Crash Course or Course Crash: Gaming, VR and a Pedagogical Approach

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Abstract

The human brain is wired for spatial thinking (GERSMEHL & GERSMEHL 2007), and research has demonstrated that spatial visualization abilities can be improved through education (SORBY & BAARTMANS 2000). This paper describes the uses of cutting edge technology and games to grow spatial thinking, improve spatial design, and solidify landscape planning concepts within the classroom. Specifically, this paper discusses how SimCity 2013, ESRI CityEngine and the Oculus Rift were embedded within a graduate level landscape planning course to see if it improved students understanding of spatial concepts and interest in using related new technologies. While the paper provides a narrative of the experience, some interesting results from student evaluations were discovered. Primarily, that they thoroughly enjoyed using SimCity, that CityEngine was not quite as fun, but that students wanted to spend more time using the technology.

1 Introduction

The human brain is wired for spatial thinking (GERSMEHL & GERSMEHL 2007), and research has demonstrated that spatial visualization abilities can be improved through education (SORBY & BAARTMANS 2000). For landscape planners and architects, spatial thinking and communication of designs in space is a critical skill. Therefore it is important to provide students in these fields with educational opportunities that will grow spatial thinking and communication. This is because the practice of these disciplines will support the problem solving of highly complex spatial human-environmental problems of our future. While theory and experience are essential for addressing these problems, so are the tools and skills. GOODCHILD (2010) suggests that design technologies which help improve the human decision-making process will help us become more effective stewards of our planet.

This paper is about a trial (and error) experience searching for strategies and technologies to grow spatial thinking, improve spatial design, and solidify landscape planning concepts within the classroom. In the fall of 2014, students in a graduate level GIS-based landscape planning studio course embarked on a learning experience using untraditional and cutting-edge technology. The technologies are: SimCity 2013, ESRI CityEngine, and the Unity Gaming engine combined with the Oculus Rift. The purpose for introducing these technologies in the studio was to explore if they would be effective at promoting learning of the core course goals: conducting systems inventory, producing analysis and impact assessments, and to better understand how analytical and spatial modelling methods can be used to inform design. Together, these technologies were intended to encourage students in learning GeoDesign-based methodology. As the title alludes, learning these technologies

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was a crash course for both professor and student; the experience begs the question of the value which these technologies provided in addressing course goals.

The variety of software selected for the class was chosen because they are at the forefront of technological development to improve design and decision-making. SimCity is one of the longest standing software games in the industry. With over a 20 year history, the planning strategy game has a strong following; SimCity 2013 alone has sold over 2 million copies (MATULEF 2013). The game has been used for formal educational learning within the classroom (KOLSON 1996, WOESSNER 2013). CityEngine is a 3D modelling environment originally developed by Procedural and purchased by ESRI in 2011 (DE MERITT 2011). The tool works along with ESRI's ArcGIS software enabling the rapid development of 3D models of cities using existing GIS data. Unity is one of the most advanced gaming engines in the industry and is capable of importing models directly from CityEngine and outputting the models into a 3D environment within Oculus Rift. The Oculus Rift is a high definition virtual environment headset. The goal was to demonstrate how new technologies can be used to better understand space and how to design within it, model ideas, and provide a more interactive experience for stakeholder engagement.

The studio course is one of the last required of the M.L.A. program; students in the class have been exposed to a variety of technology and are mature in their academic endeavours. Given this scenario, several pedagogical methodologies were used in class. A game-based method (PRENSKY 2005) was used during the SimCity project in order to enhance interest in the course concepts before the theoretical lecture material was presented. The faculty-coached method (BOLTON 1999) was employed at the beginning of the CityEngine project, in order to provide technical support at a one-on-one basis since students were assigned to different project tasks and had different learning rates. Finally, a peer-led guided inquiry learning method (FARRELL et al. 1999, LEWIS & LEWIS 2005) was used once students understood the basics of the CityEngine project and had been divided into teams. To some extent the CityEngine project employed a pseudo-flipped classroom methodology (SAMS & BERGMANN 2012), where students were assigned tutorials outside of class and then work was conducted in class with faculty support. The methodologies used for this project are effective in research-based learning environments where students are actively engaged in a problem and developing new technical skills.

