Discoveries in Gaming and Computer-Mediated Simulations:

New Interdisciplinary Applications

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Chapter 7
Promoting Civic Thinking through Epistemic Game Play

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ABSTRACT

A growing body of research suggests that computer games can help players learn to integrate knowledge and skills with values in complex domains of real-world problem solving (P. C. Adams, 1998; Barab et al., 2001; Gee, 2003; Shaffer et al., 2005; Starr, 1994). In particular, research suggests that epistemic games—games where players think and act like real world professionals—can link knowledge, skills, and values into professional ways of thinking (Shaffer, 2006). Here, we look at how a ten hour version of the epistemic game Urban Science developed civic thinking in young people as they learned about urban ecology by role-playing as urban planners redesigning a city. Specifically, we ask whether and how overcoming authentic obstacles from the profession of urban planning in the virtual world of a role playing game can link civic values with the knowledge and skills young people need to solve complex social and ecological problems. Our results from coded pre- and post-interviews show that players learned to think of cities as complex systems, learned about skills that planners use to enact change in these systems, and perhaps most important, learned the value of serving the public in that process. Two aspects of the game, tool-as-obstacle and stakeholders-as-obstacle, contributed to the development of players' civic thinking. Thus, our results suggest that games like Urban Science may help young people—and thus help all of us—identify and address the many civic, economic, and environmental challenges in an increasingly complex, and increasingly urban, world.

INTRODUCTION

I personally believe...that U.S. Americans are unable to do so because…uh, some… people, out there in our nation, don't have maps.

—2007 Miss Teen South Carolina, when asked why a fifth of Americans cannot find the United States on a world map.

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Today, half of the world's population—some 3.3 billion people—live in cities. By 2030, the urban population will exceed 5 billion. (United Nations Population Fund, 2007, p. 1) As the United Nations Population Fund suggests, "their future, the future of cities in developing countries, the future of humanity itself, all depend very much on decisions made now in preparation for this growth." Thus, understanding and engaging with the complex interrelationships of cities is a fundamental form of citizenship in the 21st Century.

Unfortunately, as a geographic literacy study suggests, "young people in the United States...are unprepared for an increasingly global future…Far too many lack even the most basic skills for… understanding the relationships among people and places that provide critical context for world events" (The National Geographic Education Foundation, 2006, p. 7). One-fifth of Americans cannot even locate the United States on a world map—a statistic that led a Miss Teen USA contestant to suggest that geographic illiteracy is so pervasive because "U.S. Americans… don't have maps." (R. Adams, 2007)

But the problem is not that U.S. Americans lack maps. Nor is it even that young people cannot locate the United States on a world map, depressing though that may be. Rather, the problem is that our public understanding of what it means to be geographically literate equates geographic thinking with the ability to locate places on a map. Questions like this focus solely on *knowledge*: bits of information disconnected from any meaningful context.

Of course civic thinking does require knowledge of social, economic, and ecological—and, yes, geographic—information. But as Ehrlich (2000) argues, civic thinking means more than just recall of isolated facts. Solving civic problems requires putting knowledge in the context of real world skills and in the service of civic values that create a democratic republic (2000). Developing civic thinking requires learning opportunities where the use of knowledge and skills are guided by civic, social, and ecological values.

A growing body of research suggests that computer games can help players learn to integrate knowledge and skills with values in complex domains of real-world problem solving (P. C. Adams, 1998; Barab et al., 2001; Gee, 2003; Shaffer et al., 2005; Starr, 1994). In particular, research suggests that *epistemic games*—games where players think and act like real world professionals—can link knowledge, skills, and values into professional ways of thinking (Shaffer, 2006). To establish these links, epistemic games present players with the same meaningful obstacles that professionals-in-training face and give players a chance to reflect on those obstacles with more experienced mentors.

Here, we look at how the epistemic game Urban Science develops civic thinking in young people as they learn about urban ecology by role-playing as urban planners redesigning a city. Specifically, we ask whether and how overcoming authentic obstacles from the profession of urban planning in the virtual world of a role playing game can link civic values with the knowledge and skills young people need to solve complex social and ecological problems—and thus be a powerful context for learning civic thinking.

THEORY

Ehrlich (2000) argues that civic education has two distinct, but related, parts: civic engagement and civic thinking. For Ehrlich, *civic engagement* consists of "individual and collective actions designed to identify and address issues of public concern" (2000, p. xxvi). Activities that impact and strengthen the community—such as volunteering at a soup kitchen or picking up trash on Earth Day—are important components of civic education. But, according to Ehrlich, the *civic thinking* that develops from such activities is what creates a long-term commitment to civic engagement. Civic thinking prepares people to participate in their communities (Ehrlich, 2000).

