurtured
- Students are motivated to master the material they are learning
- Learning is student-centered, rather than teacher-centered

Overview of SimCity4

SimCity4 is a giant PC-based city simulator. As the name suggests, the objective of the game is to design and built a city from scratch replete with all the bells and whistles of a thriving metropolis: soaring skyscrapers, well-designed and well-managed transportation systems, state-of-the-art school facilities, a strong and effective city administration, booming industries, and other critical aspects of urban life. Its graphic interface makes it easy enough for children to use. Its flexibility and modeling accuracy make it suitable for adults.

My Goals

My primary goal is to utilize the interactive and engaging nature of computer and video games to challenge and motivate students to accomplish their educational goals. Using this medium, we present complex information in a game format, which makes both teaching and learning more exciting. I also want to provide my fellow traditionalists with sound and well-researched reasons why they should get on board this wagon. I am also providing teachers who are on board with a practical application for the use of video games in the classroom.

Grade Level and Subject Area

The SimCity Teachers Guide has two main focuses: geometry and elementary civil engineering. It is designed to help middle school teachers teach geometry. Depending on the school and student ability, it can also be adapted to teaching geometry in the

ninth and tenth grades as well. Teachers in a post-secondary school setting can also use the guide. Vocational students aspiring to be civil engineering technologist or college freshmen majoring civil engineering can benefit from this guide as well.

Applicable Content Standards

SimCity4 is replete with opportunities that satisfy New Jersey Core Curriculum Content Standards (NJCCCS) in Mathematics and Technology. Under geometry and civil engineering and/or technology, the following standards are satisfied.

Standard 4.2

(Geometry and Measurement) all students will develop spatial sense and the ability to use geometric properties, relationships, and measurement to model, describe and analyze phenomena

Standard 8.1

(Computer and information literacy) all students will use computer applications to gather and organize information and to solve problems.

Standard 8.2

(Technology Education) all students will develop an understanding of the nature and impact of technology, engineering, technological design, and the designed world as they relate to the individual, society, and the environment.

Hardware Requirements

The following materials will be required in order to accomplish the goals of this guide. Each student is to have his or her own computer or laptop if possible. Otherwise, students can work in groups. This guide is designed to have each work student working independently.

- PC computer
- Laptop/Computer lab
- LCD projector
- Overhead projector and screen
- Software – The SimCity4
- System Requirements
- Windows XP, Windows 2000, Windows Me, Windows 98
- 500 MHz Intel Pentium III. Or AMD Athlon Processor
- 128 MB RAM for Windows 2000 and Windows 98; 256 MB RAM for Windows XP and ME
- 8x CD ROM/DVD-ROM Drive
- 1.6 GB free hard disk space plus room for saved games
- 32 MB Direct3D capable video card with DirectX 7.0 compatible driver
- DirectX 7.0 compatible sound card
- Keyboard, mouse

Part II

Before Lesson One

In order to take full advantage of the functionality of this guide the teacher must familiarize himself with the software. He must have at his finger tips parts of the software such as the terraforming tools, steps for incorporating a city, selecting a region for a city, transportation tools, and utilities tools. SimCity4 is fairly complicated software. Not all parts to the simulation are needed for this guide. For our purposes, the teacher must focus on the parts named above as they will be used to accomplish the goals and

objectives outlined in this guide.

Lesson One Objectives

Students will:

- Familiarize themselves with the SimCity4 controls, functions, tools, especially those that construct geometrical objects.
- Construct geometrical figures such as lines, circles, arcs, and angles
- Analyze properties of geometric figures constructed

Lesson One Setup

This lesson is design to help students gain a fuller understanding of the geometry of plane and solid figures by using the SimCity4 simulation. From the onset is very important for the students to familiarize themselves with the software. Each student is assigned a computer. (In the event where there are more students than computers the teacher can assign two or three students to a computer). The students can then start the computer, open the SimCity program, and take a guided tour of SimCity4. Several or tutorials are available: terraforming tutorial, big city tutorial, and rush hour tutorial. For the purposes of this guide the students need to focus on the first two. The teacher guides the students through the tutorials and explains what each icon or button does. At this point, the teacher can encourage experimentation by letting the students select some of the options available during the tutorial session. He can lead them through the steps to incorporate a city. Finally, teacher passes out copies of the instructions (see Appendix C) for the construction of streets, highways, interchanges, and buildings. Using a LCD projector, He demonstrates how streets are laid out by dragging the appropriate icon on a pristine landscape and shows how city structures such as bridges, overpasses, interchanges, and tunnels are put in place.