2 Methods and Process

The introduction of the technologies was conducted through two distinct studio assignments. These assignments are each described below. The first assignment using SimCity was a two-member team assignment and commenced early in the term. The second assignment used CityEngine as a learning platform, aiming to simulate the local college town using city GIS datasets. The final project was separated into tasks, with individuals volunteering to tackle the problems based on personal interests.

SimCity: Using Data to Design

The assignment for this project was for students to design a city using SimCity 2013[1]. They were given immense freedom being allowed to approach their design in whatever manner they preferred, and no coaching was involved. Their grades were assigned based on a set of four criteria: approval rating, budget loss or gain rate, total population, creativity (the latter being peer reviewed). They were all given codes to allow for unlimited funds so as to not constrain the design experience. Students were assigned in pairs by pairing one strong and one weak technologically savvy student together (savviness was based on self-rated survey conducted at the beginning of the term). Before beginning the game, students were shown tutorial videos, example images explaining the geospatial concepts associated data, as well software navigation. The groups were given a maximum of 4 hours for project completion.

3D City Modelling with CityEngine

The final class project aimed at creating a CityEngine project of Manhattan, KS in 2 weeks. Students had no prior experience with the software, and the faculty lead had limited knowledge of the software. The project intended to be a fun learning experience where both student and professor learn about the software and gauge how it may change future workflows, modelling projects, and design thinking as planners and landscape architects.

Before modelling began, an enterprise level geodatabase was created (as this allows simultaneous editing) with the essential data. The data included networks (roads, bike lanes, and sidewalks), buildings, and vegetation. Students were separated into different groups; one designated for data management of each dataset, another for creating CityEngine rules for each dataset and three others for developing building façades, rendering and the migration to the gaming engine for Oculus Rift. In total 17 students were involved in the project.

The Creation Process

The process began by introducing students to the technology through videos and tutorials. Then, those students working on editing and adding data were given access to the enterprise database and worked on ensuring that the data were accurate and up-to-date. Both the building and vegetation data management groups needed to create new data. For the former, building heights and roof types needed to be modelled, while the latter needed to develop a tree inventory (trees were the focus of vegetation modelling). With a two week timeline, the class decided to focus efforts on developing data around AggieVille, a historical business district in the heart of town, and model the rest of the city simply. The building group developed an accurate height map for each structure in the 2x2 block area of town. These heights were then transferred into the building footprints. For the remaining buildings students developed a random height generator based on the six different classifications for each of the city's zoning types. While the building data was more difficult to model, the vegetation group took a simpler (but more cumbersome) approach of using satellite imagery to identify a general age class and manually entering tree locations in AggieVille.

[1] SimCity is offered through Electronic Arts Inc., which provides a 4 hour trial version.

3 Results and Outcomes

SimCity: Using Data to Design!

The SimCity project resulted in nine unique projects. Design concepts were based on a variety of methods. One method aimed to maximize growth (grid zoning), another historical design (Garden City Movement) and another on social foundations (Maslow's hierarchy of needs). The result was an equally diverse range of outcomes. Populations ranged from 15,000 to 130,000, annual budgets ranged from -7500 to 20000 units, and approvals ratings were more consistent with ranges between 80 % − 90 %. Some students noted challenges using the software and lack of knowledge of advanced features. One group experienced a shocking surprise when Godzilla decided to rampage their town, wiping out population and infrastructure toward the end of their four hours. At the end of the assignment students reported enjoying the experience and better understanding the application of spatial data. One example of the application of design applied to spatial data was demonstrated by one group that based their design upon the Garden City Movement introduced by Ebeneezer Howard (Fig. 1). Here they focused growth in the centre of the city, while the outermost circle acted as an agricultural/industrial zone.