For Ehrlich, civic thinking is composed of three separate, but interrelated elements: knowledge, skills, and values, or as he describes it, "mutually interdependent sets of knowledge, virtues, and skills" (2000, p. xxvi). *Knowledge* of civic thinking, in this sense, includes understanding the institutions and the processes that drive civic, political, and economic decisions in the body politic—including understanding how a community operates, the problems it faces, and the richness of its diversity (p. xxx).

Ehrlich writes that the *skills* of civic thinking are essential for applying this knowledge to solve civic problems (p. xxvii). Civic skills include: communicating clearly, orally and in writing; collecting, organizing, and analyzing information; thinking critically and justifying positions with reasoned arguments; seeing issues from the perspectives of others; and collaborating with others. However, civic knowledge and skills are incomplete without the core *value* of civic thinking: willingness to listen to and take seriously the ideas of others. (p. xxvi)

This conception of civic education in terms of knowledge, skills, and values is reflected in the National Assessment Governing Board's Civics Framework (2006). The civics framework consists of three components that guide its curriculum benchmarks: knowledge, intellectual and participatory skills, and civic dispositions:

Civic skills involve the use of knowledge to think and act effectively and in a reasoned manner in response to the challenges of life in a constitutional democracy. Civic dispositions include the dispositions to become an independent member of society; respect individual worth and human dignity; assume the personal, political, and economic responsibilities of a citizen, participate in civic affairs in an informed, thoughtful, and effective manner; and promote the healthy functioning of American constitutional democracy. (2006, p. xi)

As Ehrlich points out, however, civic education is not merely about learning a list of knowledge, skills and values:

Such a listing may imply that the elements involved have precise definitions and parameters that might be gained through a single course or even reading a few books. (2000, p. xxvi)

Instead, he argues that civic education needs to integrate these different domains of understanding into a coherent vision of responsible civic action.

In this paper, we look at how a particular kind of computer game can help players develop and integrate the knowledge, skills, and values of civic thinking.

Games and Learning

A growing body of research suggests that computer games can promote learning (P. C. Adams, 1998; Barab et al., 2001; Gee, 2003; Shaffer et al., 2005; Starr, 1994). In the popular commercial game SimCity, for example, players can learn about civic issues by designing and running a city. In the game, they have to manage issues such as an increasing population, environmental changes, urban and economic development, crime, and transportation. Players raise or lower taxes, build and destroy schools, hospitals, power plants and other civic infrastructure, and rezone and reshape their virtual city.

Gaber (2007), Adams (1998), and Teague and Teague (1995) have shown that SimCity provides a dynamic decision-making environment in which students can understand urban geography and community planning concepts by thinking about cities as ecological and social systems. For example, Gaber argues that students playing SimCity in his college course, learned "about the multi-dimensional 'systems' understanding of cities and the interconnected aspect of planning decisions" (p. 119).

But while SimCity can help players think about complex systems, there are also significant limitations in using this game to encourage civic thinking. As Beckett and Shaffer (2005) discuss, SimCity models the whole city whereas people typically experience cities and their impacts locally. In addition, time in SimCity is compressed. Civilizations can develop from small hamlets to empires in a matter of minutes or hours, covering hundreds of years in the blink of an eye. Finally, and perhaps most importantly, decisions in real cities are made through a complex process of political deliberation. In SimCity, players exercise God-like power. The sims who live in the city are free to come and go, but they have no voice in the fate of their city. SimCity provides a fictionalized process of urban growth, in which the lives of citizens are glossed over by the scale of the model, the scope of the timeframe, and the despotic powers of the players.

Professional Practices of Planners

Like players of SimCity, urban planners have to think about cities as complex systems. But rather than working as virtual urban despots like in SimCity, real urban planners use professional skills to serve the public interest.

Barton & Tsourou (2000) argue that planners view a city as a living, breathing organism, the health of which is closely linked to that of its citizens. Planners work with the complex, interrelated components inherent in urban systems, and in this sense, SimCity reflects some of the knowledge professional planners have. But as Ehrlich argues (2000), knowledge is just one component of civic thinking. Here we examine how urban planners, unlike SimCity players, use particular civic skills and values to solve complex problems in urban systems.

A professional planner develops skills to "manage the planning process itself, involve a wide range of people in making decisions, understand the social and environmental impact of planning decisions on communities, and function as a mediator or facilitator when community interests conflict" (American Planning Association, 2010). As Friedmann (1987) suggests, planning links "scientific and technical knowledge to actions in the public domain" (p. 61).