Lesson One Gameplay

By this time students should be familiar with the instructions for playing SimCity4. The steps outlined below assume the students have performed prerequisite actions such as terraforming their lands and incorporating their cities. Using the appropriate icons, the students should

- Construct streets crisscrossing at various angles
- Construct highways (elevated and ground), ramps, and interchanges
- Include a few railroad tracks (elevated and ground)
- Place buildings in different blocks of the city

Hint: *To undo whatever you have done, use the bulldozer icon*

Note: As these structures are put into place, the budget will decrease. The student does not have to worry about complaints form the city council members. This lesson is about math, not social science. If the student runs out of cash, he simply saves this city and starts another one. It is a good thing, though, to spend carefully so that you don't have change cities.

Lesson One Debrief

The teacher engages the students in a discussion using though-provoking questions such as: How many sets of parallel lines (streets) can you identify in your city? What is the advantage of the streets intersecting at right angles? Can you identify objects that represent skew lines in your city? How are skew lines different from parallel lines? Some of the students can volunteer to have their work displayed on a screen via an LCD projector for the purpose of further discussion and peer review. The students should then discuss their successes and frustration while playing. During this time students can

give each other tips and tricks learned during the gameplay. This part of the lesson can culminate in a brief assessment of the type given in the Appendix A

Lesson One Extension Activities

Allow the students to get back on the computer. This time they are looking at area and volume. Students can try to fit a number of buildings in a certain block to see what happens and why. Can they give an estimate of the area of a block in their city? They can sketch a building on paper, use a ruler or scaled paper to measure the dimensions, and then calculate or estimate the volume.

Before Lesson Two

The teacher must make sure that the students know how to use SimCity4's transportation tools to construct bridges, elevated railways, ramps, and overpasses. Construction of bridges can be a tricky affair and requires a bit of practice.

Lesson Two Objectives

- Create a freehand sketch of a building or bridge and identify the engineering components
- Write an analysis detailing the engineering components of the structure sketched

Lesson Two Setup

By now students should be quite familiar with SimCity4's transportation tools. The teacher should demonstrate as he did in lesson one how elevated highways and railways are constructed. He can also show students the trick of spanning a river with a bridge. Students should ask as many questions as possible as this part of the lesson is a little more challenging.

Lesson Two Gameplay

For this part of the lesson the students need to select a new city, preferably one that has a body of water. Using the appropriate icon the student can

Construct a bridge over a body of water

Place an elevated highway and rail system in the city

Lesson Two Debrief

A discussion follows which centers on the various components of an engineering structure. There are steel components, reinforce concrete components and wood components. The students should be made to grapple with the following questions:

- Which building or bridge had steel components and why?
- What type of loads were the steel components carrying?
- How do steel components compare with reinforced concrete components?
- Which buildings have wood components and why?

This session can end with the students making free-hand sketches of a structure they have chosen. They can write a 100-200 word essay detailing the engineering composition of the structure. The analysis should include the beams, columns, and girders that made up the structure. They should discuss what these elements support or how they are supported. It will be instructive to mention if the structure is made of steel, wood, reinforce concrete or a combination of two or more of these components.

Lesson Two Extension Activities

Students can research and write about the architectural aspect of structures and how it relates to civil engineering. The can do further research and report on the difference between civil engineering and architecture

Part III

Teacher Resources

Kuntz, Margy. *Teacher's Guide: An Educational Companion for SimCity 3000.*

http://spectrum1.blackboard.com/webapps/portal/frameset.jsp?tab=courses&url=/bin/common/course.pl?course_id=_24935_1

SimCity4 Manual, Deluxe Edition, (2005) Electronic Arts Inc.

The following websites will provide hints in understanding and playing SimCity4 as well as exploring practical applications for using SimCity4 in your classroom.