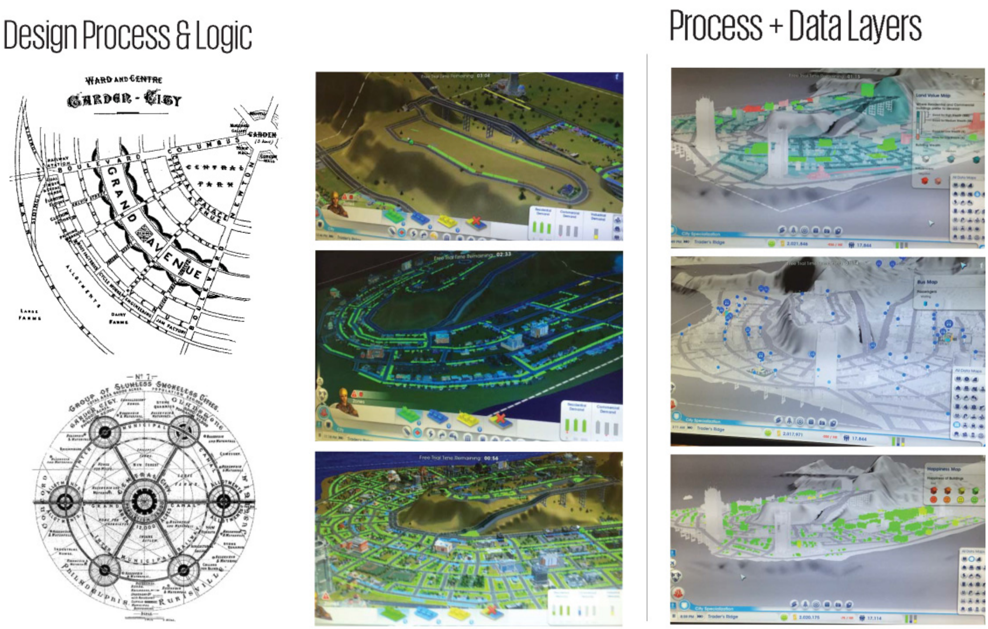

Fig. 1: Student example of SimCity project demonstrating design process using template and spatial data (MERCADO & GLASTETTER 2014). Templates on left are of the Garden City concept, to the right are screen captures from SimCity. The center column shows the progression of outward growth and development, and the right column shows the spatial analyses (top right as land values, bottom right as happiness, and center right as public transit usage).

3D City Modelling with CityEngine

The combined efforts of all groups resulted in a final product. This product included updated datasets for all networks, estimated building heights (with detailed inventory of building heights in AggieVille), and a large set of façade images which were digitally modified to reduce visual noise (pedestrians, vehicles, etc.). Several groups attempted to create custom rules from which to apply surfaces, textures and models to the GIS data. While it is easy to create cities from Wizards and use built-in rules from ESRI, these rules did not apply directly to GIS-based data. Thus, learning how to code in CGA (CityEngine proprietary language) in the shortened time period proved challenging for students. The program was seemingly cumbersome, published help limiting, and even with good support from ESRI (10 support tickets opened for the project) the end product was not as students or faculty hoped. Nonetheless, a product was developed (Fig 2, left). Early test porting CityEngine to the Unity Gaming Engine did function, but the final CityEngine models were unable to be migrated due to lack of time. However, students did receive a demonstration with Oculus Rift (Fig 2, right), so the process of planning, to gaming and then virtual reality was understood. The primary problem with importation of the final CityEngine problem into Unity was a result of incompatibilities of CityEngine and Unity, resulting in too many topological errors between roads and terrain.

Fig. 2: CityEngine project in ESRI WebViewer (left) and a student using the Oculus Rift (right)

Follow-up Survey

At the conclusion of the course, a brief 5 point Likert-scale stated choice survey (LOUVIERE et al. 2000) was included with the usual term-based teacher evaluation. Results from the 11 of 18 respondents surveyed are given in Table 1 below.