Planners use their professional skills to manage an urban system that involves people, their opinions, and their life experiences. Planning-related decisions are made daily through a complex, often politically charged process involving the interests of multiple stakeholders (Nedovic-Budic, 2000). Thus, a core value of planning is to:

involve all affected parties in important planning decisions; help communities to develop their own vision of the future, preparing plans responsive to shared community objectives; analyze qualitative and quantitative information to suggest possible solutions to complex problems; evaluate the cost-effectiveness of proposed projects and plans; and present recommendations to public officials and citizen groups in a comprehensive and understandable way. (Association of Collegiate Schools of Planning, 2009, p.8)

In other words, though Herwig and Paar (2002) argue that the urban planning profession can be interpreted as a complex strategic game, the profession of planning is markedly different from SimCity. Professional planners think about cities as systems, but also have specific professional skills that they use to serve the public interest. Upon leaving the virtual world of SimCity, players find few roles for aspiring urban despots in the urban planning community of their own cities. On the other hand, a game modeled on the professional practices of planners might create an environment in which players could learn to connect civic knowledge with real-world civic skills and values.

Professional Obstacles

Shaffer (2006a) argues that becoming a professional, such as an urban planner, involves developing the epistemic frame—the ways of knowing, of deciding what is worth knowing, and of adding to the collective body of knowledge and understanding—of a particular community of practice. For example, the epistemic frame of planning involves thinking about cities as systems and using professional skills to serve the public interest.

Epistemic games are role playing games that help young people learn the knowledge, skills, and values of a profession by simulating professional training. By playing, for example, a well-designed game based on the training of real urban planners—rather than on a fictionalized process of urban growth and development—young people can begin to engage in the complex compromises and decision making processes that shape their social and physical realities.

Professional training, including the training of urban planners, is characterized by a professional practicum—a training environment that allows a novice to do things he or she would do as a professional and discuss the outcomes with peers and mentors (Schon, 1987; Shaffer, 2006b). For example, in a planning practicum, novices are hired by organizations to complete a planning project. They visit the site in question, meet with stakeholders, use geographic information system (GIS) models to weigh tradeoffs, create preference surveys and final plans, and present their findings (Shaffer, 2006b). During the practicum, novices meet with their instructor for advice and feedback, and collaborate closely with peers.

In other words, in a practicum, novices encounter the kinds of challenges and obstacles that are faced by trained professionals—but they do so in a supervised setting with the help of expert mentors. Learning takes place in a practicum when a novice encounters these professional obstacles while trying to accomplish a meaningful goal (Shaffer, 2006b). The obstacles, in effect, push back on the intentions of the players, forcing them to use particular kinds of knowledge, skills and values to solve a problem or take an action. The basic structure of a practicum is thus a set of professional obstacles, combined with forms of feedback relevant to the ways of thinking and working of a particular profession. This experience lets a novice act—and thus to learn to think—as a particular kind of professional.

Urban planners do not use the term 'obstacles' when referring to stakeholders since they do not see stakeholders as obstacles to overcome, but rather as people with whom and for whom they work. However, in this paper we refer to stakeholders as obstacles with the understanding that obstacles drive learning, and thus help players learn to value the public interest. According to Dewey (1934), learning—and specifically learning by doing—is characterized by trying to do something, making mistakes, and then figuring out how to fix them. The kind of learning that involves overcoming obstacles is the foundation of all learning by doing (Dewey, 1934). As a result, players learn to see stakeholders not as obstacles by encountering and overcoming them first as obstacles. Thus, seeing stakeholders as a problem helps players see them as part of the solution.

In previous work, Beckett and Shaffer (2005) constructed an epistemic game modeled on an urban planning practicum. It incorporated professional obstacles that addressed two components of civic thinking: knowledge of systems thinking and skills for enacting real world processes. The interactive geographic information system (GIS), MadMod, modeled the complex relationships between land use zoning decisions and important social and ecological factors, such as the number of jobs and housing units. To solve problems using MadMod, players had to think of the city as a complex system and understand the social and environmental impact of planning decisions on the community. In this sense, the GIS model itself was the professional planning obstacle: a *tool-as-*

obstacle which required players to use planning knowledge and skills to succeed in the game.

Beckett and Shaffer's study showed that players of the game gained a deeper understanding of the domain of ecology and of their city as an ecological system. Players made frequent reference to urban planning practices when explaining their thinking about ecological interconnectedness. In short, the game helped players think like planners (Beckett & Shaffer, 2005).

Here, we extend that work through the epistemic game Urban Science. In developing Urban Science, we hypothesized that building additional professional obstacles into Beckett and Shaffer's original game would preserve the knowledge and skill gains and further improve players' civic thinking abilities. Specifically, we hypothesized that by incorporating virtual stakeholders and their feedback into the game, players would begin to think about a core value of the planning profession and component of civic thinking: the value of serving the public interest.