- http://www.SimCity4.com
- http://www.simcity4.co.uk/content/view/13/2/
- http://simcity.ea.com/update/
- http://www.gamespot.com/pc/driving/streetsofsimcity/review.html
- http://www.gamefaqs.com/computer/doswin/review/565064.html

References

New Jersey Department of Education Mathematics and Technology Content Standards http://www.state.nj.us/njded/cccs/index.html

Aldridge, C. (2004). Simulations and the Future of Learning. San Francisco, CA: Pfeiffer

Elearningpost (2001). Exclusive interview with Marc Prensky. Retrieved from the internet on September 24, 2005 www.elearningpost.com/elthemes/prensky.asp

The Motivation of Gameplay, (2002) Article by Marc Prensky. Retrieved from the Internet September 24, 2005 http://spectrum1.blackboard.com/webapps/portal/frameset.jsp?tab=courses&url=/bin/common/course.pl?course_id=_24935_1

SimCity4 Reward Buildings http://compsimgames.about.com/library/files/simcity/blsimcity4_rewards.htm

About the Author

Joel Bleah is from the West African country of Liberia. For six years he taught math and physics at a rural school in his native country before coming to the United States for graduate studies in 1991. After graduating from Florida Tech in 1993, he joined the staff of a small Christian School in Somerset, NJ. During this time he got interested and experimented with educational software such as Geometers Sketchpad and Mathcad. Since September 2001, he has been a Trigonometry, Discrete math, and statistics teacher at University High School in Newark, NJ.

Part IV

Appendix A

Problems

1. A section of highway stretches for five miles, rounds into a semicircular arc with a radius of .5 mile, stretches again for another two miles and then rounds into another semicircular arc of radius 1 mi. What is the length of that section of the highway?
2. A city block measures 96 ft x 115 ft. Can four identical houses measuring 40 ft x 68 ft fit on this block?
3. What is the volume of a skyscraper measuring 43 ft x 43 ft x 1000 yds?
4. Four streets run north parallel to each other. Another street due northwest intersects the first of the four parallel streets at 68 degrees. At what angle will this street intersect the fourth street?

Appendix B

Solutions

$$5+\frac{1}{2}\pi(\frac{1}{2})^2+1+\frac{1}{2}\pi 1^2$$

$$blocksize = 96(115) = 11040$$
$$fourhouses = 4(40)(68) = 10880$$
$$11040 - 10880 = 160$$

$$V = lwh = 43*43*1000*3 = 5547000\ ft^3$$

Answers

1) Length of highway section is 7.9mi,

2) The four houses fit on the block since the area of the four houses is less than the area of the block

3) The volume of the building is 5547000 cubic feet

4) The northwest street is a transversal to the four parallel lines; therefore, it intersects all the lines at the same angle (68 degrees)

Appendix C

How to Play

The objective of SimCity4 is to design and built a city from scratch. You (the player) have the title of Mayor and are responsible to build a metropolis with all the bells and whistles: soaring skyscrapers, well-designed and well-managed transportation systems, state-of-the-art school facilities, a strong and effective city administration, etc. You are given a certain amount of money to work with. It is your responsibility to manage this amount properly so that your city does not go broke.

You have the choice of being a hardworking saint of a mayor, a corrupt mayor, or a despotic mayor who inflicts all the evils on his poor unsuspecting Sims (your subjects).

The city-building sequence goes something like this. You (the Mayor) are given a track of land in its pristine condition. You have the option to terraform the landscape. By terraform we mean you raise mountains, add lakes and valleys, or create whatever landform you desire for your city. The would-be city is then incorporated and the fun begins. Follow the instructions below.

- *Allow SimCity4 to load.*
- *Go through the big city and the terraforming tutorials to familiarize yourself with the various icons and modes*
- *Double click on the new city icon*
- *You may choose to cancel or reconcile the altitudes of your city.*
- *Choose the terraforming icon at the top*
- *Create the terrain effects that suit your city using the various icons*
- *When satisfied, click on the Mayor icon*
- *Type your name, name your city, choose the difficulty level (easy recommenced)*

- *When finished, click to establish your city*
- *Click on the Mayor icon to access to the building options*
- *Click on each of the icons to see the various levels and what each does.*
- *To build a street, highway, tunnel, railway, or subway, click on the appropriate icon and drag the icon across the surface of the land*
- *To span a body of water with a bridge, drag a highway completely across a body of water*
- *To construct a building, click on the appropriate icon and set it wherever you desire*