Table. 1: Course evaluations of specific curriculum (SimCity, CityEngine)

Question[2]	Avg	SD
How enjoyable was the experience working with SimCity in class	4.8	0.4
How useful was the SimCity exercise for understanding the use of geospatial information for decision making and/or suitability analyses	4.4	0.6
How enjoyable was the experience working with CityEngine in class	3.5	1.1
Would you have like to spend more time working with CityEngine?	4.1	0.9

A final follow-up open-ended question was asked of the students: "After learning the theory and tools for this class, what do you feel most and least confident about as you enter your career?" The responses were varied, but most centred on an understanding of technology and core planning concepts. For example, one student stated, "Least confident using GIS and other computerized technology, Most confident using/understanding geospatial information to inform design decision-making." Likewise, another, "I feel MUCH more confident in creating suitability analysis." And finally some agreement that there was value in learning "… new programs, especially programs that in the near future will most likely be used more widely."

4 Discussion and Lessons Learned

From observation, the outcome was useful in shaping students' knowledge of the regional design challenges and how spatial information can be used to improve design. The SimCity exercise created an indelible visual memory for students. Thus, it was referred to numerous times throughout the course, primarily in order to augment key planning theory concepts such as systems inventory and suitability analysis. As the survey suggests, students enjoyed the exercise. The game will be repeated in future years because of the positive feedback and learning experience, and because it has garnered a reputation and interest among the other students in the program. In future years, the initial help will be increased using tutorials and videos, but stronger formal linkages with course theory will be made. The CityEngine project did not garner the same interest. While students were engaged in the project, the software was extremely difficult for most to use, and the reliance upon custom rules coded for GIS data became a significant barrier to developing models. Students also reported that ESRI documentation was not helpful for their level of technical expertise, making it difficult to get started at the most basic of levels. The experience has inspired a re-evaluation of the value of exposing students to the software, and solidified the primary question: why should students learn CityEngine and advanced 3D planning software and will it be helpful for their careers or to society, in lieu of more theoretical knowledge or practical application of geospatial concepts?

As it relates to GeoDesign, one argument for the use of these technologies in the classroom is that they offer a vision of the future, a demonstration of the technology to greatly enhance stakeholder dialog, and a cutting-edge communication tool. While there may be

[2] 1 is very low (least enjoyable), 5 is very high (most enjoyable).

technical hurdles for students now, as software usability improves and planning teams become more technically sophisticated, these hurdles should become less challenging.

From a pedagogical approach, the two projects seemed to work well using the variety of pedagogy methods. The SimCity project required far less time to complete and the learning objectives were quite simple. The software was developed as a game, and had numerous online resources and videos for students to research in order to develop their city. The game-based pedagogy of allowing the game to guide their thinking and development was appropriate for this project. However, the CityEngine project necessitated a wider variety of pedagogical methods. The faculty-coached method was necessary in the beginning because of the steep learning curve and because the software lacked beginner level support. As students began feeling more comfortable with the software and better understood their group tasks, the use of a peer-led inquiry seemed a natural transition. This method aims to give students responsibility for their learning. It was a useful approach because it instilled ownership of their task and pushed them to be active participants in knowledge dissemination rather than consumption. In the coming years, the combination of pedagogies will continue to be used, but it will be important to find a balance of the right methods in order to develop a quality product (video game, or regional model).

5 Conclusion and Outlook

In order to get students thinking about landscape scale, complex problems, spatial thinking is critical. Tools which help the student understand key spatial concepts connected to theoretical landscape planning concepts will improve their capacity as planners and landscape architects to derive solutions in tandem with stakeholder engagement. This experience in a pedagogical approach to enhancing spatial learning has revealed benefits and challenges. Observation and evaluations demonstrate that students enjoyed the experience using SimCity as a teaching tool and that they would like to spend more time using CityEngine, but that there are many technical hurdles. The tools used in this curriculum experiment provided a unique learning opportunity on simulation and analysis in a real-time virtual environment, a key premise of GeoDesign (FLAXMAN, 2010). In the future, curriculum improvements will be made to provide more structure, following the coaching pedagogy, at the beginning of the CityEngine exercise, with more distinct examples of how to build and create rules. The use of game-based and flipped-classroom pedagogies in tandem with a peer-led inquiry will continue to be employed as they provided students with an excellent opportunity to engage with problems with unknown outcomes, engaging their critical spatial-thinking skills and design risk-taking.

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