In this paper we examine Urban Science and ask: (1) Did the Urban Science epistemic game help players develop urban planning knowledge, skills, and values? (2) Did the professional obstacles, specifically the stakeholders, help players develop this civic thinking?

METHODS

Urban Science Game

Game play in Urban Science was modeled on an ethnographic study of a graduate-level planning practicum, Urban and Regional Planning 912, at the University of Wisconsin-Madison (Bagley, 2010). As described above, this capstone practicum helped novice planners develop the epistemic frame of urban planning through a series of mentored activities. The practicum included:

- a site visit, where novice planners learned about the features of the planning challenge from first-hand observations and meetings with stakeholders
- preference surveys, where novice planners prepared alternative plans using GIS software to elicit feedback from stakeholders about features of the neighborhood they wanted preserved
- staff meetings, where teams of novice planners discussed information gathered and proposed planning solutions
- drafting of a final plan, where teams decided on and constructed a proposed plan using GIS software
- proposal preparation, where teams developed a presentation that explained and justified their proposed plan
- final proposal, where teams presented their proposals to relevant stakeholders.

Game play in Urban Science adapted these activities to be played by a group of twelve middle school students during two weekend days. Table 1 provides a summary of the relationship between a planning practicum and the Urban Science game.

The game began with a cut scene, in which a local expert planner charged the players with redesigning State Street, a popular pedestrian thoroughfare in Madison, Wisconsin: "We need a plan," he said, "that incorporates the various visions of a sustainable State Street into one comprehensive plan. The plan should create an economically vibrant, distinctive district that reflects the cultural heritage of the area."

Players acted as planning liaisons for one of four stakeholder groups concerned with the development of State Street:

- Business Council
- People for Greenspace
- Urban League
- Cultural Preservation Organization

Table 1. Urban science activity structure

Planning practice	Day 1	Urban Science Activity
Cut Scene	10:30	Staff meeting:Introduce problem through visit from expert planner(s)
	10:45	
Site visit	11:00	Visit virtual person 1 on State Street, take pictures, record impressions in digital voice recorder
	11:15	Visit virtual person 2 on State Street, take pictures, record impressions in digital voice recorder
	11:30	Visit virtual person 3 on State Street, take pictures, record impressions in digital voice recorder
	11:45	Lunch
	12:00	
	12:15	Debrief from site visit. Discuss stakeholder issues and introduce idea of thresholds
	12:30	
Preference survey	12:45	Model creating alternative scenario probes for stakeholders
	1:00	Begin working on 3 plans for one stakeholder by deciding what issues each plan will address
	1:15	Make zoning changes to create one plan for team's stakeholder
	1:30	Model the feedback the probes elicited from stakeholders
	1:45	Discuss the results from the current plans and suggest changes
	2:00	Make changes to model
	2:15	Submit plans to stakeholders for feedback
Staff meeting	2:30	Model understanding the stakeholder feedback and presentation of process
	2:45	Write a summary of the stakeholder's preferences for team presentation
	3:00	
	3:15	Team meeting to compare stakeholder feedback with whole group (jigsaw)
	3:30	
	Day 2	
Draft plan	9:30	Welcome back/staff meeting. Model incorporating numerous stakeholders into plans
	9:45	Begin working on final plan in teams. Discuss ways to craft the final plan to please all stakeholders
	10:00	Make zoning changes to incorporate all stakeholders' needs
	10:15	Teams report progress
	10:30	Incorporate changes discussed in team meeting and finalize plan
	10:45	
Proposal preparation	11:00	Model writing justifications
	11:15	Write justification statements
	11:30	Finish final plan as a team
	11:45	Lunch
	12:00	
	12:15	Model final presentation
	12:30	Prepare for final presentation
	12:45	
	1:00	Organize speaker order and practice
	1:15	
Final proposal	1:30	Final presentations with client
	1:45	
	2:00	

In teams, players conducted a site visit of State Street with digital cameras and handheld global positioning system (GPS) units. While on the site visit, stakeholders' pictures and text characterizing their visions for the future of the community appeared on the handheld GPS units at pre-determined locations. For example, when players came to the one small park on State Street, they "met" Maya, a member of People for Greenspace, who said:

Hey, I'm Maya, and I'm a member of People for Greenspace. We're committed to improving the natural beauty of State Street by creating parks. Too much congestion and back-to-back buildings make for a crowded and unhealthy city environment. Cities need natural areas to support birds, trees, and plants, and people are happier when they have access to natural places—now and in the future. There are other advantages of greenspace, such as cleaner water, cleaner air and more wildlife! This is the only park on all six blocks of State Street. We definitely need more!

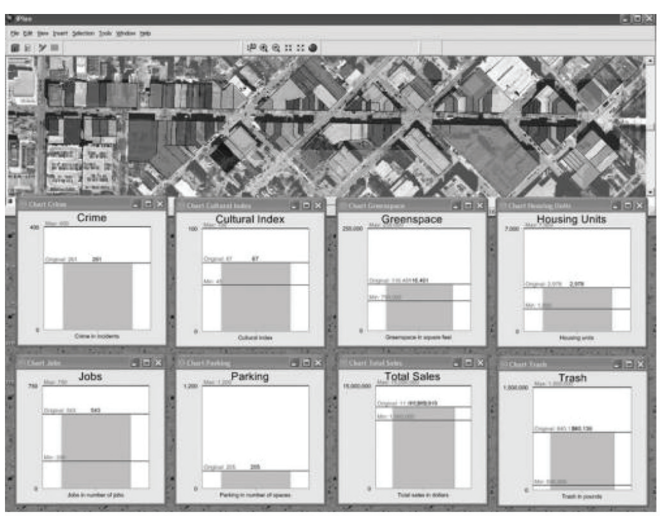
Players recorded the virtual stakeholders' opinions in their planning notebooks, and returned to the computer lab to incorporate their findings into a custom-designed interactive GIS model, iPlan (Figure 1).

In iPlan, players could change zoning designations for the parcels, units of land held by a single owner, on State Street. Zoning codes included "Arts and Humanities", "Local Retail Store", "National Chain Store", "Greenspace", "Parking Garage", and a variety of options for housing above the retail establishments (Figure 2). Each zoning code was represented on the map in a unique color:

The iPlan model also included graphs representing social and economic indicators important to State Street:

- Crime
- Cultural index
- Greenspace
- Housing
- Jobs
- Parking
- Trash
- Total sales

Figure 1. An image of the iPlan interface. Zoning changes were dynamically reflected in graphs representing indicators such as crime, cultural index, greenspace, housing, jobs, parking, trash, and total sales



As players made changes in the zoning of parcels, the graphs dynamically updated, showing the projected impact of the zoning changes on the social and economic conditions of the neighborhood. For example, if players chose to rezone a large arts complex as a surface lot to increase parking, not only would the cultural index decrease, but jobs and total sales would also suffer. Any single change to the physical representation of State Street resulted in changes in the eight indicator values: crime, cultural index, greenspace, housing, jobs, parking, trash, and total sales.

Using iPlan, in other words, players saw a physical representation of State Street, the land use allocations for the street, and the consequences of their zoning changes (Figure 3).

Using iPlan, players worked in their stakeholder teams to construct preference surveys. As in the planning practicum, preference surveys in Urban Science were a set of possible planning alternatives designed to elicit information about the desires and hopes that stakeholders had for their neighborhood. Specifically, players in Urban Science developed and used preference surveys to try to determine the minimum or "threshold" values that would lead stakeholders to support (or reject) a proposal. For example, players may have used a preference survey to determine how many additional housing units were needed in a plan to gain the support of the Urban League—or how many additional square feet of parks were needed for the support of the People for Greenspace.

Figure 2. Zoning codes used by players to change land use designations of State Street's parcels

AR	Arts and Humanities
C1-L	Local retail store
C1-L-HDH	Local retail store with high density housing
C1-L-LDH	Local retail store with low density housing
C1-N	National chain retail store
C1-N-HDH	National chain retail store with high density housing
C1-N-LDH	National chain retail store with low density housing
C2-L	Local restaurant
C2-L-HDH	Local restaurant with high density housing
C2-L-LDH	Local restaurant with low density housing
C2-N	National chain restaurant
C2-N-HDH	National chain restaurant with high density housing
C2-N-LDH	National chain restaurant with low density housing
HDH	High density housing
LDH	Low density housing
OS	Greenspace
P-G	Parking garage
P-S	Surface parking

Once completed, players submitted their preference surveys to their stakeholder group. The virtual stakeholders responded to the preference surveys through short dialogue based on the specific indicator levels, delivered in the form of a printed report from a focus group. For example, one player working with the Urban League received the following feedback from a stakeholder named Ed:

"I've looked at your plan and there's really no way that it's going to work for us. There just isn't enough housing on the street! With so few places to live, landlords will be able to raise rents as much as they want, and there will be even less affordable housing. I'm sorry, but this is unacceptable."

Next, players held a staff meeting in their planning teams to summarize the feedback they received. Each planning team presented their findings to the group as a whole, and new planning teams (with one player from each stakeholder planning team) were formed to draft a final plan.

Each team worked to create a final plan using iPlan that could incorporate the needs of all of the stakeholder groups. When plans were complete, each team prepared a presentation of their findings and recommendations, which was delivered to a local planner acting as a representative of the city council.

Figure 3. An image of the iPlan interface. Players created preference surveys and final plans by choosing the zoning codes of parcels and aligning their zoning choices with indicator values

DATA COLLECTION AND ANALYSIS

In April 2006, twelve middle school aged players (eight females, four males) recruited from 4-H clubs, Girl Scout troops, and home school networks in southwestern Wisconsin played a 10-hour version of Urban Science. Players had no prior experience with urban planning.

We conducted an hour-long interview with each player before and after the game. In the interviews, players answered open-ended questions about science, technology, and urban planning. During post-interviews, we also asked questions about the game and players' experiences during game activities.

Pre- and post-interviews from the game were transcribed and recorded. Transcriptions were segmented into units representing one complete answer to a question, and included any follow-up questions or clarifications between the player and the interviewer. A single rater coded excerpts for elements of an urban planning epistemic frame, the interrelated set of skills, knowledge, values, identity and epistemology of the profession. Paired t-tests were used to compare interview responses between pre- and post-interviews.

Coding

Matched-pair excerpts were coded K/CS (knowledge of cities as systems) when they mentioned interconnections inherent in cities.

"…To get to a job, you need transportation… Transportation and trash are connected to housing because trash comes from housing…People are connected to every single one of them [indicators] because all of them are connected to us somehow…"

Matched-pair excerpts were coded S/PP (skills of planning process) when players referred to specific urban planning skills, as in this example where a player mentions site visits and helping stakeholders:

"They go to the site they're looking at and like try to find things that could be changed or that could stay, and if they have stakeholders, that they try to help them as much as they can."

Matched-pair excerpts were coded V/PI (value of serving the public interest) when players referred to particular norms of good urban planning practice. In this excerpt, for example, the player used norms of the urban planning practice to explain why State Street looks the way it does:

"…When they were building State Street…the urban planners were compromising between… trying to plan how the community and groups like that would want it planned..."

Excerpts from questions asked only in the post-interview were coded SO (stakeholders as obstacles) when players referred to the difficulties of responding to stakeholders' needs.

"It was definitely a hard feeling to like think that you've got to please, you want to please everyone, but you can't please everyone because it's just really hard… "

RESULTS

We present our results in two sections. First, we look at the knowledge, skills, and values of planning that players developed in Urban Science. Then we examine the role of stakeholders in this development.

Knowledge

Matched-pair questions from pre-interviews were coded for K/CS (knowledge of cities as systems) significantly more in post-interviews than in pre-interviews (mean pre = 0.17, mean post = 2.33; $p<0.05$, Figure 2).

Before the game, only two of the players could define ecology; seven could do so after the game. For example, before the game, one player defined ecology as planning or sculpting a place:

"Well okay, that's to do with something; the planning of something involving, I don't know…City scaping."

In the post-interview, the same player described ecology in terms of a complex system:

"Ecology, well my view of the…word has changed since yesterday to today…I guess it's the interconnectivity in a complex system. I mean I guess like if you change one thing, it's going to change another thing in some way, and everything is all related."

Skills

Matched-pair questions from pre-interviews were coded for S/PP (skills of the planning process) significantly more in post-interviews than in pre-interviews (mean pre = 0.58, mean post = 1.5; $p<0.05$, Figure 2).

When asked before the game what an urban planner does, one player said an urban planner "plans an urban environment." After the game, the same player said:

"Well first you need to talk to the general public to see what they want…Talk to your stakeholders who actually own the stuff, and begin to plan stuff, find your problems, work up compromises with your stakeholders, talk to the general public again about what you work out with your compromises…Have the general public vote on 4 or 5 plans. Whichever plan is used, you go back and debug it with your stakeholders again, and then you publish your plan, and then you start demolishing stuff that needs to be demolished and start building back up…Talk to our stakeholders, make a plan, talk to our stakeholders again, go back to the general group, go back and take one person from each group, and make a finalized plan."

In other words, after the game this player was able to talk about the specific skills planners use to make decisions.

Values

Matched-pair questions from pre-interviews were coded for V/PI (value of serving the public interest) significantly more in post-interviews than in pre-interviews (mean pre=0.92, mean post=1.9; $p<0.05$, Figure 2).

For example, during the pre-interview, when asked what planners need to know, one player focused his answer on the location of businesses, but not on the people involved in the process:

"I think they need to know what type of businesses…would be best for whatever spot…I don't know; to have like auto body shop like built right next to like a car part shop instead of way across town…"

In the post-interview, the same player recognized the importance of listening to and acting on the ideas of people involved in the planning process and explicitly talked about serving the public interest.

"…I think [planners] need to know how to be able to listen to everybody and incorporate everyone's ideas to the best of their abilities, and if they can't do that, then be able to justify like fairly."

Similar to previous work conducted in this area of research, in Urban Science players learned about systems thinking and real world processes. However, in Urban Science, players also engaged with the core planning value of serving the public interest and learned civic thinking as a result

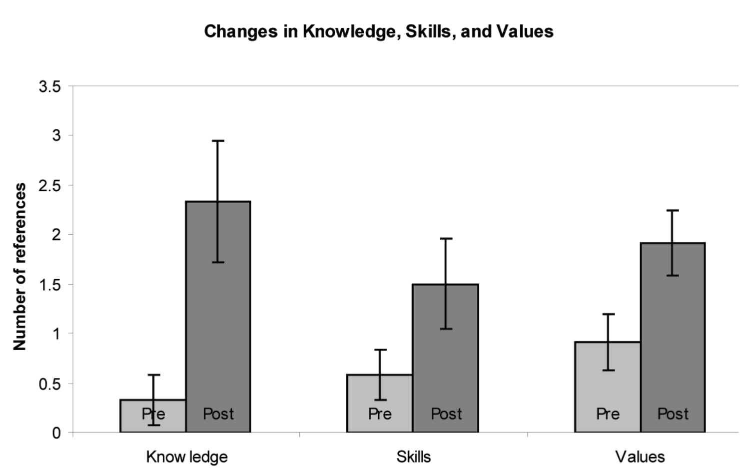
Game Features Contributing to Value Creation: Interacting with Stakeholders

In this section we look at the role of stakeholders in the development of planning values in Urban Science. First we examine data from the post-interviews on stakeholders as obstacles at two key points in the game. Then we describe the experiences of one player during the game, illustrating the role that tool and stakeholders played in the development of planning knowledge, skills, and values.

Stakeholders as Obstacles

During the post-interviews, 11 out of 12 responses from players were coded for SO (stakeholder as obstacle) when talking about feedback they received from virtual stakeholders in the preference survey. For example, one player discussed

Figure 4. Changes in knowledge, skills, and values for 12 Urban Science players



the challenge of meeting stakeholders' conflicting requests with a single plan:

"It's really hard to get the, what all the stakeholders wanted, and you, like whenever you put in a parking garage or a building, you also affected the things of some other thing, like if you put a parking garage in, the greenspace would go down and you wouldn't want the greenspace to go down…"

Similarly, 9 of 12 responses from players were coded SO when asked about their experiences making the final plan. For example, one player said:

"I thought [making the final plan] was sort of hard because we had to make everyone's like idea fit in, and that was sort of hard to have everyone like put their ideas together because some people had really wide like wants and stuff, so that was sort of hard…"

In other words, players saw pleasing stakeholders as a challenge in the planning process in the game.

Sara's Story

To see how planning values were developed through game play with virtual stakeholders, we now draw on data from the post-interview questions about the game to look at the experiences of one player, whom we will call Sara.

Like all of the players, Sara started the game by going on a site visit which she thought was "fun", and she thought that "practically everything was interesting." On the site visit, Sara encountered stakeholders as an obstacle when she heard from the virtual People for Greenspace stakeholder group and realized that the range of civic indicators that stakeholders would accept could be very narrow. The stakeholders, she said "helped me learn that it's hard to please everybody because some people have big ranges, some people have small ranges."

After hearing the People for Greenspace's desires, Sara encountered the tools as obstacle when she used iPlan to change zoning designations and create a preference survey and final plan. She said she learned "a lot" from using iPlan. Specifically, she said that she learned "how when you change something, a rate [indicator value] might go down or up in another one. They are all somehow connected…It was like crime was connected with trash, and trash was connected with housing, and it was all connected."

After creating a planning alternative, Sara submitted her preference survey to her stakeholder group for feedback. "It was good," she thought, "because then I started understanding a bit more like how to deal with it and how like what I should do because I didn't know exactly how we were supposed to balance it out, and once I got the feedback, I actually learned from it, like learned some of the things like how to balance it, and I also learned that it's really hard to please everyone. It's really, really hard."

After receiving the stakeholders' feedback, Sara worked with a new team to create a final plan that could meet the needs of all of the stakeholders. In the process of creating a final plan, both the tool and stakeholders became obstacles. Sara found trying to satisfy all of the stakeholders "kind of stressful because you would find out like you thought that you had it but then you would look onto the [preference survey] and say, oh my gosh, I forgot this person didn't want so much, so you would have to go back and change it all." Once Sara and her planning team were able to satisfy the stakeholders, it "felt good." Sara said: "It was fun trying to [satisfy them]…since it was so hard."

Sara and her team presented their final plan to a local planning expert. Sara told us that she "usually doesn't like standing in front of a lot of people, but [presenting] was fun, especially since I wasn't alone because I feel more excited when I'm alone and I have to be speaking every single thing."

Sara's experience presents a picture of how Urban Science proceeded for one player. While using iPlan to construct the preference survey and final plan, Sara struggled with the tool as an obstacle and learned about the interconnectedness of the urban system and the skill of enacting real world processes. When she received feedback on her preference survey and worked to create a comprehensive final plan, Sara encountered the stakeholders as an obstacle and learned that meeting the diverse needs of stakeholders is difficult—but also that trying to serve the public interest is satisfying and motivating.

DISCUSSION

Today, civic thinking and community participation are more important than ever. As Ehrlich (2000) argues, solving complex civic problems requires putting knowledge in the context of real world skills, and in the service of civic values, rather than merely recalling isolated facts or locating countries on a map.

The results presented here show that Urban Science gave players a chance to engage with exactly these kinds of complex civic problems. In Urban Science, players learned to think of cities as complex systems. They learned about skills that planners use to enact change in these systems. And perhaps most important, they learned the value of serving the public in that process.

Two aspects of game contributed to the development of players' civic thinking. First, as had been shown by Beckett and Shaffer (2005), players developed civic *knowledge and skills* through their work with the *tool-as-obstacle*. The geographic information system in the game modeled the complex relationships between land use decisions and important social and ecological tradeoffs in the city. The obstacles to action that the GIS model presented were thus concepts and processes urban planning professionals routinely use. As a result, as Shaffer (2006b) suggests, in overcoming these obstacles in pursuit of a meaningful goal—in this case, creating a comprehensive plan for civic redevelopment—players came to see the city as a complex system and understand how planners make changes in it.

In a similar way, the data here suggest that players developed the professional *value* of serving the public interest by working with *stakeholders-as-obstacle*. Though urban planners do not see stakeholders as obstacles, in this paper we referred to stakeholders-as-obstacle with the understanding that obstacles drive learning, and thus, help players learn to value the public interest. In the game, virtual stakeholders presented conflicting responses to proposed zoning changes that were difficult—and in many cases impossible—to resolve. The virtual stakeholders modeled the complex relationships between people and land use decisions in the city. The obstacles to action that the stakeholders presented were resolved only using a key value of urban planning: serving the public interest. As a result, in working with stakeholders in pursuit of a meaningful goal, players linked civic knowledge and skills with civic values. In other words, players learned to see stakeholders not as obstacles by encountering and overcoming them first as obstacles. Thus, seeing stakeholders as a problem helped players see them as part of the solution.

The results presented here have several limitations. First, this preliminary study only describes what a small number of students did while participating in 10 hours of the Urban Science epistemic game. As a result, this work provides insufficient grounds for making strong causal claims. Follow-up work is already underway, and we look forward to establishing more broad claims in future papers (Shaffer, et al., 2009).

Another clear limitation is in the profession of urban planning itself. As one planning scholar remarked, "Urban planning is a mile wide, inch deep profession. We know a little about a lot of things." (D. Marcoullier, personal communication, 2005) However, our goal in creating Urban Science was not to capture every aspect of the planning profession in exhaustive detail. Rather, we presented players with a specific view of the profession modeled on an ethnographic study of one planning practicum. Thus, this design represents only one way that planners approach and solve problems within their profession.

During this iteration of Urban Science, all of the planning consultants were game researchers with limited urban planning experience. The planning consultants were minimally trained and were in the same place as the players at all times. The planning consultant to player ratio (1:3 in this case) is not a ratio that can be duplicated in most traditional school settings. Follow-up work is currently testing remote mentoring using an internal chat program with a 1:12 mentor: player ratio (Chesler, et al., 2010).

Despite these limitations, however, the results here suggest several implications for the larger community of people interested in games and game development.

First, educational game designers might use these results to consider when and how including pro-social non-player-characters (NPCs) can develop pro-social values through game play. In the specific context of Urban Science, the NPC stakeholders provided pro-social obstacles that led to the development of professional values and civic thinking.

This success, in turn, suggests that further research needs to be done on the role of pro-social NPCs and the conditions under which they contribute to the development of players' values. Here we have explored one specific hypothesis: that NPCs modeled on real-world roles in professional training can recreate the effects of real-world training through game play. However, more work clearly remains in determining the impact (and limits) of that process.

Finally—and perhaps most directly, these results suggest that teachers may be able to use games that link knowledge and skills with values via professional obstacles to develop civic thinking. Games like Urban Science may help young people—and thus help all of us—identify and address the many civic, economic, and environmental challenges in an increasingly complex, and increasingly urban, world.

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